African Highlands Initiative

Integrated Natural Resource Management in Practice: Enabling Communities to Improve Mountain Livelihoods and Landscapes

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Edited by Tilahun Amede, Laura German, Sheila Rao, Chris Opondo and Ann Stroud

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AHI Proceedings

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The African Highlands Initiative (AHI) is an eco-regional program of the CGIAR and an ASARECA network aimed at promoting better livelihoods for farmers and sustainable use of the natural resources in the highlands of eastern Africa.

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It is with much gratitude that this book is dedicated to Dr. Ann Stroud for her many years of devoted service and engagement to address rural poverty in Africa through grassroots-led integrated natural resource management.

Integrated Natural Resource Management in Practice: Enabling Communities to Improve Mountain Livelihoods and Landscapes

Foreword

The residents of the eastern African highlands are challenged with small and fragmented landholdings, intensive soil and water loss, nutrient depletion, increasing loss of forest cover and associated environmental services, scarcity and inefficient use of water resources, declining ability of livestock to positively contribute to the maintenance of the system, and poor public services and infrastructure limiting access to credit and markets. The economic conditions and policy environment have not provided the necessary incentives to highland dwellers to make longer-term investments in better management of their resources, a situation that is exacerbated by limited credit and persistent low local wage rates. The situation is worsened by the increase in HIV and vulnerability. Since 1995, the African Highlands Initiative (AHI) has promoted an "integrated natural resource management" (INRM) approach where coordination of collaborative and participatory research and development efforts are integrated to: (i) improve agricultural production and natural resource management in highland watersheds, (ii) address the human and institutional factors affecting livelihoods and natural resource management, and (iii) enable more conducive development strategies and policies.

Over the past 8 years, AHI and partner organizations from Ethiopia, Kenya, Tanzania, Madagascar and Uganda have been rapidly evolving into new areas of research, development and institutional learning using participatory and integrated methods to raise agricultural productivity while improving environmental management. As lessons from these experiences are emerging, in-country site teams and their regional counterparts are synthesizing experiences from farm and watershed level approaches to improve natural resource management and agriculture productivity. This conference was organized to take stock of findings, challenges and lessons learned to date – but also to share experiences on "best practice", approaches and methods. The conference also represents a step toward building awareness and institutionalizing promising new approaches to agricultural research and development in eastern Africa.

These proceedings compile the experiences of AHI and its partners in addressing integrated livelihood-NRM challenges across eight diverse themes. These contributions display the challenges and opportunities in agricultural research for development, as well as select social, economical, biophysical, policy and institutional innovations that have been identified and tested at plot, farm, watershed and higher levels. It is hoped that it will also direct the reader towards new research frontiers and emerging opportunities. The AHI team is grateful to Dr. Ann Stroud, National Agricultural Research Institute partners and our donors, who have provided strategic leadership, support and guidance to the NRM agenda to address the perennial challenges of African highlands.

Chapter 1:

Historical Perspectives and Future Scenarios

A Historical Perspective of AHI

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Abstract

During the eighties, heads of NARS and the IARCs operating in the region expressed concern at the decline in productivity in the highlands of Eastern and Central Africa in spite of adequate rainfall and relatively heavy investment in research and extension. This situation was generally attributed to inability of the farmers to invest adequately on maintenance and improvement of land productivity, including control of soil erosion, crop pests and diseases. It was further observed that the opportunities offered by collaborative and systems research, were not being exploited. ICRAF was therefore requested to coordinate the development of an integrated natural resource management research programme for the highlands of Eastern and Central Africa. A consultative study was launched under the guidance of a joint Task Force comprising of representatives of NARS, IARCs and interested donor agencies. The result of this exercise was "A Conceptual Framework" which formed the basis for the launching of the African Highlands Initiative (AHI) and its subsequent adoption as the first regional programme under the auspices of the newly established ASARECA. The AHI has become a model of tenacious effort to establish a new method of adding value to commodity and disciplinary research and enlisting the participation of stakeholders to find sustainable solutions to problems of natural resource management and improvement in land productivity. Progress is being made, but evolution of more effective and efficient methods and mechanisms for integrated approach to management of natural resources at farm and watershed levels remains the biggest challenge to the AHI.

Introduction

The highlands of East and Central Africa comprise 23% of the total land mass, but accommodate and provide livelihood to over 50% of the population. The highlands are also the main source of export crops and food for one third of the population who live in urban systems. The highland ecosystems also provide timber, fuel wood and are the source of rivers that support life and industrial activities in the lowlands.

One of the major problems affecting land productivity in the highlands has been land degradation. As population pressure has built up, demand for fuel wood and building materials and land for cultivation has resulted in decimation of forest cover and bio-diversity. Intensive cultivation of steep slopes without adequate soil conservation measures has resulted in soil impoverishment through soil erosion and, in some cases, total loss of agricultural land due to gully formation. Land tenure systems, inappropriate extension approaches, and diminishing farm incomes have further discouraged investment in soil conservation, while intensification of cultivation has increased incidences of crop pests and diseases. The spiral of land degradation, reduced productivity, reduced farm incomes, and mining of the land resources has reduced the once prosperous highland communities to poverty and food insecurity.

THE ORIGIN OF AHI

The situation described in the forgoing section became particularly noticeable during the eighties as the region, unlike the countries of SE Asia, appeared unable to translate the considerable investment in research into commensurate improvement in agricultural productivity and farming output. It was especially observed that although substantial increases in the yield potential of major food crops had been achieved, yields at farm level had stagnated and in many cases declined. On the other hand, farmers who had access to and could invest in improved technologies (improved crop varieties, good quality seed, pest management, timely planting, and improved soil fertility) could achieve high yields and farm incomes.

Thus considering, the concern expressed by heads of NARS and IARCs that not enough attention was being devoted to research on natural resource management; and overlap and duplication of activities conducted by the IARCs, especially in training courses, information and documentation services and network steering committees, the subcommittee of Directors General of IARCs on sub-saharan Africa requested ICRAF in October 1991 to coordinate the development of an integrated resource management research programme for the highlands of East and Central Africa.

ICRAF responded by preparing a brief concept paper which was discussed informally by IARC representatives in the region. This was followed in June 1992 by a meeting of directors of NARS of Burundi, Ethiopia, Kenya, Rwanda, Tanzania, Uganda and the Democratic Republic of Congo (then known as Zaire). The meeting endorsed the concept and agreed to form a task force to be chaired by ICRAF

- to develop a regional programme on the management of natural resources in the region; and
- to ensure cooperation among NARS, IARCs and regional programmes and the integration of the NRM research activities.

In order to facilitate planning for such a programme, the task force commissioned a team of two consultants to study and report on the status of natural resource and related research in the region, to identify the main gaps, and to propose a suitable regional programme to address them. The team of consultants spent 40 days visiting and interacting with research and other relevant institutions in all countries of the region. A further 20 days was spent studying the documents collected, analyzing the findings and preparing a report.

FINDINGS AND PROPOSALS BY THE CONSULTANTS

The consultant report (Loevinsohn and Wangati 1993) identified ten major constraints to effective NRM research viz:

1. research priorities were developed with little or no input from small scale farmers;
2. farmers with small pieces of land could not in general absorb production losses for the periods required for soil conservation and agro-forestry techniques to yield benefits
3. farmers were unable to meet the initial cost of acquiring new technologies
4. farmers could not access facilities for implementation of new technologies
5. in some cases, research results had not been updated to meet priority problems and needs at farm level
6. packages of technological recommendations may not have included provisions for maintenance of the natural resource base
7. although farm conditions were diverse, recommendations from research were based on broad optimum varieties and practices
8. extension systems were largely ineffective
9. soil conservation programmes failed to integrate physical and biological techniques thus limiting acceptance by farmers
10. little effort was made to understand and document the basis for decision making at farm level.

It was further suggested that the key challenges for a regional NRM initiative would be:

- to generate and evaluate the diverse technical options that are needed to match highland farmers' diverse physical and social conditions
- to broaden the focus of off-farm research to encompass processes that occur over a longer term and on broader scale.

The consultants also found that the definition of highland ecosystem in terms of the problems identified could vary from country to country. Several methods were also being used in the region to delineate the highland ecosystem depending on purpose. It was therefore recommended that for the purposes of the proposed initiative, a combination of 1000mm rainfall and 1000 metres altitude could be used. National programmes should however be allowed to adjust these boundaries on the basis of land use, population density and practical considerations.

Six themes were proposed for NRM research under the AHI:

a) Improving the diagnosis of resource management issues
b) Maintenance of soil productivity
c) Improved management systems for highland valleys
d) Increasing the diversity of varieties on offer to fit farmers' conditions
e) Pest management strategies from an agro-ecological perspective
f) Research on natural resource policies

It was also proposed that the initiative be governed by a multipartite Steering Committee.

Consultation with Stakeholders

After intensive discussions within the Task Force, the consultants' report was presented to stakeholders at a consultative workshop in Entebbe, Uganda in1993. The Workshop endorsed the proposals for the initiative and made recommendations on priority agenda (Wangati and Kebaara 1993). Three categories of research themes were agreed on:

Category 1 – Agenda setting themes
- Diagnosis
- Policy research and structure of social dynamics

Category 2 – Land use/land type themes
- Maintenance of soil productivity under population pressure
- Valley bottoms
- Wood lots, plantations and natural forests

The issue of land reclamation/ rehabilitation was not considered of high priority for research under the initiative.

Category 3 – Cross-cutting themes
- Soil/crop management strategies to alleviate pests encouraged by intensified cropping
- Conservation of crop genetic diversity

Three levels of programme management were also recommended:
- Regional Steering Committee comprising Directors of NARS, IARCs and other participating institutions
- Technical Committees and project leaders for each project
- Team Leaders for each sub-project (envisaged as a selected NARS research station)

CONCLUSION OF THE INITIAL PLANNING PHASE FOR THE AHI

The recommendations of the consultative workshop were distilled further by the Task Force and summarized in form of a conceptual framework (Wangati 1994). The final proposal outlined the overall goal, focus, research agenda and implementation as follows:

The overall goal: To improve and enhance land productivity and its sustainability within the intensive land use systems of the highlands of East and Central Africa by working with farmers to evolve policy and technologies that increase agricultural production while maintaining the quality of the natural resource base.

Focus: Problems of enhancing sustainable land productivity in the intensive land use systems

Research themes

- Maintenance and Improvement of Soil Productivity (MISP)
- NRM Strategies for effective and sustainable plant protection

a) *Supporting themes*

- Diagnostic and socio-economic studies
- Training
- Information and documentation services

b) *Management structure*

- National teams based at zonal stations
- Technical Advisory Panel (TAP) for each theme
- Governance provided by Task Force and a Coordinating Unit reporting regularly to the Committee of Directors

c) *Phasing of activities*

The first phase would constitute the establishment phase during which

- results of past research on soil and water management would be synthesized with a view to identify knowledge gaps
- research activities would be initiated to fill the gaps identified using existing regional research networks
- methodologies for participatory diagnostic studies on NRM in existing land use systems would be developed and refined
- understanding of the highland ecosystems and their potential would be improved
- mechanisms for utilizing facilities available in the region to strengthen NARS research capacity through training courses would be developed.

Since the methodologies and approaches recommended had not been tested, there was no experience to go by and the new ideas were to be tried out as an initiative rather than a project. The African Highlands Initiative was therefore born and launched in 1995. ICRAF offered to provide the initial facilities for coordination and sourcing of financial support – a good gesture that was to bring problems later as the AHI became increasingly but erroneously considered an ICRAF project.

The scope of AHI was restricted to maintenance and improvement of productivity of the intensively cultivated agricultural lands above 1400 metres above sea level where rainfall is generally over 1000mm and not a major obstacle to agricultural production. Although most crop improvement programmes include some elements of natural resource management, it was considered that AHI would add value to these activities by developing methodologies for a more integrated approach at farm level.

Phase 1 of AHI

The first phase of AHI (1995 – 1997) therefore focused on sensitization of the relevant programmes, projects and institutions on the need to establish coordination mechanisms, selection of benchmark sites, and recruitment of research teams for each site and characterization and diagnosis (C&D) to determine the most important technological requirements for each site. The AHI was coordinated by ICRAF staff on part time basis with the assistance of Regional Research Fellows posted to provide technical guidance to each site team. Participating researchers were NARI and IARC scientists allocated to the AHI activities as part of their regular duties. Apart from coordination expenses, only a few small grants were issued to support NARI scientists engaged in relevant IPM and soil productivity research. As expected, multi-disciplinary projects were a new mode of research and a lot of effort was spent during this phase in popularizing the AHI among scientists used to deriving professional recognition from achievements within narrow scientific disciplines.

Phase II of AHI

The second phase of AHI (1998-2000) saw the formation of a Technical Support Group (TSG) as a mechanism for integrating inputs from site teams, Research Fellows and the IARCs .The number and disciplinary diversity of RRFs was increased, and the small grants were replaced with larger projects designed to enable multi-disciplinary and multi-institutional teams to work more holistically. An internal Planning, Monitoring and Evaluation (PM&E) framework outlining specific goal, purpose, outputs and strategy for implementation was also developed.

An external review of AHI was carried out in 2000. A number of recommendations were made including:

- improvement of commitment by research managers, communication and documentation;
- focusing and phasing of activities to concentrate on process and partnerships;
- specialization of benchmark sites to focus on research and dissemination;
- structural changes to reduce transaction costs;
- use of zonation for the purposes of dissemination and marketing of products;
- better incorporation of socio-economics; and
- increased participation of farmers.

Phase III of AHI (2001 – 2004)

With experience gained through concentrated effort at benchmark sites, and the greater confidence evident among participating institutions, farmers and other stakeholders, the AHI entered the third phase with scaling up of scope to integrated natural resource management at watershed level. A re-definition of integration to include:

- integration across disciplines,
- scale of activities,
- technologies and perspectives, and
- management to include decision making as a foundation for selection and application of technologies to suit specific socio-economic and resource base situations, is expected to help in priority setting and improved focus of AHI activities.

Conclusions

The AHI was introduced as a platform for integration of natural resource management technologies within farming systems research. This was to be accomplished within a deeply entrenched culture of fragmentary (disciplinary) approach to solution of agricultural problems. It is therefore not surprising that the introduction of AHI evoked mixed feelings and even some cynicism among researchers and research managers during the early stages of implementation. The fact that the participating institutions were expected to allocate some of their limited resources without compensation did not help. The unwavering support by the ASARECA CD and several donors has however given AHI a chance to prove its worth. Notable achievements have been made, but a number of issues still need to be addressed as AHI enters its second decade and up-scaling of its scope and objectives.

The first major issue is the impact of AHI on the structure and organization of NRM research programmes and the acquisition of skills to operate them. Whereas there is little doubt that the complexity of small holder agriculture requires holistic approach, services to farmers are still highly fragmented at policy, technical and technology transfer levels. Training and reward systems for scientists and technicians are also still highly structured along disciplinary specialization. It is therefore hoped that as AHI progresses, it will encourage and develop capacity to accommodate post graduate students and provide training materials in form of case studies of results and experiences from integrated research and development projects.

The second issue concerns scope of AHI. As the initiative expands from farm to watershed levels, the number and type of partners will increase. Coordination of the initiative will therefore become more complicated and transaction costs are bound to increase. It will therefore be necessary to develop audit procedures that can be used to determine realistic trade-off points between intensity and scope of research at AHI sites.

The third issue concerns the ultimate responsibility for INRM research. Whereas AHI can demonstrate the benefits and feasibility of participatory INRM research and the benefits of regional collaboration, real impact of such an approach can only be achieved through sustained long term activities covering a large number of representative sites (communities). The methodologies and institutional partnerships developed through AHI will hopefully help to eventually transfer the responsibility of continuing AHI activities to the NARS. The now popular strategic planning exercises should provide valuable opportunities to inject this agenda within NARIs and their collaborating partner institutions.

References

Loevinsohn, M. and F. Wangati, 1993. Integrated Natural Resource Management Research for the Highlands of East and Central Africa - Proposals for a regional Initiative. Report to Joint IARC/NARS Steering Committee. ICRAF, Nairobi

Wangati, F. and K. Kebaara, 1993. Integrated Natural Resource Management Research for the Highlands of East and Central Africa. Report of the Consultative Workshop, 6-8 Jan 1993 Entebbe, Uganda. ICRAF, Nairobi.

Wangati, F. 1994. Integrated Natural Resource Management Research for the Highlands of East and Central Africa: The African Highlands Initiative: A Conceptual Framework. ICRAF, Nairobi

Integrated Natural Resources Management and Genetic Diversity: Two Sides of the Coin for Sustainable Livelihoods and Development

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Abstract

Integrated natural resources management is a simple thing to say, but not necessarily an easy thing to study or develop. By its very definition and name, INRM involves the integrated analysis and management of the components of production, in such a way that one is able to achieve the products required by man for survival, while maintaining environmental balance and sustainability. INRM operates on the principle that natural resources are neither indestructible nor infinite; they can be destroyed or depleted through agriculture and other land use practices. They require to be managed in a holistic and integrated manner, accounting for the complexity of the ecosystem and the inter-relations amongst its various components. This paper emphasizes the point that simplistic, reductionist or commodity-driven approaches to agricultural research or systems, simply would not work. This realization gives rise to recent emphasis on and promotion of the integrated natural resource management paradigm. One of the principal components of natural resources within agricultural systems is the biodiversity that is available within agriculture. Agricultural biodiversity, comprises all the elements, from genes to agricultural ecosystems, that are used in food production. The importance of maintaining this diversity and the balance among its various components lies in the benefits that accrue to users in terms of agricultural productivity, food security, socioeconomic and nutritional value and environmental sustainability. Oftentimes agricultural biodiversity is treated as a separate issue from the rest of natural resources. This paper analyzes and presents the viewpoint that natural resources management and agricultural biodiversity are indeed two sides of the same coin. Effective agricultural and NRM capital can be made only if we are able to develop these components together, and channel their synergies and influences towards the production of products and ecosystem services that are required for food security and environmental health. The paper advocates for a stronger integration between agricultural biodiversity, soil and water conservation, and other components of natural resources. In all this, the contribution to well being and sustainable livelihoods of people and communities needs to be paramount.

Introduction

The world in which man lives contains a number of resources. These resources make it possible for man to exist on the planet earth and reproduce after its own kind, and produce goods and services to meet its needs. Man did not create these resources; we met them here, existing “in nature”. Consequently, these resources have come to be known as “natural resources”, simply because they occur naturally. These resources include the geophysical resources of water, soil and its productive qualities, intermediate and long-term carbon stocks, biodiversity of the managed landscapes, and the stability and resilience of the ecosystem of which agriculture is a part (CGIAR, 2003). In the early ages, when human populations were low, there were more than enough of these resources for each person; there was no shortage and presumably therefore, no conflicts over these resources. Consequently, an erroneous impression was created that these resources were infinite, indestructible and permanent, no matter how they were used or managed. That impression is now known to be obviously false. Even more worrisome is the realization that that these resources can be completely destroyed, while some elements of resources are prone to extinction.

In response to this, there has been growing emphasis on the need to conserve and sustainably manage our natural resources. The concept of natural resources management (NRM) recognizes the need for a more conscious effort towards judicious and sustainable management of natural resources. It also recognizes that natural resources are inter-related to one another within a defined ecological system, and therefore need to be managed in an integrated fashion. This has given rise to the concept of Integrated Natural Resources Management (INRM), which drives home the need to take a holistic integrated approach in dealing with natural resources, and to be conscious of the interactions among the different components of the resource base.

Within any given ecosystem, stocks of natural resources (sometimes referred to as natural capital) exist and yield useful flows of services and amenities at different spatial and temporal scales. Consequently, the management of natural capital has impacts on a range of stakeholders, from farmers to communities, to international concerns. Examples of flows of services and amenities (i.e. ecological functions useful to mankind) associated with stocks of natural capital include nutrient cycling, water cycling and carbon sequestration. All these are elements that need to be addressed in the context of INRM.

Integrated Natural Resources Management

According to a definition of the INRM Task Force of the Consultative Group of International Agricultural Research (CGIAR), INRM is "an approach that integrates research on different types of natural resources, into stakeholder-driven processes of adaptive management and innovation, to improve livelihoods, agroecosystem resilience, agricultural productivity and environmental services, at community, eco-regional and global scales of intervention and impact" (Task Force on INRM, 2001).

Before getting any deeper into what this means, and what INRM involves, it is prudent to look into what INRM is not. INRM is not a uni-disciplinary approach to research or development. It is not a commodity-driven process or program, nor is it intended to be a dogma. INRM is also not represented necessary by the individual components and sub-components of systems that might contribute to it. Thus it should not be seen as just another name for approaches such as farming systems, soil fertility replenishment, biodiversity conservation and use, integrated pest and disease management, or even of participatory and action research processes. All these research systems may indeed involve elements of INRM, but they do not in themselves, constitute INRM. The point here is that one could be involved in any one of these resource management systems, but doing it a manner that is INRM-unfriendly. So what then does INRM involve?

At the heart of INRM practice, is not the environment or the natural resources *per se*. These resources are indeed the principal elements within the environment, and they are the basic capital within INRM. However, at the heart of INRM, are 'People' - their needs, their livelihoods and their rights, and how these needs interact with management of the natural resources (see Figure 1). This view is in line with the thinking of the CGIAR INRM task Force, which also stresses human well-being at the center of INRM, and places emphasis on the ecosystem and production system functions at the same level (CGIAR, 2003). INRM accepts the notion that natural resources exist not just to stabilize or beautify the environment; they were created to be used to meet the needs of man. Any management strategy on natural resources that limits itself to the conservation or protection of natural resources without considerations given to the use of the resources by people, and how it influences livelihoods is not likely to be sustainable.

Two points are worth making at this juncture. The first is that the use of the resources must be within the framework of sustainability. It is the responsibility of man to ensure that the way the resources are used today does not compromise their availability for tomorrow; this is a paradox. Man needs to use the resources in a way that enhances livelihoods of people today, and ensures that the resources remain to be used tomorrow, not just by the present generation but also by subsequent generations. Sustainability in this context involves successful management of resources for agriculture to satisfy changing human needs, while maintaining or enhancing the quality of the environment, and conserving natural resources (TAC, 1988). What mechanisms are available to ensure that natural resources are being used sustainably, and not destructively? That is a primary question for research.

The second point to be made, is that people (especially communities living around a particular natural resource domain, e.g. forest) need to be involved in the management and conservation of the natural resource. An example of this, which involved empowering forest dwellers in the sustainable management of forests in

Borneo, yielded positive outcomes (Campbell et al. 2003). Communities need to be involved in the development of policies and regulations for ensuring sustainable use of the resources. They must feel a sense of ownership and responsibility in the management of the resource, and in the benefits that accrue from its use. Whatever management and control system is put in place is likely to face barriers in implementation, if it ignores the community role and benefit-sharing mechanisms. Oftentimes this creates conflict situations in the management of natural resources. This also is a challenge for research.

The key elements of INRM and the complexity of interactions within it are illustrated below, in Figure 1. The figure shows the key elements as biodiversity, soil and water, with people at the centre. Within the component of biodiversity are plants, animals and micro-organisms (e.g. soil microbes). The soil biodiversity component also needs to be analyzed in relation to soil structure, fertility, and other factors. A central dimension in INRM is the way in which the natural resources interact within and among themselves, and how their management and interaction relates to people and livelihoods.

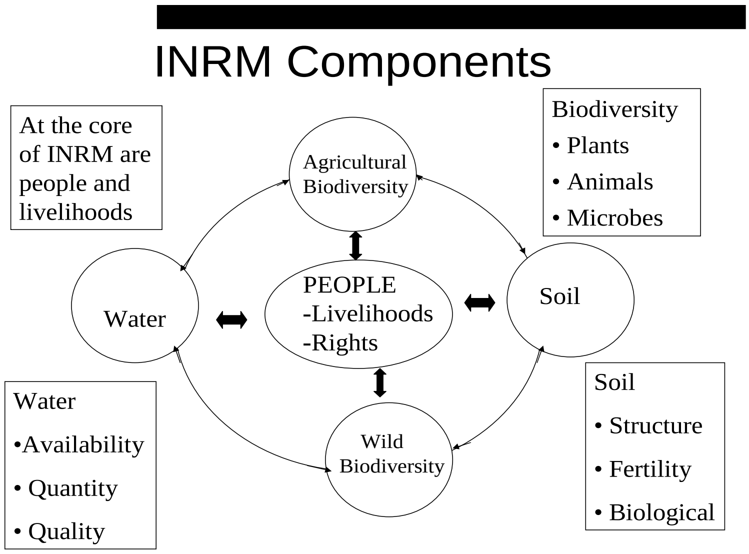

Figure 1: Components and interactions in INRM

BIODIVERSITY WITHIN INRM

Biodiversity can be represented as having two broad dimensions: wild biodiversity, and agricultural biodiversity (see Figure 1). The former represents the biodiversity that is present in natural, uncultivated ecosystems (e.g. forests), while the later involves biodiversity that is used within agriculture. This indeed is a very simplistic division; there is a lot of interaction across the two domains. It needs also to be stressed that biodiversity exists and operates at three different levels. Intra-specific diversity refers to the diversity at genetic level within species; inter-specific diversity refers to the diversity between or among species; while diversity can be assessed on ecosystem basis, as the diversity of different ecosystems. All these three levels are important, and all are prone to genetic erosion.

Biodiversity, in its broadest dimension is considered as one of the top five priority sectors in ecosystem management. In a ground breaking speech at the World Summit on Sustainable Development (http://www.un.org/events/wssd/) in May 2002, UN Secretary General Kofi Annan, set out proposed priorities for ecosystem management within the innovative framework of "WEHAB", representing Water, Energy, Health, Agriculture and Biodiversity. The key essence in the WEHAB concept does not lie just in the individual components identified, but rather in the integration and interactions across and among the various components, as illustrated in Figure 2, below. The WEHAB concept is considered to be of great significance for the UN strategy on the Millennium Development Goals (MDGs) (http://www.un.org/millenniumgoals/), which aim among other things to eradicate extreme hunger and poverty, reduce child mortality, improve maternal health, and ensure environmental sustainability, all planned with specific goals and timelines leading to the year 2015.

All five priorities, including biodiversity, mentioned in the WEHAB concept, are essential for achieving the MDGs. The emphasis in this paper is however on agricultural biodiversity, which may be simply defined as biodiversity or life forms within agricultural ecosystems.

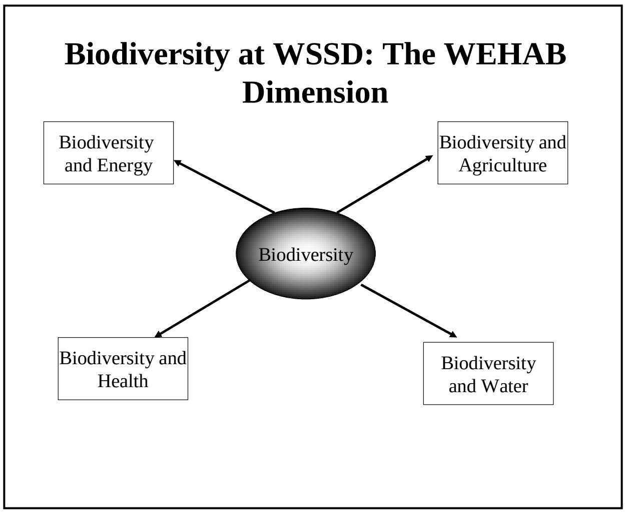

Figure 2: The WEHAB model

The paper intends to show the importance of agricultural biodiversity to agricultural development, and also to make the case that agricultural biodiversity is part and parcel of Integrated Naturan Resources Management.

AGRICULTURAL BIODIVERSITY

According to the Convention on Biological Diversity (CBD), agricultural biodiversity comprises those elements at all levels of the biological hierarchy, from genes to ecosystems, involved in agriculture and food production. Thus, it includes all trees, fish and livestock, and all interacting species of pollinators, symbionts, pests, parasites, predators and competitors (www.biodiv.org/welcome.aspx) (see also Qualset et al., 1995). The diversity present in any agricultural production system depends on the biological characteristics of the species and their interactions, the effects of the physical environment and the ways in which people manage the system. In particular, the degree of intensification of agricultural management, including the substitution of biological functions by manufactured inputs, has a dramatic impact on system diversity. Specific examples include the use of pesticides for pest control or the use of inorganic fertilizers to supplement nutrient cycles. These changes result not only from the direct actions of farmers and communities in rural areas, but also from the influences of local and national governments, private agricultural industries, consumer demands and international policies. Thus agricultural biodiversity, and biodiversity generally, can suffer through human-induced actions. Agricultural practices therefore can influence not only the biodiversity within agriculture, but also can have effects on wild biodiversity, especially those in the peripheries of agricultural ecosystems.

In discussing biodiversity in relation to agriculture we can identify three broad domains within global biodiversity; 1) biodiversity that is unaffected by agriculture, 2) biodiversity that is affected by agriculture but has no implications for sustainability of agriculture systems, and 3) **agrobiodiversity**, which is biodiversity that is affected by agriculture and other factors, which has impact for long-term sustainability of agriculture.

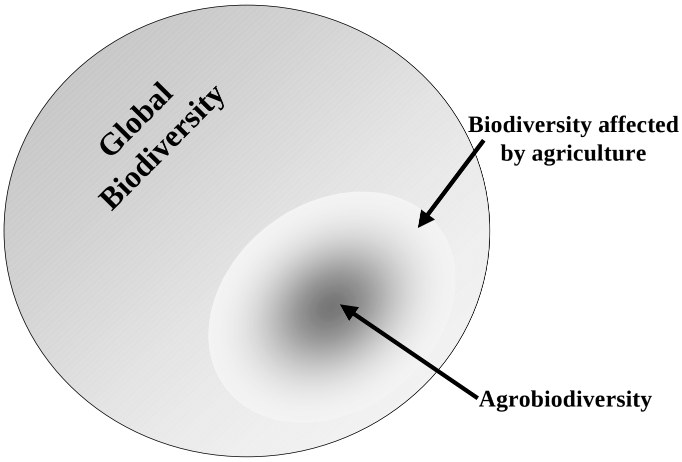

Figure 3: Biodiversity domains in relation to agriculture
(source: John Gibson, personal communication)

These divisions are illustrated schematically, above (Figure 3). An important point is that, as indicated by the graded boundaries in the schematic above, the boundaries between the three broad domains of biodiversity are not clear cut. For example, there are many species that are affected by agriculture that have unknown potential effects on sustainability of agriculture systems and thus it is unclear if they fall into domains 2 or 3. Nevertheless, the above framework form is useful and could be used to identify the interactions between agriculture and biodiversity (John Gibson, *pers. Comm.*)

The importance of the different components of agricultural biodiversity, and the contribution they make, to sustainable production, livelihoods and ecosystem health are now widely appreciated. Thus, crop and tree diversity (within and between crop variation) can be used by farmers for risk avoidance, increased food security and income generation, as well as to optimize land use and help adapt to changing conditions (Brush,1995).

The importance of the different components of agricultural biodiversity, and the contribution they make, to sustainable production, livelihoods and ecosystem health are now widely appreciated. Thus, crop and tree diversity (within and between crop variation) can be used by farmers for risk avoidance, increased food security and income generation, as well as to optimize land use and help adapt to changing conditions (Brush, 1995). Livestock and fish diversity has been shown to have the same functions and to provide the same benefits in many farming and aquatic systems. Soil organisms contribute a wide range of essential services to the sustainable function of agro-ecosystems through their actions in nutrient cycling, their regulation of the dynamics of soil carbon sequestration and greenhouse gas emission, their effect on soil physical structure and water regimes, and influence on plant life (e.g. nitrogen fixation and the interactions in the soil of pests, predators and other organisms) (Swift et al, 93). Pollinators are essential for seed and fruit production and their number and diversity can profoundly affect crop production levels. However, knowledge is still limited on the interactions and synergies among these different systems (crop, livestock, and aquatic) and their associated biodiversity (e.g., soil organisms, pollinators) that sustain the functions and productive capacity of the agroecosystems for sustainable agricultural and human well-being.

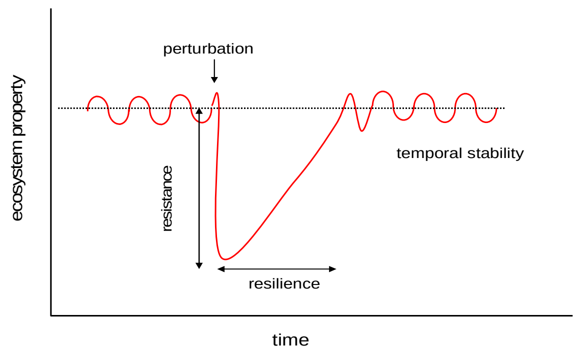

Figure X: Components of Stability

Source: Thomas

Figure 4: Resilience and resistance as elements of stability in agroecosystems

The diversity of plant and animal species maintained in traditional farming systems over many centuries and the knowledge associated with managing these resources constitutes key assets of the rural poor. The management and use of these assets, and the practices that maintain pollinators and associated below ground diversity, provide the natural capital of their livelihood strategies. In marginal and difficult farming conditions these materials are especially important. In these circumstances, diversity management can become a central part of the livelihood management strategies of farmers (particularly pastoralists) and communities in stress-prone production areas.

Historically, a substantial decline in biodiversity in agroecosystems has been observed with agricultural intensification and development, and these trends continue. The consequences of such a decline for small-scale farmers in developing countries can be devastating. These consequences amount to a substantial decrease in the **resistance** and **resilience** within farmers' agroecosystems and a consequent increase in farmers' vulnerability. This therefore negatively affects the **stability** of the farmers' production base and of the agro-ecosystems within which they operate. Resilience is 'the capacity to absorb shocks while maintaining function. When change occurs, resilience provides the components for renewal and reorganization '(Folke et al, 2002). The resistance within a system is a measure of its ability to counter perturbation and disturbance. In a system that has lost its resilience, adaptation to change is not possible and therefore, all change is potentially disastrous. Inability to cope with risks, stresses and shocks, be they economic or environmental, or vulnerability, undermines small-scale farmers' livelihoods substantially. These two concepts, resilience and resistance, are of fundamental significance to biodiversity, and agricultural biodiversity, in particular, and are illustrated in Figure 4. The loss of agricultural biodiversity potentially puts the agroecosystem at risk.

VALUING BIODIVERSITY

Biodiversity carries additional values because of its role in providing further ecosystem services. These services are conventionally not given any value, and are often regarded as 'free' resources. Such ecosystem functions, such as nutrient cycles and water regimes, biological control of diseases and pests and the regulation of greenhouse gases are exploited by humans for their benefit. Costanza et al (1997) costed these 'ecosystem services' and estimated a value in excess of that of the total of global manufactured goods. These services, which are biologically controlled, can also be sustained in biodiverse agricultural systems. The biodiversity maintained by farmers is not therefore only of benefit to them but also to society as a whole, because of its role in maintaining ecosystem services such as erosion or disease control. It can therefore be asserted that the benefits for farmers of retaining biodiversity will only be fully realized and rewarded when other sectors of society accept and pay full value for them.

Over the last ten years the importance of maintaining agricultural biodiversity has been increasingly recognized by international agencies and in international agreements. In decision V/5, 2000, the Conference of the Parties to the Convention on Biological Diversity (CBD) adopted a programme of work on agricultural biodiversity by both the CBD and GEF. In 2002 at the sixth, and most recent, Conference of the Parties, work on agricultural biodiversity was reviewed and further action was called for on increasing our understanding of the functions of biodiversity in agro-ecosystems and on promoting methods of sustainable agriculture that maintain appropriate levels of biodiversity. The Conference of the Parties also adopted the Global Plant Strategy, which includes specific targets on sustainable production. FAO and its Commission on GRFA oversee the Global Plan of Action (GPA) on Plant Genetic Resources for Food and Agriculture (PGRFA) and the Global Strategy for Farm Animal Genetic Resources, which emphasize the sustainable management and use of crop and livestock diversity. The International Treaty on PGRFA, adopted at the FAO Conference in November 2001, and which came into force in June 2004, provides the policy framework for conservation and sustainable use of PGRFA, *ex situ* and *in situ*/on-farm.

Improving knowledge and understanding

To be able to conserve agricultural biodiversity effectively, and use it to enhance agriculture and natural resources management, all the available information on all its components and associated interactions must be understood, collated and used. Information is needed on the extent and distribution of species and populations at local, national and regional levels so as to provide an integrated picture of agricultural biodiversity in order to plan sustainable futures. A fuller, more coherent and more rigorous understanding must be developed, not only of the available agricultural biodiversity, but also of the **relationships** and **synergies** among different components (crop, livestock, fish, and associated biodiversity), agricultural production, agroecosystem health and the provision of ecosystem services (e.g., Costanza *et al*, 1997; Loreau *et al*, 2001). The focus will need to be on understanding the interactions between different components of the production systems studied.

THE INRM RESEARCH APPROACH

As a research approach, INRM combines a flexible set of integrative frameworks, methods and tools aimed at capturing synergies among specialized research areas, each of which deals with a natural resource on its own. It aims to optimize sustainable benefits in natural resources, and augment social, physical, human, natural and financial capital towards livelihoods and environmental health.

Figure 5 presents a generic framework for integrating science within INRM. The framework is a product of the CGIAR Task Force meetings on INRM (CGIAR, 2003; Thomas 2002). INRM incorporates and builds upon participation of all stakeholders (research disciplines, policy makers / decision makers, community members and leadership, development actors: Government Agricultural Extension Agencies, Non-Governmental Organizations, and Community-based Organizations (CBOs). It involves interventions and relationships across different scales and levels of decision making, and requires application of participatory methods and processes. It focuses on human well-being in the many dimensions affected by the management of natural resources. This is meant to include both economic production as well as environmental services.

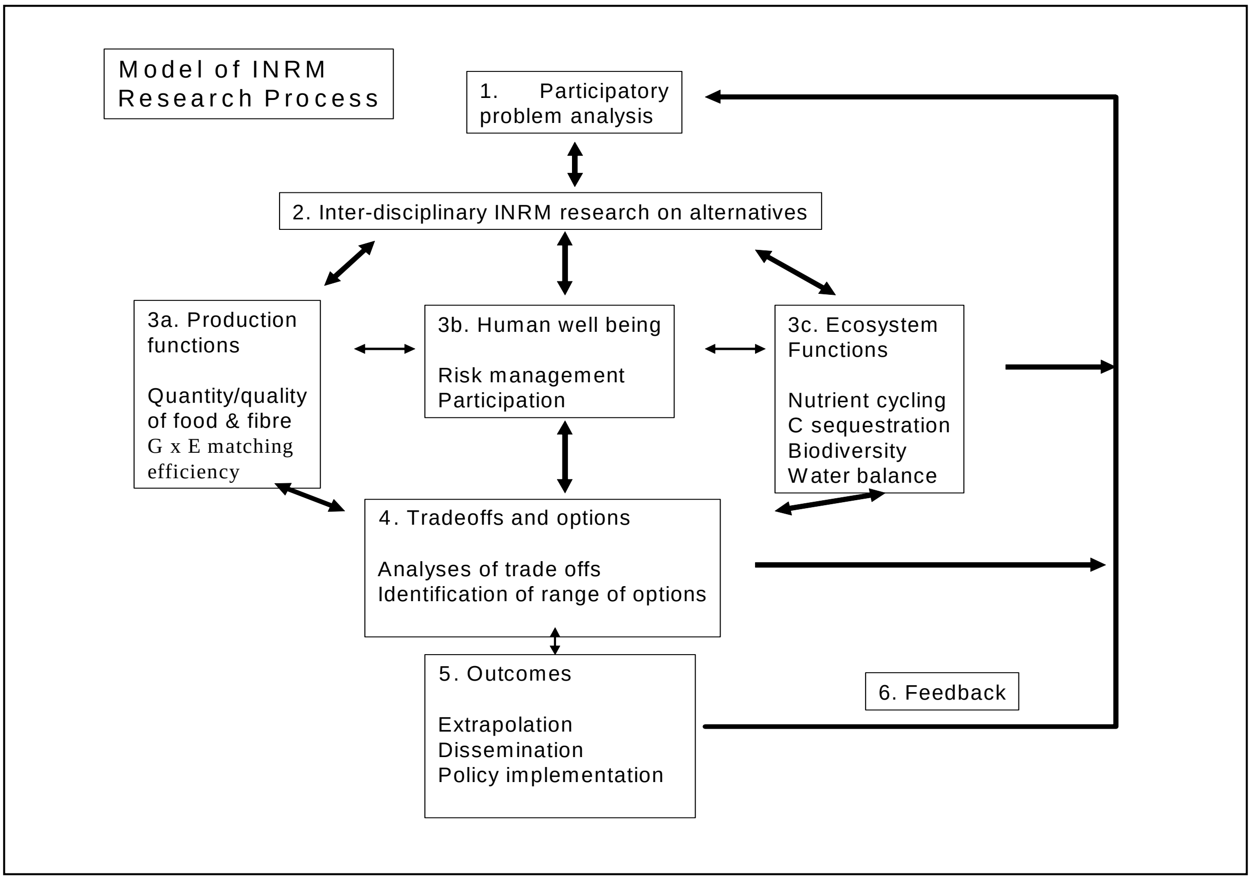

Figure 5: Model of INRM Research Practice

According to an analysis provided by the CGIAR (CGIAR, 2003) the INRM research process has the following characteristics:

- Focuses on key causal elements
- Integrates levels of analyses
- Merges disciplinary perspectives
- Generates policy, technological and institutional alternatives, and
- Focuses on increasing the adaptive capacity of stakeholders to increase the resilience of the agroecosystem.

Among the key components of the INRM research approach is the assessment of trade-offs (e.g. between the management options that enhance the food and income functions of systems, and those options which enhance the other ecosystem functions of systems). At the heart of these trade-offs, is the fact that the use and management of natural capital generates a number of positive and negative externalities. These are effects, which are not priced by the market mechanism and which impinge (to varying degrees) on the welfare of different stakeholders. These externalities therefore, create discrepancies between private and social costs and benefits.

INRM research, therefore, is about studying these natural capital interactions and flows, and about studying the trade-offs that arise from the different management options, across different spatial and temporal scales. Figure 2 gives a schematic model of research domains and process in INRM. Some of the principal research domains are:

- Analysis of production function within a particular ecological system
- Analysis of the interactions on human well-being and participation
- Ecosystem functions

AGRICULTURAL BIODIVERSITY RESEARCH AS COMPONENT OF INRM

Research on genetic resources has components on-farm, in research stations, at gene banks, at the markets, with the private sector, and with society and community at large (Figure 6). The core of this research is the understanding of what diversity is out there on farm, who manages it, how and why, and research aimed at linking this diversity with other elements of research aimed at raising the utilization and value of the resources. Such research will therefore be multi-dimensional, multi-disciplinary and multi-institutional. Some of the components of this research will be:

- Understanding and managing genetic diversity on farm / in situ
- The link between gene banks and community-based management of diversity on farm
- Research aimed at increasing the productivity of the farmers' landraces
- Raising the economic value of genetic resources
- Policy and legislation aspects of genetic resources, at community and national levels.

It is the integration of these research elements along with elements of soil and water management, and the socio-cultural and economic considerations of the communities that constitutes the broad dimension of the INRM research agenda.

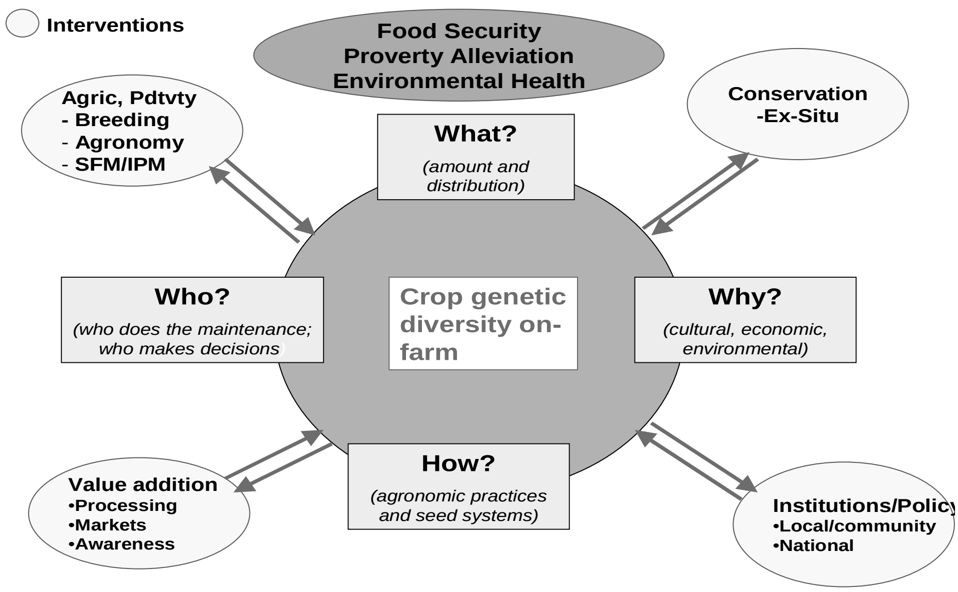

Figure 6: Different elements of genetic resources research on station and on-farm

As part of the programme of research on INRM, there should also be pilot studies on agroecological zone basis, in which farmer communities are supported to make maximum use of biological diversity for enhancing food security, income generation, and improved health and community interactions. This can be done through tools such as improved seed management at community level, community seed system enhancement, seed diversity fairs, farmer field fora and participatory breeding and selection. Such pilot studies could be used as framework to scale up the impact of research. This approach would lead to better understanding of how farmers and communities manage their genetic diversity within the broader agroecosystem. The elements of extrapolation, dissemination and policy are other key aspects of INRM, and are of prime importance in linking research on INRM to development.

Conclusion

Integrated natural resources management is of prime importance for ensuring the sustainable use and conservation of our natural resources. INRM is not just a subject for researchers; it is equally relevant and significant for farmers, communities, and development agents. Biodiversity, at both wild and cultivated levels, is an essential component of INRM. It should not be seen as an end in itself, but rather as a means of achieving productivity, stability, resilience, improved environmental quality, and the conservation of crop genetic diversity. These in turn are part of larger societal goals – sustainable food security, reduced poverty, and improved public health. Societies also value natural biological diversity in the broader sense. People are concerned about the possible extinction of species because of their potential future benefits, their role in ecological balances, and simply because people place a value on their continued existence, regardless of future human benefits. We need to take steps to ensure that efforts aimed at dealing with the food security situation of today do not compromise the ability of the system to deal with the food security situation of the future. We should not look for 'silver bullet' technologies, or for silver bullet varieties or species. Ensuring the security of biological diversity (including recognition of the role played by indigenous crops and varieties) should be a key concern. INRM offers a framework within which agricultural biodiversity can be sustainably managed, and contribute towards food and nutrition security, poverty alleviation and maintenance of environmental health.

References

Brush, S, 1995. In situ conservation of landraces in centers of crop diversity, Crop Science, 35, 346-354.

Campbell, B.M., P. Gunarso, K. Kartawinata, P. Levang, S. Rhee, D. Sheil, P. Sist and E. Wollenberg. 2003. Empowering forest dwellers and Managing Forests more sustainably in the landscapes of Borneo. IN: Research towards Integrated Natural Resources Management. Harwood, R.R. and Kassam, A.H. eds. CGIAR, Rome 2003

CGIAR, 2003. Research towards Integrated Natural Resources Management. (Harwood, R.R. and Kassam, A.H. eds.) CGIAR Interim Science Council, CGIAR Rome 2003

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neil, R.V., Paruelo, J., Raskins, R.G., Sutton, P. and van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. *Nature* 387, 253-260.

Folke, C. et al., 2002. Resilience and sustainable Development: Building Adaptive Capacity in a World of Transformation. Scientific Background Paper on Resilience for the process of the World Summit on Sustainable Development, on behalf of The Environmental Advisory Council to the Swedish Government. Available on the WSSD website

Loreau M, Naaem S, Inchausti I, Grime JP, Hector A, Hooper DU, Huston MA, Raffaelli D, Schmid B, Tilman D, and D.A. Wardle, 2001. Biodiversity and aecosystem functioning: current knowledge and future challenges. Science, 294, 804-8.

Qualset, CO, McGuire, PE and Warburton ML, 1995. 'Agrobiodiversity': key to agricultural productivity. California Agriculture 49, 45-49.

Settle WH, Ariawan HA, Cayahana ET, Hakim W, Hindayana AL, Lestari D, Pajarningsih AS and Sartanto, 1996. Managing tropical rice pests through conservation of generalist natural enemies and alternative prey. Ecology 77, 1975-1988. Ecological Society of America.

Swift, MJ, Izac, AMN and M. Van Noordwijk, 2003. Biodiversity and ecosystem services in agricultural landscapes: are we asking the right questions? *Agriculture, Ecosystems and Environment* (accepted for publication).

TAC, 1988. Sustainable Agricultural Production: Implications for Sustainable Agricultural Research. TAC Secretariat, FAO, Rome.

Task Force on INRM, 2000. Integrated Natural Resources Management Research in the CGIAR: A brief report on the INRM workshop held in Penang, Malasia, 21-25 August.

Task Force on INRM, 2001. Integrated Management for Sustainable Agriculture, Forestry and Fisheries: A brief report on the INRM workshop held at CIAT, Cali, Colombia, 28-31 August.

Participatory Action Research for Development and Science

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Abstract

Modern theories of living systems, including humans, define knowledge as "effective action in the domain of existence". This reaffirms that knowledge is essential for human life and progress, i.e., for their successful adaptation to and shaping of their environments. Knowledge results from the mind process, i.e. cognition, knowing, learning, stimulated by the interaction and mutual perturbations between humans and their domains of existence, which include nature, other humans, and the results of human actions. Thus also, effective learning occurs in the continuous present and is necessarily adaptive, which may be helped or not by "existing knowledge". Early realization of the importance of knowledge for life and progress, led humans to develop a process of accumulating and systematizing resulting knowledge, which became more rigorous and known as science. Such realization has become stronger and remains at the heart of science today, especially among scientists and those able to benefit most from their contributions. Obscuring this are controversies, such as that on the value of "hard sciences" versus "soft sciences", among people that seem to confuse the means of science with what sciences has been, it is and it is expected to be, i.e. an effective, reliable and timely generator of knowledge essential for human life and progress. As human populations have grown larger and more able to communicate, they have also increased the intensity and speed of their actions and interactions, e.g. globalization today. As a result humans have multiplied and made more complex and accelerated changes in their environment. Science has certainly contributed to such changes but has lost ground, or at least time, in providing the knowledge people have needed to adapt successfully to such changes globally, but most dramatically in relation to the presently growing section of the population we characterize as "poor". Science has evolved: 1) biased towards focusing on nature and its control, separate and away from focusing on humans, especially human groups, their collective functioning and the subsequent effects on themselves and on nature; and 2) hesitant or restricted to developing equally rigorous science methods that are different from those used for learning about nature, when focusing on humans. This is reflected in the "hard" versus "soft" science controversy and may also explain a great part of science's inability to effectively contribute to tackling the ultimate challenge of growing poverty and related human and environmental health degradation that plagues the world today. Presently, the emergence of more integrative and collaborative research concepts and tools seem to show a better way. These include concepts ranging from researchers controlled multi-disciplinary and systems approaches, to trans-disciplinary or participatory approaches in which scientists, users and beneficiaries of the research efforts share responsibilities and learn simultaneously. Their intention is to develop more immediately accessible and useable knowledge for those in the domain of the research effort, and to learn more about the processes required for accomplishing similar results more quickly in other contexts. These approaches still need development and sustained dedication by those willing to commit themselves to a science that meets its social responsibilities quickly, and to make them more cost effective, especially in helping to alleviate poverty and environmental degradation.

Introduction

This paper is the response to an invitation to look at the research for development work of the African Highlands Initiative (AHI) from a "bigger picture perspective"[1]. The perspective chosen is that of science, its evolution and contributions to society's development. Main attention is given to the Participatory Action Research (PAR) type of approaches used by the AHI and similar endeavors.

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[1] The paper was prepared for the African Highlands Initiative Workshop on Integrated Natural Resource Management in Practice: Enabling Communities to Regenerate Mountain Landscapes, held on 12-15 October 2004. ICRAF Campus.

Research for development is understood here as the conscious attempt to apply science's procedures and knowledge to improve development processes and outcomes. Research for development practitioners face many challenges especially when focusing the imperatives of reducing poverty and environmental degradation.

These challenges relate to inherent difficulties of development that society and scientists do not know how to address well because they are new, dynamic, complex, or have been disregarded for other reasons. Many are aggravated by the intensifying activities of people with the help of science. The most pressing ones are associated with poor populations and poor or degraded environments in developing countries, contexts that do not offer a high prestige or pecuniary pay-off to those who work there. Furthermore, most benefits from diminishing poverty and environmental degradation accrue to the whole society; they are public goods, which only few conscious or altruistic groups want to support without compulsion or special enticement.

Furthermore, many development challenges do not lend themselves to the application of trusted scientific concepts, approaches or tools. Scientists have the means to adjust and evolve such tools as required. However, they appear hesitant in their attempts to do it because of perceived risks related to their professional progress. The adjustments needed usually require scientists to look out of the domain of their respective discipline and profession and to accept the need for collaboration, which implies that credit is no longer exclusive. Other scientists many times discard adjusted research approaches and their results as non-scientific. This behavior seems determined mostly by the current academic culture and structure of institutions and incentives that society has developed to nurture sciences and scientists.

However, many brave scientists venture with enthusiasm into research for development and its challenges. They produce research results mainly as public goods. They know that effective development can be stimulated externally but that it is mainly an endogenous phenomenon, a phenomenon that must be driven and implemented collectively by the people in the context of development. These scientists are using and evolving approaches that include the contribution of their respective disciplines but in collaboration with other scientists in multidisciplinary teams, and growingly in interaction with promoters and users of research results, in partnerships that many call trans-disciplinary. They brace the dual challenge of contributing to their respective disciplines while also contributing effectively to specific research for development outcomes.

These scientists are "pioneers" in an old but still fairly unexplored and complex area of human and scientific concern: sustainable and equitable development. With their concerns in mind, the following sections revisit concepts and understanding of the nature and functions of knowledge and science as determinants of documented trends in human actions, human progress and development as a collective. Following sections focus on the implications of such trends for the emerging participatory action research concepts, practicing scientists and their tools.

This paper draws from literature pertaining to knowledge and research in general. More specifically it draws from cases of research for development with foci in agriculture, natural resources management, education and health. Literature from sociology and political sciences is also reviewed.

KNOWLEDGE AND ITS LINK TO HUMAN ACTION AND DEVELOPMENT

Knowledge is invariably defined as the result of the human "mind process". This process is viewed as cognition, knowing, learning stimulated by the interaction and mutual perturbations between humans and their domain of existence, which includes nature, other humans, and the results of human actions. Two biologists, Maturana and Varela (1992), as cited by Röling (2000), defined knowledge as "effective action in the domain of existence". In its most basic dimension then, knowledge is awareness and consciousness – understanding – by an individual of what it is, and what are the implications of a perception obtained through the senses, other instruments or experience.

Maturana and Varela's influential definition highlights the "empowering" value of knowledge regarding human decisions and actions. Fundamentally this value means survival, then security and comfort, and eventually other more advanced forms of human actions and development, such as enjoyment, intellectual and spiritual enhancement. The main implications are one, that knowledge is first of all experiential in the context of existence and two, that effective learning occurs in the "continuous present and is necessarily adaptive" (Röling, 2000). As a result, knowing and learning may be helped or not helped by existing knowledge. In fact, stored knowledge developed in an old context "can become a downright barrier to effective action in a changed or a new context" (Röling, 2000, drawing from Maturana and Varela). In turn, all this has practical implications for the interpersonal transfer and personal acquisition of knowledge, as in capacity building and training. Also appealing to basic biology and evolution of the human brain, Goleman (1998) indicates that for knowledge to be effectively transferred to affect behavior, if that is the intention, the process must usually go beyond the intellectual discussion and understanding of it, to include related action or emotional engagement by the individual "acquiring" it.

This also applies to the science-produced knowledge, especially that which is intended to stimulate and empower people's development. This is usually the case in research for development, and especially in poor areas where development priorities are closer to survival needs. The key challenges in research for development then are: fitting the knowledge to be produced to the people's development context and their appropriation of it for action. This is to ascertain that the people accept the new knowledge as theirs, validating it through their thought process based on a proxy or direct experience with it, and trusting it to be part of their decisions and actions.

Meanwhile, traditional "science based" development interventions or public innovation system structures are not conducive to this type of results. The African agriculture technology innovation systems, for example, include scientific research groups who are usually mandated to "cost effectively produce knowledge" that could potentially apply to a wide range of contexts and great numbers of people in their country or area of mandate. This is certainly consistent with the idea that "knowledge is like light, weightless and intangible, it can travel the world, enlightening the live of people everywhere" (World Bank 1998-1999, as cited by Dalrymple 2003). In most cases, however, such scientifically produced knowledge, if appropriate at all, requires "adaptation" to the more specific context of the potential users or development effort. Then, the "adapted" knowledge needs to be "transferred" to the people in the development context, with the expectation that, finally, those people will "appropriate and use" such knowledge as part of their actions and as anticipated in the development intervention.

Different forms of "extension" organizations have been in charge of knowledge adaptation, transfer and monitoring-and-support-of-utilization phases, which are the critical phases in the innovation process. Usually, they have attempted to do this with limited operational resources and with little trained personnel. Traditionally also, these innovation structures have not worked well except occasionally and temporarily, for example when enough extra attention and resources have been provided. The notable experiences of Sasakawa 2000 can be offered as example here. In most cases, actors and activities constituting the different phases of the innovation process appear weakly linked, and usually ineffective.

Responding to internal scrutiny and external criticism, agricultural researchers began in the early 1970s exploring the downstream phases of the innovation system in which they participated. Their initial intention was to find recommendation to improve work in those phases, such as extension and, thus also, to enhance the utilization of existing research results to "demonstrate" the effectiveness of the research contribution. In doing this, many researchers discovered a new world of challenges and opportunities, and there emerged several methodological innovations for research, which usually include elements of what were the downstream phases in the innovation system. The examples include cropping systems research, farming systems research, on-farm research and production-to-consumption systems research.

The growing number of variables and the complexity of the new research settings and methodologies promoted collaboration across disciplines, first among natural scientists, and later with social scientists as well. This multidisciplinary collaboration helped to evolve accompanying tools such as Rapid Rural Appraisal that later evolved to Participatory Rural Appraisals (Chambers, 1994). Biophysical and social science groups are now coming even closer together in the conceptualization, promotion, utilization and evolution of participatory action research type approaches. These approaches are still new and vary greatly in the degree of participation, inter-disciplinary and trans-disciplinary processes involved.

Also emerging from mainstream practices, some social scientists had begun developing concepts and tools for action research as early as the 1940s (Castellanet and Jordan, 2002). The addition of participation to action appeared in education research in Latin America during the 1960s, inspired by Paulo Freire's "conscientization" method (Castellanet and Jordan, 2002). The partnerships of social scientists with biophysical sciences as part of this evolution, however, is more recent, and still evolving in relation to issues of research on natural resources management and agricultural development.

PAR-related concepts and tools do respond to the key challenges inherent in the concept of "knowledge" as discussed above. The participants in the development and research cases bring in an intimate knowledge of their context, facilitating the fitting of the knowledge to be produced to such context. By participating in the PAR, they also have the opportunity to evaluate, trust and appropriate the knowledge produced as part of their decisions and actions. As result also, PAR-related approaches bring closer together the phases and participants constituting the traditional innovation systems revisited above. This promises shorter time and improved cost effectiveness for the whole innovation process in producing outcomes for a given bundle of resources. Finally, the emerging approaches help to bring the attention and action of scientists closer to practitioners, which promises to stimulate or devolve the capacity of collaborating practitioners for own R&D, and thus improve further the overall innovation system.

PAR-type approaches are proposed with a dual aim: to make practical contributions in development contexts and scholarly contributions based on such experiences. The jury is still out regarding the potential contributions to development from their application and in relation to more traditional research approaches, also on whether they can be considered scientific or as contributors to science or not. Many attempts are viewed with suspicion, especially in terms of the potential for scaling-results-up and costs, and in terms of contributions to science. However, traditional approaches are known to be ineffective or slow in providing knowledge that can be put to practical application on call, which is necessary in most development contexts. In such contexts, the promises of PAR approaches are attractive at least as complement if not as alternative to the traditional research approaches. In relation to the scientific type concerns: are PAR-type concepts and tools incompatible with the concepts and evolution of science and its methods? Are they necessarily "less objective" and are their results "non-reliable"? Do their attention to action and interventions prevent all scholarly contribution? What do others say regarding the value PAR? These questions are explored in following sections.

SCIENCE AND ITS RELATION TO DEVELOPMENT IN SOCIETY

From N. Georgescu-Roegen's historical analysis of science, (Georgescu-Roegen, 1971 p.22), we obtain that "Science is a many splendored thing". It has been and it is evolving in different degrees across the globe and societies. It obeys no single definition, and it is a social product as well as an asset.

Science as social product and asset

Since the "dawn of mankind", men and women acquired and accumulated knowledge from informal observations and reflections on own survival-related experiences, explorations, and intuition. Early realization of the importance of knowledge for life and progress led humans to develop a process of accumulating and systematizing knowledge, which became more rigorous and known as science[2]. Such realization has become

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[2] **Science** is both a process of gaining knowledge, and the organized body of knowledge gained by this process. The *scientific process* is the systematic acquisition of new knowledge about a system. This systematic acquisition is generally the scientific method, and the system is generally nature. Science is also the *scientific knowledge* that has been systematically acquired by this *scientific process* (http://www.wordiq.com/definition/Science).

stronger and remains at the heart of science today, especially among scientists and those able to benefit most from their contributions.

Two critical aspects in science are:

- the reliability of the accumulated knowledge, which depends of the reliability of the method of acquisition – the research method,
- the accessibility of the knowledge to community members, which includes its presentation in the simplest form and depends of the means and approaches to storing knowledge and the forms and channels used for disseminating it.

Over time, the methods used by scientists in knowledge acquisition, storage and dissemination have changed and succeeded in different ways. Most attention given by scientists is related to the "acquisition of scientific knowledge", that is to maintain or improve the reliability of the scientific methods of research and resulting knowledge. In most cases, the judges of this reliability are other scientists ("peer review system") as part of the scientific process.

The scientific community has not been as attentive to the storage or to the dissemination of knowledge to the community in general, to facilitate access and appropriation of the knowledge by all potential users.

Thus, developments in knowledge storage and dissemination have been less uniform and associated to:
the differential preference, development and progress of different disciplinary divisions, or
the development and progress of countries and sectors, especially those with greater capability to pay for scientific work or utilization of scientific knowledge, usually for private goods production (Lee-Sohng, 1995; Brown, 1998; Sellamna, 1999; Sagasti, 2003).

Eventually this has also influenced the evolution of science, particularly its focus and the distribution of its benefits.

The Method of Science

For some, such as Veblen, cited by Georgescu-Roegen, (1971 p.24) the primitive science based on the practical accumulation of knowledge resulting from people's informal observations and reflections on own survival-related experiences, was later expanded and transformed by the "idle-curiosity" of humans. This instinct has not been equally developed or cultivated across the land and the differences are offered as explanation of differentiation in the evolution and use of science and thus in the development of different societies (Georgescu-Roegen, 1971 p.30; Sagasti, 2003).

Knowledge was initially "stored" in the mind of people and disseminated orally. Memory was a valuable "virtue" among humans and an asset for the "scholars and teachers" of the day. Elders also became assets for their communities because of their accumulated and proven long-life knowledge.

As knowledge accumulated, human memory became the limiting factor and a risk for maintaining and improving community knowledge. The invention of writing and papyri lifted a restriction to knowledge accumulation and probably permitted its earliest classification. However, as knowledge continued to expand, the problem of accessibility to the right bit of knowledge gave place to discussions on taxonomic filing and criteria for this, such as chronological order for historical facts.

The Ancient Greeks (600-400 BC) appear as the only culture that dedicated attention to principles of knowledge classification. Even though the Greeks never reached a general agreement on it, taxonomic classification became the filing system most widely used for factual knowledge in biology, high realm of physics and other fields.

From their inconclusive attention to classification, the Greeks moved to notions and their relationships, which gave birth to Logic and “Logical Filing” as alternative to taxonomic filing of knowledge. Inspired by the logical proofs of geometric propositions by Euclid, Aristotle arrived at the logical syllogisms. The Euclid’s logical proofs and derived algorithms helped to save effort in memorizing geometric relations. Aristotle captured such “economical” aspects in his logical syllogisms, which became the basis of logical algorithms, their mathematical manipulations and eventually for theoretical science (Georgescu-Roegen, 1971 p.25). The development of logical reasoning and its eventual application to science cataloging of knowledge for simplicity of presentation and dissemination are considered as the most important contribution of the Greek civilization to human thought and science-based progress, especially in the Western World (Georgescu-Roegen, 1971 p.25).

However, logic was not the only triggering factor for science as we know it today, as both India and China had already developed logic of their own, in some aspects more refined than those of Aristotle. Another factor was the Greeks’ philosophical belief on a non-divine natural order of reality and thus on the existence of equally non-divine causes for everything, except the First Cause. The search for the first cause (the “why?”) through ratiocination focused the quest of Greek thinkers while the Asian thinkers were concerned with understanding the divine, through contemplation (Georgescu-Roegen, 1971 p.31).

The syllogism fostered deductive reasoning, which provided a superb methodology of intellectual discovery and addition to human knowledge up to and throughout the Middle Ages. Then, practitioners began neglecting Aristotle’s added emphasis upon the direct observation of nature and began to derive conclusions by means of logic alone. Late in the sixteenth century, Sir Francis Bacon and others attacked this method of reasoning as unsound, more similar to a method of debate, to prove through logic and eloquence a given reasoning right than in finding true answers.

Bacon, and Leonardo da Vinci before him, stressed the need for basing general conclusions upon specific facts through direct observation, which is inductive reasoning. He advised scholars to ignore authorities, observe nature closely, to experiment, to draw own conclusions, to classify facts to reach minor generalizations, and then to proceed from these minor generalizations to greater ones. Specifically, he warned against formulating any hypothesis until all the facts have been gathered.

Darwin, later, was one of the first to faithfully experiment with Bacon’s ideas. He found out that inductive reasoning alone couldn’t solve all problems. In his work he collected facts, formulated tentative explanations (hypotheses) based on those findings, and then tested such hypotheses using additional facts. He used both inductive and deductive reasoning to arrive at his final conclusions about evolution, which is also how modern research works. Authors also acknowledge the contributions of Descartes in France and Newton in England to the final establishment and reliability of the scientific method.

Even though many authors argue that scientists do not use just one method or approach, the basic or generic steps of the scientific research approach, are as follows:

- Identification or definition of the problem or issue to be investigated, which may require some fact observations and analyses;
- Collection of essential facts pertaining to the problem or issue;
- Selection of one or more tentative “solutions” of the problem (hypotheses);
- Evaluation of these alternative solutions to determine which of them is in accord with all the facts, and
- Selection of the most likely solution (usually the hypothesis that was not rejected by the evaluation process).
- A final step consists of the presentation of the results and the process followed, to permit repetition and scrutiny by peers.

The level of details or complexity in the presentation of the scientific method, on the whole or for each step, varies across fields of research and disciplines. These differences usually respond to the nature of the research field and the accepted theoretical framework and philosophy of the corresponding research community. The main purpose of the scientific research method has been to eliminate researchers' biases, to make reliable the knowledge they produce and especially to peers. Not much is said of the relevance of the issue under investigation, except probably for the scientific peer group, or about the potential users and uses of the research results.

The scientific method is usually presented as subject matter neutral, which is consistent with the claims of objectivity and impartiality in science. However, the predominant method of science discussed above was developed in and fits better the natural sciences.

Thus, also, science and its method have:

- developed biased in focusing on nature and its control, separate and away from focusing on humans, especially human groups, their collective functioning and the subsequent effects on themselves and on nature; and
- been hesitant or restricted to developing equally rigorous science methods, that are different from those used for learning about nature, when focusing on humans. This situation may partly explain science's inability to effectively contribute to tackling the ultimate challenges of growing poverty and related human and environmental health degradation that plagues the world, and also the ongoing controversy between "hard" science and "soft" science among defenders and critics of the status quo today.

However, mounting pressure for research on development issues that include humans individually and collectively, and their actions as determinants or resulting variables, are stretching the friendliness and usefulness of the traditional scientific method. They have also intensified the controversy mentioned above and deepened criticisms of science in general (Brown, 1998). All point to the need for alternative approaches and probably to a new paradigm, which should not be strange to scientists since science has successfully evolved through these types of changes (Kuhn, 1970).

DEVELOPMENT IN SCIENCE AND SOCIETY

The co-evolution and mutual influencing of science and societies is well documented (Karle, 1995, Sagasti, 2003). There are important milestones that dramatize this. As discussed in the previous section, up to and through the Middle Ages, the predominant science powerhouse from a western perspective was Greece. Societies with parallel development and science of their own were China, India, and Aztec, Mayan and Incas in the recently discovered America (Sagasti, 2003). The Middle Ages put a brake to the evolution and dissemination of science and also to human progress in the Western World.

The situation changed dramatically from the sixteenth century AD with the contributions to scientific thinking and methods by Sir Francis Bacon in England, reinforced by that of Leonardo da Vinci in Italy, Descartes in France and later Newton and others. For some, these changes gave rise to the "enlightenment" and "modernism" as movements. They also gave momentum to the industrialization of Western Europe, and strengthened its exploration missions and eventual colonization of many parts of the world. This was probably also the beginning of "the world coming together", today commonly referred to as "globalization". Unfortunately, not all developments were positive; some colonized civilizations were destroyed or their progress slowed, particularly those in the "New Continent".

The next well-documented milestone was right after World War II when a victorious America recognized the contribution of science to the victory of the Allies, not to say to the detonation of two atomic bombs. Riding on the "Science: The Endless Frontier" report to the Senate by Vannevar Bush in 1945 (US National Science Board, 1997), Americans enthusiastically agreed to increasing governmental support to science and technology. The report was considered a blueprint for a new science and of government support to science and especially basic research (US National Science Board, 1997).

For many authors, including Nobel Laureate Jerome Karle (Karle, 1995), the main link of science and the development of society has been technology, especially the technologies resulting from industrial science. These technologies are usually associated with activities such as manufacturing, transportation and communication. In fact, for Karle, technologies had been associated with the evolution of man starting with tools, clothing, fire, shelter and various other basic survival items.

Technology includes hardware (artifacts) and software (sets of instructions) that embody knowledge and facilitate the effective utilization of such knowledge for determined actions and purposes. As such, many technologies have also facilitated and enhanced the work of science; an example is the microscope, and its contribution to, for instance, improved medical diagnostics, studies and medicine. In fact, many early artifacts were built and used before anybody knew why they worked, and Japan showed clearly that the technology development process could be reversed to develop a science-based successful technology development capability (US National Science Board**,** 1997).

Undoubtedly, science has helped humans to grow in numbers (health science, food production science) and to be better able to travel and communicate. As result people have increased the intensity and speed of all their actions and interactions, as witnessed by the phenomenon of globalization today. In turn, they have made more complex and accelerated many changes in society and the environment. Many among those changes have been positive but many others have been negative, including environmental degradation and worsening poverty (Lee-Sohng, 1995). While contributing to accelerate changes, science has lost ground even time to provide the knowledge people need to adapt successfully to such changes globally; most dramatically it has lost ground in providing such knowledge to those in most need, to the growing section of the population characterized as "poor".

Gap in science's contribution to society

The support to basic science that was promoted by the Bush report to the US Senate in 1945 reinforced the "modernism" trend in science. This is "associated with a linear and unidirectional model of knowledge creation and application, where lone scientists work at the frontier of science to provide the intellectual grist for societal progress" (Consortium for Science, Policy and Outcomes, 1995). Despite its undeniable usefulness, this model that has also influenced the shaping of innovation structures and systems across the developing world, has denied many people the benefits of science. The main shortcomings include knowledge necessary to diminish:

- gaps in people's well being and development opportunities across and within countries, especially
- poverty, gender inequity and environmental degradation,
- consequent health problems and different kinds of social conflicts and unrest.

These shortcomings reflect the main weaknesses of science today and point to traditional science and the prevailing development paradigm it has supported as contributors to such problems (Brown, 1998; Sagasti, 2003).

The co-evolution of science and society has not been harmonious. Science has benefited certain countries and sectors within countries more, especially those with greater capability to pay for scientific work and utilization of scientific knowledge. The main contributions have usually been associated with the military, big infrastructure and programs, or private goods production (Dalrymple, 2003). Public-good type research results being provided are usually too general or otherwise inaccessible for utilization by the people in most need of it. IPR legislation contributes to the difficulties in the access to knowledge by the poor.

Response to the gaps in science's contribution to SED

Reviewing the co-evolution of science, technology and society in table 1, Lars Fuglsang (2001), distinguishes three perspectives that have predominated after the Bush paper in 1945. These are:

- "Science and Technology Shape Society" (1950s – 1960s), based on the science and technology optimism of the post World War II period, to which the Bush report was an important contribution (Consortium for Science, Policy and Outcomes, 1995), and Karle (1995), an adherent; it promoted support for basic research;
- "Society Shapes Science and Technology" (1970s –1980s), promoted by academic and business discussants who saw a poor spillover from basic research to business and thought that science should be more connected to commercial purposes and, also, that science and technology should be seen in the light of social, economic and political interests and the concern of the wider population;
- "The interactive view of Science, Technology and Society relationship" (1990s), which is probably a refinement of the previous perspective. It suggests
    - that technologies are not developed in a linear way and
    - that the sequence of steps to take depends on negotiation with the constituency that is involved with the technology. In many cases such constituency needs to be empowered for the negotiations. For more details on Fuglsang perspectives see Table 1 in the Appendix.

Positions 2 and 3 in Fuglsang's account seem to correspond to what other authors refer to as "post-modernism" (e.g., Sellamna, 1999), which also cover the promotion and practice of PAR-type approaches. These perspectives and proposed approaches configure a clear attempt to compensate for the gaps left by science in its response to society's needs of knowledge for a sustainable and equitable development under fast changing circumstances.

Table 1. Three perspectives on Science, Technology and Society compared

	Science and technology shape society	Society shapes science and technology	Interactive approaches
Time	1950s-60s	1970s-80s	1990s
Definition of technology	Cause	Consequence	Cause and consequence
Independent variable	Technology	Society	Social group
Relationship of actor to technology	Beneficiary (or victims)	Negotiate interests	Seamless web
Role of policy	Protect or reject science and technology	Empower actors, create networks	Democratize
Power structure	Technological regime	Negotiations	Frames, discourses
Method	Study impact of technology	Follow the artifact	Follow the actor

From: Fulgsang, 2001

Doubts cast on the scientific soundness and value of these proposed new approaches and their outcomes have fed on and into the wider discussions and criticism of science today (Brown, 1998). They have also contributed to the controversy regarding superiority between the hard (but "easy") sciences – mainly natural sciences – and soft (but "difficult") sciences – mainly social sciences. This is unfortunate given the imperative and urgency to attend to the gaps that the promoters and practitioners of the PAR-type approaches are addressing, and the risk that the controversies weaken their resolve to continue evolving the new approaches.

CONVERGENCE IN THINKING, ACTORS AND ACTION IN SCIENCES AND SOCIETY

The call for more integrative, collaborative and participatory concepts and tools of the PAR type approaches and their practitioners do not appear to be isolated but in a trend across all sciences and society. This may anticipate a short remaining life for the controversies alluded above.

“Research institutions are experiencing a surge of innovative interdisciplinary initiatives aimed at bringing together students, postdocs, and faculty from different departments to solve complex problems in ways that they have never tried before” (Pray, 2003). Examples include the Stanford University's fledgling Bio-X program to the Massachusetts Institute of Technology's (MIT's) 17-year-old Biotechnology Process Engineering Center (BPEC) and several interdisciplinary centers supported by the National Science Foundation in the US. "Obviously, this is an area that is affecting many universities … interdisciplinarity is running rampant” (Nils Hasselmo, president of the Association of American Universities, as cited by Pray (2003)).

The “Convergence of Sciences” program (in agricultural innovation) being initiated by Wageningen (North-South Centre) can be offered as an example from the European side. It is being implemented with several research and NGOs partners in Benin, Ghana and Europe, plus IITA and the backing of FAO Global IPM Facility and GTZ. “The objective of the programme is to develop jointly a framework for interactive identification and development of solutions, with emphasis on the complementary roles of knowledge and problem solving capabilities of the involved stakeholders – farmers, extension and research organisations, NGOs, policy makers, private enterprises, consumers, etc–” (North-South Centre, 2004).

The development of technological products must now integrate new materials but also new concepts and market competition concerns. Thus, the process has been rendered more complex and requires the participation of more people with different competencies and responsibilities. It also requires new work practices that involve collaboration with stakeholders outside the research and development companies (Brandt, 2003).

Certainly, programs such as the African Highlands Initiative and related efforts across IARCs, NARSs, AROs, universities and even NGOs from the North and across Africa constitute part and reinforce these trends. Also worth to note is that many among those that seem to bet on the value of these new approaches are donors, such as the International Development Research Centre (IDRC), and others concerned with research for development. Those most skeptical are usually researchers. Some of their critical positions seem to confuse the means of science with its ends. As seen throughout this paper, science has been, is and is expected to be an effective, reliable and timely generator of knowledge essential for human life and progress. The traditional scientific research method is not sufficient to help science with this responsibility.

The convergence in thinking, actors and actions is also reflected in the nature and methods of emerging and evolving sciences such as sustainability science (Kate et al, 2001), and complexity science (Reason and Goodwin, 1999).

Even at the philosophical level, a renewed attention to dialectics indicates awareness of the need in science and practice to consider in a more integrated manner the different constituent and sources of change. These include quantitative and qualitative variables, dialectic concepts and even more contradictory or conflicting concepts or positions, chaos, and system’s “emergent properties”, among others. Change is probably the only “constant” of natural or human realities that human beings try to understand and adapt to (Reason and Goodwin, 1999).

Finally, the strengthening attention to the ideals of respect for human rights, gender equity, economic equity and democracy feed into these trends of convergence in thinking, actors and actions in science and society. They all point to effective collective action at different levels[3]. In fact many justify and promote PAR-type approaches because of their potential democratization and empowering value at the grassroots level (Cornwall and Jewkes, 1995, M^C^Kee et al, 2000). Trends in governance policies and practices, such as decentralization, public private partnerships, and even “globalization” are in line with such ideals. They are certainly creating “new playing fields”, which still are work in progress. The ground still needs levelling, rules of the game need to be clearer and fairer, even regarding team access and assurance that all “teams” will be in comparable footing and strength for the games.

[3] In my view, collective action (effective, democratic, equitable, efficient) is the potential and proper end point for many of these efforts (“search of knowledge as/for effective collective action”), which has not featured as strongly as it probably should have as part of the PAR related discussions.

Table 2. Participatory and conventional research: a comparison of process

	PR	Conventional research
What is the research for?	Action	Understanding with perhaps
		action later
Who is the research for?	Local people	Institutional, personal and
		professional interests
Whose Knowledge counts?	Local people's	Scientists'
Topic Choice influenced by?	Local priorities	Funding priorities, institutional
		agendas, professional interests
		Disciplinary conventions,
Methodology chosen for?	Empowerment, mutual learning	"objectivity" and "truth"
Who takes part in the stages of		
research process?	Local people	Researcher
Problem identification	Local people	Researcher, enumerator
Data collection	Local concepts and frameworks	Disciplinary concepts and
Interpretation	Local people	frameworks
Analysis	Locally accessible and useful	Researcher
Presentation of findings	Integral to the process	By researcher to other academics
Action on findings	Local people, with/without	or funding body
Who takes action?	external support	Separate and may not happen
Who owns the results	Shared	External agencies
What is emphasized?	The process	
		The researcher
		Outcome

From: Cornwall and Jewkes, 1995

THE CASE FOR AND AGAINST PAR-TYPE APPROACHES

The following is a brief account of the concerns and promises associated with field research for development that includes action and participation of stakeholders in the process. This account draws from different authors and especially from papers by Chambers, 1994, Cornwall and Jewkes, 1995 (table 3) and Castellanet and Jordan 2002.

Table 3. Types of participation in PAR type approaches

Type	Description[4]
Contractual	People are contracted into the projects of researchers to take part in their enquiries or experiments
Consultative	People are asked for their opinions and consulted by researchers before interventions are made
Collaborative	Researchers and local people work together on projects designed, initiated and managed by researchers
Collegiate	Researchers and local people work together as colleagues with different skills to offer, in a process of mutual learning where the local people have control over the process.

From Biggs (1989) as cited by From: Cornwall and Jewkes, 1995

[4] Other authors refer to the "shallow" participation as "functional" and to the "deep" participation by community members as "empowering"; thinking of number of participants representing their populations, Farrington and Bebbington cited by Cornwall and Jewkes (1995), talk of "narrow" (i.e., few people are involved) and "wide" (i.e., many people are involved) participation; type and degrees of participation may also change along the RxD process for different actors.

Some of the concerns with participatory and action research

- Approaches take considerable time, especially if the social groups concerned are among the poorest and most dominated and therefore the least likely to perceive themselves as having shared interests.
- They are seldom compatible with the researchers' or funding agents' limited time span, which usually is a main underlying concern. Those that researchers want to work with are usually too busy securing the basic necessities of life or are engaged in other projects.
- The risk that well organized participants will contest the control of all research activities, abstractions and evaluations that appear useless to them – this is more critical for those with a strong research agenda, less so for those including empowerment as important part of the agenda.
- The cropping of practical and ethical questions regarding publication and social property of resulting scientific knowledge.

Procedures and results that lack the rigor and resulting reliability, which is considered necessary for scientific and academic credibility.

- Research agendas cannot be planned in advanced without negotiation and revisions with the end users, which for some make the process non-scientific – this certainly stretches the usefulness of the traditional scientific approach but science is more than just a method, and scientist seldom use just one method.
- Lack of objectivity leading to uncertainty in observation and interpretation
    - Due to the researcher's potential emotional and social involvement with the subject matter or influence of participants (on observations and conclusions)
    - Issue of uncertainty is not exclusive to these approaches, nor new - Heisenberg[5] theorem shows that uncertainty of observation and interpretation exists even in refined methods of pure physics.
    - Consciousness of the increased risks of subjectivity allows scientists to compensate and approach objectivity through discipline in taking field notes, writing and discussions over the research with peers, etc.
    - Difficulties in submitting results to "falsifiability" tests

- Difficulty to submit hypotheses to (statistical or theoretical) tests that could falsify them – this is also part of wider argument or discussion on logical inference versus statistical inference

Replicability

- Difficulty to replicate experiments as in natural sciences – however, observations based on models and processes can have some level of replicability and be made useful to other practitioners.
- This calls for careful presentation of results and of the environment in which they were obtained with details of the process used and the crucial decisions taken. This would permit transferability of the results to similar conditions and problems. This predictability will always have a "relative uncertainty", which must be accepted.

Lack of institutional or academic recognition

- This concern, which seems linked to the idea that science is "what scientists do", still persists but is changing as seen above.
- Kuhn demonstrated that the "marginal scientists" of today might become the normal scientists and mainstream contributors to science's progress tomorrow.

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[5] HEISENBERG UNCERTAINTY PRINCIPLE, or INDETERMINACY PRINCIPLE, statement, articulated (1927) by the German physicist Werner Heisenberg, that the position and the velocity of an object cannot both be measured exactly, at the same time, even in theory. The very concepts of exact position and exact velocity together, in fact, have no meaning in nature.

- Difficulty to publish in traditional journals concerned with the mechanics rather than the performance of systems. New journal and corresponding peer groups are emerging, and more and more older one are beginning to accept "participatory" research work.

At best, these approaches imply "applied" and therefore "inferior" science, as per some definitions of science – this position is as arbitrary as the definition of science used and also an ethical judgment.

a. A priori, there is nothing in the applied science methodology that is different from that of pure science.
b. The main difference is in the problem investigated. Pure science tends to focus on problem, defined by the research program (Kuhn, 1970); applied science selects socially important problems (and useful results).
c. This may not be a very relevant discussion today given that almost all research agendas are determined by the interests of supporters (donors) based on expected results or products.
d. Applied science does not/ or cannot build up theories or fundamental progress in knowledge, which is considered the driving force of human progress.

    - Others point to many examples where science has just explained not driven progress;
    - Pasteur stated that there is only science and application of science.
    - Today the differentiation of pure and applied science is ever more difficult.

e. Practitioners often become involved in unproductive quantitative versus qualitative, hard versus soft science debates.
f. Participation is many times used as a catch-all and even as a cliché that causes confusion – probably by those too eager to compensate for criticisms, e.g.,

    - Enables local people to seek own solutions to problems according to own priorities
    - Helps to secure funding and co-opt local people into research agendas
    - Justify short-cut research within a top-down process

g. Participatory methods tend to be treated more as ends in themselves and less as means to an end. Thus the emphasis is not on outcomes but on processes, seen as learning and empowering opportunities for participants.
h. Control over the research is variably devolved onto the community and communities variably want it or are able to take it.
i. It is not a simpler alternative to traditional research; working with local people is far from easy, to start they are usually highly skeptical of the worth of investing their time and energy in the PAR project.

    - Commitment and interest wax and wane among participants over time, which requires constant attention and efforts to align them with what has been planned.
    - The research process can have unintended negative consequences for those who participate
        - In some cases "participation" has been used to extract free labor,
        - In others it has led to conflicts between the participants and non-participants in communities
        - A heightened awareness by a marginal group of its situation (which may include oppression) can increase unhappiness in the group, and the ethical responsibility of the researchers regarding the group's well being.

j. Some researchers tend to overemphasize the ideals of democracy in advocating participation, which some construe as little more than western cultural imperialism

SOME OF THE PROMISES AND EXPECTATIONS IN PARTICIPATORY AND ACTION RESEARCH

a. Gains of better understanding and insight into other actor's logic compensates for the potential increased subjectivity
b. Beyond understanding a group of people and their situation, it provides knowledge for the group's action under such situation.
c. Provides results that fit better the local people's priorities, processes and perspectives
d. It can create a space for and set a process of affirmation of local people as knowledge actors, improving their self-esteem, dignity, and confidence that they can identify and confront their problems directly or even mandate others to do that.
e. Shifts the focus from rapid extractive data collection to facilitating local people to produce and analyze their own information, according to their own priorities, as in the evolution of Rapid Rural Appraisals to Participatory Rural Appraisals in agricultural research.

    - Involving local people as participants enhances effectiveness and saves time and money for the whole innovation process in the medium to long term
    - It responds to the issues of agency, representation and power that form the core of the critiques to normal science methodologies when applied to development
    - It permits exploration, validation and use of local knowledge and perceptions
    - It permits innovative adaptation of conventional research methods and their use in new contexts, in new ways,

f. Stimulating and facilitating research and learning by local people, an example is the use of mapping PRA.
g. Researchers can learn beyond the scope of their disciplines, even in terms of social and emotional intelligence
h. The visibility of the researchers and the transparency of their intentions are significantly greater than in conventional research to beneficiaries.
i. PAR offers spaces for making conventional sciences more relevant, by creating an environment in which existing scientific knowledge can be synthesized through dialogue between scientists and local people and their own knowledge.
j. By acknowledging the value of local people's knowledge people are treated less as objects and more as agents capable of analyzing their own problems and designing their own solutions.
k. In general, PAR helps to visualize the constitution of and power relation among the different sub-groups that form the population in a given development context, also their present and potential contributions to and benefits they derive from the collective work. This is essential to assess the status of and propose adjustments to enhance the efficiency, equity (especially gender and economic equity) and sustainability of such collective work.

THE UNFOLDING CHALLENGE FOR PROPONENTS AND CRITICS OF PAR APPROACHES

A conclusion from the review in this paper is that approaches with the promises of participatory action research are needed. They are required to help fill the gap that traditional science and development practices have in their track record and present capability to help society respond to the imperatives of alleviating poverty and environmental degradation. Furthermore, their promises are in line with general trends in the calls for greater respect for human rights, gender equity, economic equity, environmental sustainability, and for democratization as the basis for shared responsibility and contribution to such trends.

On the other hand, nothing in the review renders the emerging PAR-type approaches as scientifically inappropriate or irrelevant. The review covered concepts of knowledge and science, evolution of science's methods and their contributions to society's knowledge and development.

On the track record of PAR

PAR-type approaches have been applied mainly at community level and in specific contexts, which is where development actions occur and effects are needed. Invariably, PAR reports refer to the work of multidisciplinary teams and their attempts to true interdisciplinary thinking and more holistic work. More advanced cases, sometimes presented as trans-disciplinary, include natural and social scientists, but also users and beneficiaries of the research efforts, all sharing responsibilities and learning simultaneously throughout the research process. Certainly, the type and degrees of participation and interaction varies across "participants", within cases and across cases.

Many reports appear to emphasize the processes and their by-product type learning and empowering benefits for the participating researchers and stakeholders along the way while specific results or outcomes are usually not well defined or impressive enough. Comments are that different groups seem to report the discovery and goodness of the same method anew, without looking or giving credit to previous experiences. However, this is also consistent with proper scientific discipline. Presently, there is no one method accepted as standard reference for the increasing audience these reports are being addressed. Both the method and the "peer" or stakeholders group are still evolving. From this perspective, it is proper and necessary to report details of the process or method and context of application to permit scrutiny by peers and other reviewers.

Furthermore, many reports are either about research for development or development intervention that are in their early stages, others are being concluded as per design after three to five years, when outcomes are at best incipient. Normally, these efforts would require much longer time to begin to show the outcomes targeted. The conclusion drawn from such reports by the critics is that the approaches used are slow and cost ineffective. This also puts in doubt their potential as options for greater and decisive investment by governments or by development donors. However, several governments, Uganda, for example, and donors including the World Bank in its evolving treatment of the PRSPs, are already betting on the promises of these approaches. This situation is also posing a challenge but also an opportunity to promoters and practitioners. This is to monitor better and contrast flows of benefits and costs from the implementation of these approaches, and document results to facilitate decisions and planning for development investors. How is this to be done and how is it to be reported? This is part of the challenge to practitioners.

It is clear that PAR-type approaches are not a panacea; they offer potential good results and also risks. Ultimately, PAR is about:

- Respecting and understanding the people with and for whom researchers work
- Realizing and accepting that local people are knowledgeable and that they, together with researchers, can work towards analysis and solutions of own problems
- Recognizing the rights of those who research concerns, enabling them to set their own agendas for research and development and so giving them ownership over the process
- Improving the quality of the research in terms of relevance, appropriateness and sustainability of the results for given people and context by involving them in taking their insights into consideration.

More on the hard questions from science

Going deeper into the concerns of academics and more traditional scientists regarding PAR approaches and results: what about rigor, objectivity and validity as the basis for reliability and scientific character of results? And, what about the possibility for scholarly contributions, which is also among the concerns of the critics and among many practitioners or would-be practitioners? How is this unique or different from other approaches in science? What about relevance of the results?

It is clear, from the review, that all sciences are expected to search for knowledge that is accurate, reliable and valid. This is a knowledge that is truthful or correct, hopefully precise but not necessarily all the time, trustworthy for decision and action by users and with authority – to compel and facilitate action in defined contexts. Objectivity, which means to be impartial, neutral, detached when making observations and drawing conclusions, appears as the necessary condition for all "scientific" approaches to such type knowledge. Expressed another way, scientists must make sure at all times that what they perceive and interpret from their research observations and reflections are not influenced:

- by their sentiments or temperament, or
- by imperfections in their instruments of observation and interpretation.

The above is valid for natural sciences as well as for social sciences, and for the handling of qualitative as well as quantitative variables in research, which are the divisions that usually cause dispute.

From the review, it is also clear that all sciences must deal with qualitative and quantitative variables, which can no longer be denied nor avoided. Equally, it cannot longer be denied that

- new instruments are needed to research human nature or nature including humans, and
- one important frontier for science today is in developing a more unified attention
- to understanding human actions and interactions among themselves and with nature, individually as well as collectively, and
- to provide humans with such knowledge for them to improve what they do and thus to approach the ideals of SED.

These are not jobs that social scientists can do alone. An immediately emerging question is about the type of knowledge, instruments and approaches needed to improve sciences (and society's) understanding of human actions and interactions among themselves and with nature.

There is no clear emerging reason to think that the general characteristics of the knowledge needed will differ from those indicated above. However, the renewed expectation that such knowledge will empower and compel humans to improve what they do, and collectively approach SED, puts emphasis on the aspects of reliability and validity that also imply relevance for the users.

To make development improvements effective and sustainable, knowledge will certainly need to be accurate. This is the main concern behind the "objectivity of methods" quality yardstick used under the dominant scientific thinking today. Will this yardstick need to go away to give place to the emerging approaches? Not necessarily.

The objectivity mandate or rigor, as a necessary condition, will still be very relevant and valid. A difference will be in emphasis. In line with the concerns behind objectivity, scientists will need to be much more alert and conscious of the instruments used for observations and interpretations, to ensure they do not provide wrong readings and conclusions. This will be also to anticipate the potential risks of distraction among researchers because of the required interaction with co-participants and attention to the targeted intervention and results of the PAR.

In any event, scientists will need new instruments to handle the greater complexity of dealing with humans as subject in the research, but also to take advantage of people's ability:

- to respond to research queries about past and ongoing experiences, and
- to participate in purposely targeted or designed interventions or actions.

These new instruments will challenge some aspects of the objectivity mandate as applied today, specially the "detachment" of researchers from their subject of research. As PAR experiences anticipate, greater closeness, interaction and sharing of research responsibilities and learning, emerge among researchers and co-participants in the context of the research. At the moment, there is no compelling evidence to believe that this situation will impede attention of researchers to all aspects of objectivity, especially to impartiality and neutrality. Certainly this attention will become more a matter of choice and discipline for the researchers than it is today, including the choice of methods to show such objectivity in the research.

A similar conclusion emerges regarding the possibility of PAR scientists making scholarly contributions. Additional and specific decisions and efforts on the part of the researchers and in the design of the projects and programs will be needed. Thus far and in great measure, scholarly contributions have not been well delineated, usually because they have been superseded by the practical contributions of the PAR approach or effort. However, authors such as Bartunek (1993) refer to the great potential for scholarly contributions found in PAR type efforts at the time, even when the reviewed publications or reports did not highlight them well enough.

There is room and need for scholarly contributions in many specific fields, such as organizational design, including self-design; organizational and group learning; diffusion of innovations; formation and work of knowledge support networks; fostering of new ideas and capabilities; and others of interest for different disciplines. There is also need for more systematic description and assessment of:

- collaborative practices involved in given interventions, and
- mediating factors or mechanisms that help or prevent intended impacts.

Many of these descriptions and assessment will also be useful for researchers that are not PAR practitioners. Better description of change processes, contrasting reaction across participants with different familiarity with the new ideas tried, for example, may contribute to theory building about change processes (Bartunek, 1993), etc.

The resolve of researchers to make scholarly contributions may also require specific strategies and additional support built into the design of PAR efforts. A strategy being incorporated in projects supported by the People, Land and Water program of IDRC in Africa and the Middle East shows promises. Mainly to capture learning from the process, to assess what works and what does not, and to produce training materials, teams have assigned the responsibility to “follow and document the process” to someone in the team or to someone hired just for this. The person also promotes and facilitates “reflection” moments, in which the team joins for revisiting and discussing the process or experiences, with the help of the documentation and analysis. This requires adjustments in the project design and resources, to specify and respond to the added tasks and the expected results. The model should also work when focusing on more specific research issues and their documentation or publication. It also offers a future desirable scenario where:

- most of the task for facilitating the action and participation required by the overall effort can be delegated to other practitioners, and
- researchers can allocate more time and effort to pursue scientific questions, lessons and principles of more general applicability but still as part of the PAR effort.

Conclusion

As final conclusions of the review focusing PAR approaches and their relation with science and development, we can say that:

1. There are remaining challenges for the proponents but also for the critics of PAR. They include the need for more concerted attention to develop further and demonstrate the value of the emerging approaches in terms of outcomes and friendliness in terms of implementation, or to propose better alternatives for similar job.
2. Both camps may need to come together sooner than many expect because of
    - the increasing realization of the imperative to close the gap left by science regarding SED, which PAR practitioners are addressing,

- the emergence of similarly complex challenges even across the "hard" sciences, both from within their respective subject matters independently or in the relation of that subject matter to humans, and
- the strengthening of wider social, political and economic trends – including more generalized respect for human rights, democratization, decentralization, globalization – which are intensifying the call for participation on equal footing.

3. Changing the relationship between researchers and those who participate in it involves political and personal transformations, which also call for institutional changes to accommodate and support the new roles for researchers within a process that is flexible and re-flexible rather than linear. This also calls for new policies regarding incentives and performance appraisals for researchers.

As to where this is going or should evolve? The next are two likely and simultaneous challenging areas of evolution:

1. Closer and clearer links of research with development efforts and policy implementation. Thus far PAR efforts are designed at best with the expectation of providing contributions to development efforts and impacts that are wider than those from the research effort. Ideally such development efforts would be designed to scale up the results of the PAR. This model is still under work and a challenge for practitioners. Options for the future include: PAR practitioners become part of teams in development projects – or policy implementation efforts - right from their design stage. This is to improve the science- knowledge-content of the project design, and of its monitoring and adjustment mechanism to ensure better delivery. This should also provide researchers an opportunity for designing their contributions in the context of the development effort, where the action and the participation are part of the overall project and could be facilitated by other members of the overall team.
2. Devolution of the tasks of facilitating the participation and the action in PAR to other participants in the effort. This requires considering PAR as the combined and shared responsibility of researchers and other groups constituting the innovation or development system in case. This could be the case of specific development or policy implementation efforts as suggested above. For more sustainable and wider results, however, this requires a more holistic treatment of the whole innovation system in case, to reinforce the components and actions that complement research in it. The "how to accomplish this" is in itself another challenge for research. Hopefully this research will build on the accumulated experience of PAR practitioners and their approaches, which included attempts by researchers to compensate for gaps or weaknesses they found in such innovation systems.

References

Bartunek, J.M. 1993. Scholarly Dialogues and Participatory Action Research. Human Relations Journal Vol. 46, No. 10, pages 1221-1233.

Brandt, E. 2003. Action Research in User-Centred Product Development. Paper published by Springer-Verlag London Limited, pages113-133.

Brown, R.H. 1998. Modern Science and Its Critics: Toward a Post-Positivist Legitimization of Science. New Literary History (A Journal of Theory & Interpretation) Vol. 29, No. 3, pages 521 - 550.

Castellanet, C. and C. Jordan, 2002. Participatory Action Research. Chapter 2 of Participatory Action Research in Natural Resource Management a Critique of the Method Based on Five Years' Experience in the Transamazonica Region of Brazil, Taylor and Francis, New York.

Chambers, R. 1994. The Origin and Practice of Participatory Rural Appraisal, World Development Report, Vol. 22, No. 7, pages 953-969.

Consortium for Science, Policy and Outcomes. 1995. Introduction to: Science the Endless Frontier 1945-1995, Learning from the Past, Designing for the Future, Conference highlights. Arizona State University, http://www.cspo.org/products/conferences/bush

Cornwall, A. and R. Jewkes, 1995. What is Participatory research? Social Science & Medicine, Vol. 41, No. 12, pages 1667-1676.

Dalrymple, D. 2003. Scientific Knowledge as a Global Public Good: Contributions to Innovation and the Economy. Proceedings of a Symposium - The Role of S & T Data and Information in the Public Domain, Session 1, pages, 35-51. The National Academies Press.

Fulgsang, L. 2001. Thre perspectives on science, technology and society studies (STS) in the policy context. Research paper 12/00, Department of Social Sciences, Roskilde University, Denmark. In: Visions of STS: Counterpoints in Science, Technology and Society Studies, Cutcliffe, S. and Mitcham, C. (Eds). State University of New York Press.

Georgescu-Roegen, N. 1971. The Enthropy Law and the Economic Process. Harvard University Press, Cambridge, London.

Goleman, D. 1998. Working with Emotional Intelligence. Bantam Books, New York.

Karle, J. 1995. The Role of Science and Technology in Future Design. http://nobelprize.org/physics/articles/karle/

Kates, R. 2001. Sustainability Science. Policy Forum:Environment and Development, Science Vol 292, 27 April 2001, www.sciencemag.org

Kuhn, T. 1970. The Structure of Scientific Revolutions, University of Chicago Press, 1962, 2nd edition, enlarged, 1970.

Lee-Sohng, S. S. 1995. Participatory Research and Community Organizing. Paper presented at The New Movement and Community Organizing Conference, University of Washington, Seattle.

McKee, N. et al . 2000. Involving People Evolving Behaviour. Southbound, Penang; UNICEF.

North-South Centre (2004), Convergence of Sciences: inclusive technology innovation processes for better integrated crop and soil management. Wageningen University. http://www.north-south.nl/index.php/item/163

Pray, L. 2003. Interdisciplinarity in Science and Engineering: Academia in Transition. Science's Next Wave, SCIENCE magazine and the American Association for the Advancement of Science. http://nextwave.sciencemag.org/cgi/content/full/2003/01/15/5?

Reason, P. and B. Goodwin, 1999. Toward a Science of Qualities in Organizations: Lessons from Complexity Theory and Postmodern Biology. Paper (to be published in Concepts and Transformation). Complexity Research Program: www.psych.lse.ac.uk/complexity/ PDFiles/publication/goodwen.pdf

Röling, N. 2000. Gateway to the Global Garden: Beta/Gamma Science for Dealing with Ecological Rationality. Eight Annual (IDRC) Hopper Lecture, ISSN 1198-0303; 8, University of Guelph, Ontario, Canada.

Sagasti, F. 2003. The Sisyphus Challenge: Knowledge, Innovation and the Human Condition in the 21st Century. FORO Nacional / Internacional, Lima, Peru (www.globalcentres.org/html/docs/Sisyphus_Challenge.pdf)

Sellamna, N. 1999. Relativism in Agricultural Research and Development: Is Participation a Post-Modern Concept? Working Paper 119, Overseas Development Institute.

US National Science Board. 1997. Government Funding of Scientific Research: A Working Paper of the National Science Board. NSB-97-186. http://www.nsf.gov/search97cgi/vtopic

Moving into Frontiers: Evolution of AHI

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Abstract

The intensively cultivated highlands ecoregion was chosen by the founders of the AHI in 1995 as an area where partnership could make a difference. AHI facilitates collaboration and institutional strengthening of partner research organizations that provide useful contributions to solve complex issues related to natural resource management (NRM) and agricultural productivity. Solving the conundrum of poverty and land degradation has been the driving force and heart of AHI's regional work. During formation, AHI started as a CGIAR initiative, but early on NARIs joined in and AHI became one of the 18 networks and programs led by the Association to Strengthen Agricultural Research in East and Central Africa (ASARECA) in 1995. AHI has evolved substantially during each 3-year phase. In Phase 1 (1995-97), AHI was organized around a regionally determined set of separate thematic technical agendas, where an early evaluation indicated that this arrangement was too top-down and theme based and would not achieve the necessary integration, systems approach, or partnerships. In Phase 2 (1998-2000), AHI used a "participatory, integrated agro-ecosystem management approach" emphasizing local development of multi-disciplinary research teams and partnerships in the benchmark sites to achieve sustainable intensification and diversification of farm systems through participatory testing and farmer integration of multiple technologies. In phase 3 (2001-2004), it was realized through stakeholder analysis that more focus on 'integration' and working at more scales, levels and disciplinary dimensions to achieve better NRM, income and food gains was needed, so integrated natural resource management (INRM) methodology and approach development and institutionalization became AHI's focus as played out in "participatory, integrated watershed management". During AHI's evolution, the conceptual underpinnings changed and grew given the 'new ways of working'. These are reviewed in the paper: NRM to INRM; on-farm research to participatory action research; R&D to R4D; new working relationships and roles; outputs to outcomes; plot to farm to watershed management; component to systems thinking; towards integration; technology transfer model to farmer innovation model.

Chapter 2:

Addressing Bottlenecks to Enhance Impact

Facilitating Participatory Processes for Policy Change in NRM: Lessons from the Highlands of SW Uganda

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Abstract

Despite the recognition that policy processes are important for sustainable natural resources management (NRM), there is concern that agricultural research and technology development have not been reflected in policy change, nor have they affected decision-making processes of wider communities. Most policy research focuses on policy analysis, often at the macro, national level, ignoring the much more difficult and rather murkier part on how to get policies implemented and adopted by users; and how to get the intended beneficiaries, small-scale resource poor farmers, to influence policies in NRM. This paper reports results of a participatory policy action research process that aimed at strengthening local-level processes and capacity for developing, implementing and enforcing local policies and byelaws to improve the adoption of NRM technologies in Kabale, Uganda. The action research was built around six key components: (i) community visioning and planning; (ii) participatory policy analysis; (iii) policy dialogue linking bottom-up processes to higher level policy processes; (iv) policy learning events; (v) policy process management, and (vi) supporting policy action at different levels. As results of this process, the pilot communities have formulated and implemented a number of integrative byelaws on soil erosion control, tree planting, animal grazing, wetlands management, bush burning and food security. Results suggest that recent decentralization reforms in Uganda provide significant opportunities for research to influence and support the process of policy change in NRM. To influence policy change in NRM, the paper suggests a five "INs" approach: (i) strengthening local institutions; (ii) providing information;(iii) linking byelaws to NRM innovations; (iv) promoting incentives, and (v) building network of influence. Influencing policy is, however, a long process that needs perseverance and commitment, and a sustained programme of interventions by multiple stakeholders.

Introduction

Natural resource management (NRM) is becoming a relatively new and expanding thrust in policy research on African agriculture. Many of these studies have concluded that if natural resources are to be protected against the risk of destruction, it is essential that governments devise a range of policy instruments that can influence behaviour for the adoption of technology innovations and institutions that promote sustainable management of natural resources to alleviate poverty (Omamo, 2003; Scherr *et al.,* 1996; Shiferwa and Holden, 2000, Egulu and Ebanyat, 2000; Pender *et al.,* 2001). The new paradigms of integrated natural resource management "INRM" (Sayer and Campbell 2001), sustainable livelihoods approaches "SLA" (Carney, 1998; and integrated agricultural research for development "IAR4D" (FARA, 2003) emphasize the need to broaden natural resource management (NRM) research from technology solutions to include socio-economic and policy dimensions, with emphasis on participatory approaches that redefine the role of scientists, farmers and other stakeholders. All these approaches explicitly recognize that policy support is an essential ingredient for widespread adoption and scaling up of NRM technologies and innovation.

However, despite the recognition that policy processes are important for sustainable livelihood outcomes and natural resources management, there is concern that NRM research and technology development have not been reflected in policy change, nor have they affected decision-making processes of wider communities (NRSP, 2000). Most research on agricultural policy has been concerned with macro policy studies at national, and international levels. There is an implicit assumption that if research results are taken on board by policy-makers, planners at the higher levels, there is high probability that research results will translate into policies that can be implemented at lower levels. In their recent review of policy research on African agriculture, Idachaba (2001) and Omamo (2003) observed that agricultural researchers and policy analysts have failed to put Africa's agricultural problems on the policy agenda in more than abstract fashions. Idachaba (2001: 46) contends that policy analysis is the easier part, "the much more difficult and rather murkier part is to get the policy implemented and adopted by users; that is to get the results of policy analysis and policy recommendations into political decisions by governments". There is still a critical gap in policy research to provide insights for change in local communities (Scherr et al., 1995). Omamo (2003) recommends a different approach to policy research focusing on piloting action research in case studies of innovative approaches for identifying convincing *how to* answers. Other studies (Scherr et al., 1995; Idachaba 2001; Keeley, 2001; Vincent, 2003; Scoones and Thompson 2003) have argued that participatory research approaches could make a significant contribution towards this critical, yet missing area of policy research.

For more than two decades, participatory methodologies have proved effective in enabling people to take greater control of the development process. However, with few exceptions, efforts have not focused on increasing local participation in policy review and formulation (Scoones and Thompson 2003). In a recent summary and reflection based on field experiences in participatory research in NRM, Vincent (2003) observed that there is still a critical gap for participatory research to address wider policy initiatives for transforming NRM, or how to build new policies to support NRM. Recent decentralisation efforts in Uganda have shown promising improvement in the participation of local people and other stakeholders in the policy decision-making process. These changes have brought some impressive results, creating a fundamentally different environment for an open and participatory policy and decision -making at the lower local community level (Saito, 2003; James 2002). However, despite such progress, there is concern that decentralisation has not resulted in improvements in the management and use of natural resources, nor has it affected the capacities and decision-making processes of local communities over the management of natural resources.

This paper reports results of a pilot participatory policy learning and action research project aimed at strengthening local-level processes and capacity for developing, implementing and enforcing local policies and byelaws and other local policies to improve the use and management of natural resources in the southwestern highlands of Uganda. The main thrust of this action research is supporting and facilitating the integration of participatory approaches to policy decision-making by building and strengthening local community capacity to initiate, formulate, review and implement policies and byelaws that promote the adoption and wider impact of improved NRM technologies. The rest of the paper is organized into five sections. First we describe the research setting and its institutional and policy framework. The results of the application of the framework are presented in five points based on the operational framework for participatory policy action research: community visioning and action planning, participatory byelaw analysis, policy learning events; and policy dialogue linking bottom-up and top down processes, mechanisms for policy process management and for supporting policy action. The implications for policy research in NRM are discussed in the concluding section.

THE RESEARCH CONTEXT AND SETTING

The action research was conducted in four pilot communities in Kabale district in the southwestern highlands of Uganda. Kabale is a mountainous district (1500 to 2700 masl) characterized by semi-permanent bench terraces along the contours of the hills, and seriously fragmented arable lands (ranging from 0 to 38 small plots, and average size of individual plots of 0.1 and 0.7 acres). The degree to which fragmentation appears on the landscape is deemed excessive, and has been found to impede incentives for better management of distant plots, and makes collective action on soil conservation and management efforts exceedingly difficult (Bamwerinde and Place 2000, Raussen *et al.*2002). Many of the old terraces have seriously deteriorated, and as a result, soil fertility decline and erosion are a serious problem. Results of a participatory field assessment of land degradation in four pilot communities in the Mugandu-Buramba watershed estimated that about 90% of the watershed land is affected by erosion due to slope, population pressure, deforestation, poor farming and vulnerable soil (Mbabazi *et al.* 2003).

Kabale is one of the eight benchmark sites of the African Highlands Initiative (AHI). AHI was established in 1995 as a CGIAR ecoregional program to focus on the issues of land degradation and agricultural productivity in the densely populated highlands of Eastern Africa. AHI's guiding philosophy is a client-driven approach using participatory methods and an effective research-development continuum to foster farmers' innovation and collective action for designing and disseminating appropriate, integrated technologies and innovations for improving watershed management. Recognizing that policy support is always needed for the adoption of NRM innovations, AHI established a policy-working group to increase the policy relevance of research at the local level, and to design alternative policy instruments to facilitate adoption of NRM technologies (AHI 2001). Kabale is one of the two AHI benchmark sites where participatory policy experiments are being tested to improve watershed management.

INSTITUTIONAL AND POLICY FRAMEWORK

Decentralization in Uganda is one of the most ambitious reforms of local governance in Africa. The decentralization process was initiated in 1986 and culminated in the 1995 Constitution and the 1997 Local Government Act which provide the legal framework for the participation of local communities in policy-making. The mechanisms of decentralization are established and functioning, with the structure of a five-tier system of local councils and local government structures, a bottom-up planning process, and powers to collect and disburse local revenue (James *et al.,* 2001; Saito, 2002), develop and implement byelaws and local policies for land use, environmental management and agricultural production.

Table 1. Decentralised structures in Uganda: levels and main functions (*Adapted from Raussen, 2000).*

Local Council Level	Composition	Functions
Local Council 1: Village (composed of more or less 50 households	9 members, at least 4 women	Assist in maintaining law, order and security Initiate, support and participate in self help projects Recommend persons for local defence units Serves as communication channels with government services Monitor the administration of projects Impose service fees Collect taxes Resolve problems and disputes Make byelaws
LC 2: Parish (composed of 3-10 villages)	Depending on the number of villages elected from the village chat least 4 women	Assist in maintaining law, order and security Serves as communication channels with government services Initiate, support and participate in self help projects Monitor the administration of projects Resolve problems and disputes
LC 3: Sub-county (Composed of 2-10 parishes)	Depending on the number of parishes, 1/3 women 2 youth 2 persons with disabilities elected councillors from parishes	Local government Enact byelaws Approve subcounty budget Levy, charge, and collect fees and taxes Monitor performance of government employees Formulate, approve and execute sub-county budgets Resolve problems and disputes
LC 4: County (composed of 3-5 sub-counties)	5, chairpersons or vice-chairperson from each subcounty	Advise district officers and area members of Parliament Resolve problems and disputes Monitor delivery of services
LC 5: District (composed of 3-5 counties)	36 members 12 women councillors 2 youth 2 people with disabilities 19 elected councillors	Exercise all political and executive powers Provide services Ensure implementation of government policies and compliance with it Plan for the District Enact district laws and ordinances Monitor performance of government policies Levy, charge and collect fees and taxes Formulate, approve and execute district budgets

At the base of the local government structure, the local council or LC1 (village of about 50-100 households) consists of all adults residing in a particular village who elect a nine-member village local council executive committee. Beyond the village or LC1, in ascending geographical size, there are parishes (LC2), sub-county or *gombolola* (LC3), county (LC4) and district (LC5) councils. The sub-county level (LC3) is the basic unit of local government, both political and administrative. The district (LC5) is the highest level of local government and links with central government. The provision of local government elections guarantee widespread representation at the various councils and include quotas by gender, people with disabilities, and youths. For example, at least one-third of the council members must be women, an affirmative action to empower women and promote gender equity.

Results

The project's approach is grounded in the tradition of action research (Reason and Bardbury, 2001; Dick 2002), a process that pursues action (policy change) and research (understanding of policy process), at the same time learning by doing (participatory natural resources management). The results of the study are discussed following the key components of the framework (figure 1) built around the following key components: i) community visioning and planning; ii) participatory policy analysis, iii) participatory policy learning, iv) policy dialogue, v) supporting policy action, and vi) policy process management.

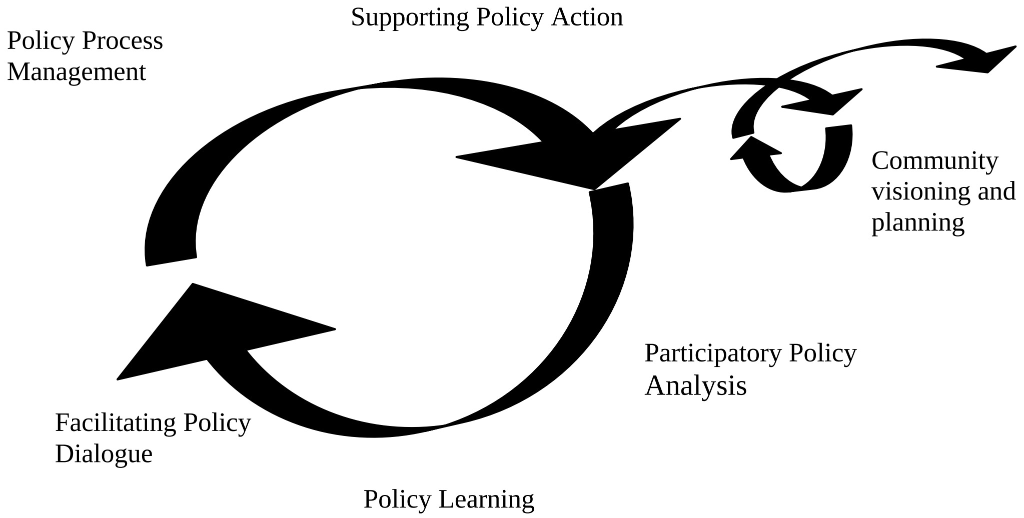

Figure 1: Operational framework for participatory policy action research

Engaging with rural communities and developing visions of desired future conditions

Most participatory research projects routinely start with a participatory rural appraisal (PRA) exercise to identify problems and constraints in the farming system, and as an entry point into communities. Recently, PRA has come under criticism for being superficial, extractive, transitory, unable to initiate change and build local capacities (Ashby, 2003; Cook and Kothari, 2001), and lack adequate process of follow up. At the heart of initiating participatory policy analysis and action, there was an intensive and iterative process of community visioning to stimulate collective learning and articulation of collective visions of desired future conditions. One important tool for community visioning is the "river code" (Timmel and Hodzi 1984). The "river code" is a play used for stimulating self-awareness and establishing dialogue for discussing participation, social change and approaches to development. It helps farmers and rural communities to realize the potential for change, and the need to be cognizant and understand the forces that can facilitate or constrain change, and define workable strategies for seizing opportunities and dealing with potential challenges. An important principle of this approach is that it starts with an analysis of strengths and opportunities, rather than problems and constraints.

The river code is based on the SARAR technique (The World Bank, 2000), which stands for the following five attributes:

- Self-esteem: a sense of self-worth as a person as well as valuable resource for development;
- Associative strength: the capacity to define and work toward a common vision through mutual respect, trust and collaborative effort;
- Resourcefulness: the capacity to visualize new solutions to problems, and the willingness to take risks;
- Action planning: combining critical thinking and creativity to come up with new, effective and reality-based plans in which each participant has a useful and fulfilling role; and
- Responsibility: for follow through until the commitments made are fully discharged and the vision of benefits achieved.

Visioning using SARAR techniques has the advantage of facilitating an internal drive for change, starting with collective analysis of opportunities, strengths and community assets and bring different perspectives for achieving collective visions. Combining SARAR with creative participatory tools such as community resources and social mapping is useful for fostering and strengthening community skills in systematic action planning, monitoring and evaluation. Through this process, all the four pilot communities have developed action plans with desired outcomes, explicit objectives, activities, roles and responsibilities of different stakeholders and partners. One of the key components of the community action plans clearly specified the need to strengthen communities' capacities to review existing byelaws, formulating new ones to facilitate collective action in the implementation of action plans for better management of watershed resources. It was therefore important to initiate participatory processes for analyzing the different byelaws to identify the key problems in their implementation and identify opportunities and incentives for their effective enforcement.

Participatory byelaw analysis

In this paper, we use the term policy in its broad sense to refer to laws, rules and regulations and their implementation resulting from public (state) or collective decision-making (Thomson 2001, Means *et al.* 2002). Policies can be generated and operate at different levels: international, national, regional, district and local levels. In this study, we are particularly concerned with those local-level policies and community regulations usually referred to as byelaws. Byelaws are rules made by lower local councils (LC1 and LC3) and provide the local policy guidelines to be followed in sectoral developments, such as agriculture and natural resource management. These byelaws or local arrangements for natural resource management are now receiving greater attention as a viable alternative for enforcing government policies and rectifying their inefficiencies in agriculture and NRM.

Across all the four pilot communities, the process of community planning identified six general byelaws in agriculture and natural resource management (soil and water conservation, food security, tree planting, bush burning, controlled grazing, and swamp reclamation bye-law). Each of these byelaws has specific regulations and enforcement mechanisms. The study found that there was a considerable awareness of existing byelaws and their different regulations and implementation mechanisms. However, the majority of these byelaws were formulated before the independence by British colonial administration without local participation, with strict enforcement mechanisms, often using force and coercion. Majority of farmers were not satisfied with their implementation mechanisms, and many of the byelaws are now outdated.

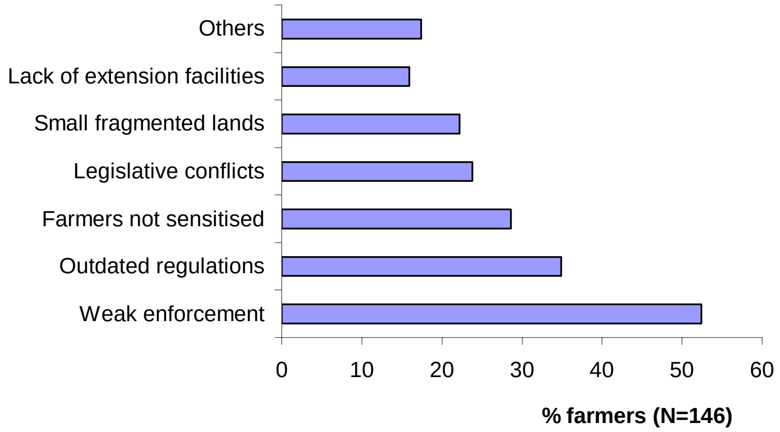

Figure 2: Farmers' assessment of the reasons for weak and effective bylaws

Table 2: Knowledge and assessment of the effectiveness of selected byelaw regulations

Details of the regulation	Percentage*	
	Effective	Not effective
Construct bunds across the slope parallel to the contour	77.8	19.0
Plant appropriate vegetation on the bunds	63.5	27.0
Construct barriers guided by extension worker	30.2	54.0
Not planting annual crops on steep slopes	28.6	27.0
Planting crops along the contour	34.9	49.2
Demarcating two agricultural plots with mark stones	81.0	14.3
Paths, cattle tracks and access roads protected against erosion	17.5	30.2
Any person who cuts a live tree shall plant two and ensure they are protected and looked after	68.3	31.7
Farmer shall ensure livestock graze only when herded	92.1	1.08
Livestock shall graze in own piece of land except with consent of land owner	74.6	25.4
Animals shall not take water from same point used to draw water for domestic uses	92.1	0.8
Pigs shall not graze where other animals graze	79.4	17.6
No grazing in crops and farmers whose crops are destroyed shall be compensated	96.8	3.2
No person shall set fire to a bush or part of it without authorisation	85.7	7.9
In the event of fire outbreak all able bodied members of community will participate in extinguishing it	82.5	17.5

** Percentages do not add up to 100%. Some regulations were not known to farmers.*

Using a number of participatory techniques, we encouraged farmers to think creatively about potential arrangements to encourage compliance and equitable implementation of byelaws, by constantly asking questions such as: For whom is this a problem? Who benefits from the byelaw and how? Who loses out from the byelaw and how? Who will have difficulty in complying and why? What mitigating arrangements can be introduced for strengthening byelaw implementation?

The analysis revealed that some categories of farmers have difficulties in complying with many of the existing byelaws. These include older men and women, widows and orphans with limited family labour or money to hire labour and to buy implements like spades and hoes needed to establish conservation measures. Farmers with alternative sources of income, which are more lucrative than farming, may not have time for putting up conservation structures on the plots they are using for food security. It was also revealed that small livestock owners, especially women, who don't own grazing land or large farm sizes will have problems complying with the controlled grazing byelaw. The byelaw may force the poor to sell their livestock, and will increase poverty, conflicts and hatred among farmers.

Participatory Policy Learning

As observed by Norse and Tschirley (2000), in many cases policy makers don't know what kind of information they can reasonably expect or ask for from the R&D community. For example, we found that the majority of political leaders and policy-makers were not aware of the existing byelaws and NRM policies, their regulations and implementation mechanisms, and the process of formulating byelaws. A proactive role was essential in assessing the information needs of policy makers and develop effective communication strategies for guiding and informing debate and fostering public understanding of the policy process. The project initiated a series of policy stakeholder workshops and other learning events (seminars, field visits, documentation) to increase the relevance of research to policy makers, to communicate research findings to policy makers, to catalyse local political support for positive and sustainable NRM. Over the four years of the project, we have facilitated a dozen of policy stakeholder workshops and seminars. In addition to these regular workshops and policy meetings, one strategy has been to organize and facilitate field visits to identified success cases. This has had a much bigger effect to convince policy makers, local leaders and farmers by seeing things with their own eyes, and sharing of experiences with more innovative farmers. We found that this process has been very useful not only for exposing policy makers and farmers to innovative NRM technologies, and research results but also to build their confidence and capacity to engage in policy dialogue with other stakeholders.

Another important aspect of policy learning was to use policy narratives and developing NRM scenarios. These have the advantage of simplifying complex problems and making them amenable to better understanding and decision-making (Keeley, 2001). For example, the soil fertility loss narrative has been a powerful strategy for getting policy makers learn about and supporting agroforestry policies and byelaws. These types of narrative, coupled with field visits to research stations and on farm demonstrations, have been useful for getting policy support for the tree planting and agroforestry byelaws.

Promoting and facilitating policy dialogue

Despite considerable progress in local government reforms, it is only to a limited extent that policy makers seek information from key stakeholders in designing and formulating policies. James *et al.* (2001) observed that decentralization in Uganda is still a relatively young process, and does not yet constitute a genuinely participatory system of local governance. Farmers and local communities are often limited to simple representation and the small-scale poor farmer is often forgotten.

Effective policy dialogue must be based on effective and sustainable local institutions (or mature social capital) capable for engaging local communities directly in the articulation of their needs, analysis, design and implementation of NRM policies and innovations. The presence of social capital is a necessary pre-condition for the participation of resource-poor farmers in policy formulation and implementation, in research and development activities, and for the adoption of NRM innovations that require collective action and collaboration.

The main thrust of this action research is supporting and facilitating the integration of participatory approaches to policy decision-making by strengthening local-level processes and capacity for developing, implementing and enforcing byelaws and other local policies to improve natural resources management. At the community level, the policy dialogue seeks to explore the multiple perspectives of resources users with the aim of gaining credibility and support of different categories of farmers through more inclusive and consultative processes**.** To make policy dialogues more effective and participatory, some specific efforts were necessary to strengthen the weakest stakeholders-the farmers, to be effective partners in the policy dialogue with district-level stakeholders. We used a range of participatory techniques and and other adult learning methods (The World Bank, 2000) for engaging and empowering local communities directly in the articulation of their policy needs, and in the analysis, design and implementation of policies and innovations. This has involved coaching and mentoring farmers' representatives to break passiveness and increase their assertiveness and confidence in articulating their policy needs and collective NRM visions.. It has been particularly insightful to sequence policy dialogues with farmers' exposure or exchange visitsand with interactions between between the different communities where they harmonise their policy needs, and demands. This also provides a good opportunity to share experience, rehearse presentations, and strategize interventions to the policy dialogue. As a result, the most interesting moments during the policy dialogues and stakeholders' workshops are when farmers articulate their community visions and experiences with the process of reviewing, formulating and implementing byelaws.

Despite progress made at the village level, it was recognised that the strengthening of community level processes cannot stand on its own. The link with local government structures is a critical element to any policy process. The subcounty and the district constitute critical aspects of the decentralisation system as they have important political and administrative powers to make byelaws, prepare development plans, budgets and allocate resources. The subcounty is the basic political and administrative unit of local government that enacts byelaws and resolves disputes. This level has good potential for stimulating local organisations and democratic processes to deliberate and influence policies from bottom up. The different byelaws initiated at the village level were presented and debated at the subcounty level for harmonisation and better co-ordination before they were enacted into byelaws.

The District level dialogues are usually high profile events aimed at raising and refocusing the policy debate. The focus of the project is on building a network of actors who can influence the policy process with messages tailored and focused to gain attention and support. Five policy stakeholder workshops were held over the three years and brought together a large number of participants (80-100), district leaders and councillors, members of parliament, subcounty councillors, local government technical services, research and development organisations, and farmers representatives, and in the later years representatives of neighbouring districts and national institutions. The Policy workshops and task forces offer a good opportunity to achieve closer relationship between the different stakeholders in policy formulation process, and for increasing the relevance of R&D to the needs of political leaders and policy makers.

Policy process management

The thrust of the project is that farmers and local stakeholders are likely to see byelaws and other decisions they have participated in making as legitimate, addressing their own needs and constraints. Such byelaws are likely to be more effective and implemented by the communities, drawing on social capital mechanisms. However, a byelaw cannot be only a statement of intent. It needs to specify the institutional mechanisms that would translate the byelaw into practice, monitoring their implementation, reporting and sanctioning non compliance. The project uses three mechanisms for managing the process of byelaw formulation and implementation. These mechanisms are complementary and feed into one another. They include bottom-up community-level inclusive processes; subcounty-level policy processes and district level policy stakeholders' task force.

At the community level, the project initiated the formation and facilitation of village-level byelaws committees. The formation of these committees followed a more inclusive and participatory process for electing the committee members and defining their roles and responsibilities, as well as mechanisms for consultation and accountability. The formation of village byelaws committees followed a process that was open and inclusive of all social categories in the community. In general, a village byelaw committee or policy task force could have between 5-8 elected and appointed members with considerable representation of women (at least 40%), and local government officials. The roles and responsibilities of the byelaws committees include: initiate and facilitate the review of existing byelaws, and formulation of new ones; facilitate the implementation of byelaws turning rules made into use, monitoring and reporting implementation, reporting non-compliance and linking with higher-level policy institutions and development organisations.

It is important to note that where the byelaw committees are integrated into other forms of social organisation, and where the local council (LC) was supportive and part of the process, there have been many more opportunities to discuss byelaw issues. In communities where there are farmers groups working on agriculture and NRM, they usually have weekly meetings for the group. For example, in Muguli village, the byelaw committee is a part of a community group working on natural resource management and reports at each community group. The chairperson of the Village local council (LC1) and a number of LC1 executive are members of the community group with different responsibilities and positions in the group.

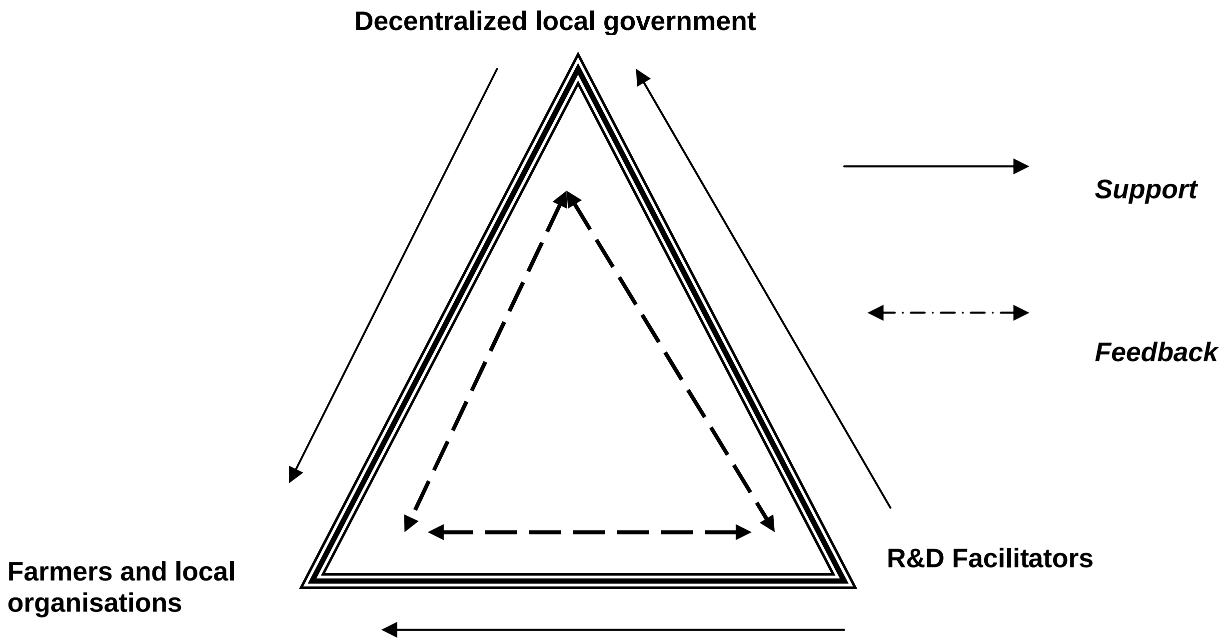

Figure 3: Policy task forces: triangle of the tripartite relations of key actors in NRM. Source: Adapted form Catacutan *et al.* (2001)

The management of the policy process is by a skilled community development facilitator to strengthen the self-organizational capacities within communities, stimulating collective analysis of byelaws and local policies, and motivating and facilitating people to participate in policy learning process. At the subcounty and district levels, the policy task forces are modelled to the "landcare triangle" (Figure 2) of the tripartite relations of key actors in NRM: farmers, local government, and R&D technical facilitators (Catacutan *et al.* 2000; Garrity *et al.* 2000). These task forces help create space for constructive exchanges and dialogue between local community and local government as well as other key policy stakeholders.They also serve as a kind of steering committee to follow up plans, and monitor implementation of the project. These task forces, usually (but not always) chaired by the local council leader and comprising of local NRM champions and district leaders have been instrumental in building networks of influence for influencing policy change and supporting the implementation of byelaws formulated by local communities.

Supporting Policy Action

As a result of this process, the pilot communities have reviewed and formulated a number of byelaws for improving agricultural production and natural resources management. These include byelaws on soil conservation and erosion control; on tree planning, on controlled grazing, drinking and wetlands management. These byelaws were debated at the subcounty and harmonised for their general application to other villages and parishes. Sequencing policies was important. Many policies and byelaws have failed because they tried to do so much too soon, with little time of efforts to learn by doing. Piloting byelaws in selected communities offer policy makers, research and development agents and other stakeholders the opportunity to test the implementation of policies and byelaws, and their effectiveness in terms of sustainable NRM practices before expanding to other areas.

For example, the soil and water conservation byelaw states that:

- Nobody in the village is supposed to clear land for cultivation, whether a resident in the village or not, on a slope where erosion can easily take place, without establishing trenches. Nobody in the village is supposed to cultivate his or her plot without putting a trench and planting stabilisers like elephant grass.
- Areas that do not accommodate trenches or where trenches cannot be accommodated, elephant grass and legume grasses to act as stabilisers should be planted.
- Every member of the community who accesses water from the community source is supposed to participate with the rest of the community in cleaning and fencing on an agreed routine and timetable.
- Any member in the village who wants to destroy a bund (Enkkiigo) should do it in the presence of a neighbour.
- Nobody in the community should wash near the source of water and anybody in the community who has land near the source of water or spring should leave some metres (1-2) before cultivating. And anybody who possesses land near a road reserve or where there is a trench or community path should leave at least 1 or 2 metres before starting to cultivate.
- Anybody in or outside the community who is to hire land from the owner or neighbour for cultivation should be able to first negotiate the conditions of hire and be able to abide by the rules and byelaws set by communities. Anybody in the village who attempts to exchange land with a neighbour in the village should be able to agree with the already formulated policies in the communities/villages.

The tree planting byelaw states that:

- Anybody in the village who cuts a tree should at least plant two and make sure that the existing ones are well protected.
- If any member of the village is to plant trees, they should plant only agroforestry trees like Calliandra, Alnus and Grivellia which add fertility to the soil and reduce erosion. They should replant the one that existed after failing to get agroforestry trees.

Some of these byelaws have been implemented with different levels of success in the four pilot communities. As a result of village policy task forces formulating and implementing byelaws, a total of 480 farmers in the pilot communities have established trenches and associated soil and water conservation measures... However, more efficient technologies for stabilising trenches and controlling soil and water run off need to be promoted. It was also reported that setting bush fires in the pilot communities significantly reduced during the last dry season, compared to previous years and other villages not involved in the policy action research process. These achievements have been attributed to the the establishment of byelaw committees and their role in catalysing community participation in the formulation and enforcement of byelaws and sensitisation through meetings in the pilot communities. It is also important to identify key points of leverage, and recognize short-term opportunities associated with related legislative calendars, planning and budgeting activities, changes in key leaderships, political appointments and government personnel. It is important to note that a constraint to effective byelaw implementation was the lack of inputs and technical innovations.

Discussion

The main thrust of this action research was supporting and facilitating the integration of participatory approaches to policy decision-making by strengthening local-level processes and capacity for developing, implementing and enforcing byelaws and other local policies to improve natural resources management. Results of this action research suggest that with current decentralisation in Uganda, there are significant opportunities that research and development can utilise to influence policies, and to translate research results into policy and decision-making of wider communities to accelerate wider-scale adoption and dissemination of NRM technologies. Drawing from Barret et al. (2002), the paper suggests a five “INs” approach (i) strengthening local institutions; (ii) providing information; (iii) linking byelaws to NRM innovations; (iv) finding and promoting incentives , and (v) building a network of influence as effective mechanisms that research and development organisations can use to influence policy action for sustainable NRM. We briefly discuss each of the five elements.

1) Strengthening institutions (local institutions and local government: Results of this paper show that to be effective, decentralization must be supported by strong local institutions or mature social capital. Pretty (2003), Uphoff and Mijayaratna (2000), Woolock and Narayan (2000) and many others have shown that social capital lowers the cost of working together and facilitates cooperation, trust, and collective action. Therefore strengthening social-capital i.e. the self-organizational capacities within communities, and create conditions in which local people are able to formulate, review, monitor and implement appropriate byelaws, and engage in mutually beneficial collective action. One key achievement of this process has been the establishment and functioning of village byelaws committees and local institutions for managing the policy process and facilitating policy dialogues with local government structures and other key stakeholders. These village committees and local institutions have proved to be critical in building support for bye-laws review and formulation, mobilising political, social, human and technical resources that are needed to sustain the participation of local communities in policy dialogue and action, and for the adoption of NRM innovations. They are also supporting mutual beneficial collective action and other important dimensions of social capital such as exchange of information and knowledge, resources mobilization, collective management of resources, cooperation and networking and community participation in research and development activities. They are increasingly becoming a vehicle through which farmers are pursuing wider concerns, initiating new activities, organizing collective action among members and extending relations and linkages with external organisations. They are also increasingly taking the lead in catalysing the development process within their communities, and are increasingly making demands to R&D organizations

Many other recommendations to make byelaws more effective require capacity building of different stakeholders, both local communities and decentralized local government structures. This is a significant role that research and development (R&D) institutions can play to facilitate the implementation of policies and byelaws, and improve the adoption of NRM technologies. Building on the strengths and opportunities of local institutions is essential for unleashing the potential of local communities to develop collective long-term visions of desired future conditions, and realistic plans for achieving them. Research and development have a role to facilitate local communities to articulate their visions and engage in policy dialogue. However, to be effective, local level processes and institutions must be supported by high-level government institutions and policy processes. Facilitating policy dialogue through effective mechanisms to link bottom-up, community level processes that must be complemented and supported by high level institutions and political leaders.

In a decentralised system, the most effective voices in reaching policy-makers are those of the elected local councillors. The inadequacy of human capital at the different levels of local government is a key constraint to policy formulation and implementation. Researchers can have an important influence on policy by helping to build the capacity of local councillors, helping their understanding of the situation, giving them credible data and evidence, and strengthening their confidence. Tailor-made capacity building events targeting those who make and implement policies are critical to have any sustainable policy change. Some of the needs for training identified during one of the policy stakeholder workshop include leadership skills, communication, participatory planning, conflict management, policy process, and as well as technical NRM issues.

2).*Providing Information:* The study revealed that majority of policy makers have a limited understanding of the policy process, and of policies and byelaws they are supposed to implement. In many cases policy makers don’t know what kind of information they can reasonably expect or ask for from the R&D community. It was observed that research results are like any other products that need to be marketed to be used. However, more often researchers rely on more passive communication channels to reach policy makers, producing policy briefs and other technical reports that policy makers and political leaders don’t read. The language of academic researchers is frequently inappropriate to a policy and development audience. To influence policy change, a more proactive communication strategy and effective communication skills are essential to influence policy. Researchers need to develop alternative innovative communication and information strategies and processes in targeting people who make, influence or implement policy. Some powerful means used in this study are tailor-made policy learning events (workshops, seminars, videos, exposure visits, field visits) that aim at disseminating NRM best practices or technologies, share lessons of experiences; and expose policy makers and other stakeholders to existing practices and knowledge that improve natural resources.

An important consideration in communicating with policy makers is opportunistic timing: If researchers wish to influence policy, they must be able to diagnose the relevant policy environment to identify key points of leverage, and recognize short-term opportunities associated with related legislative calendars, planning and budgeting activities, changes in key leaderships, political appointments and government personnel. Identifying and capitalizing on crisis situations,

3). Linking byelaw to NRM innovations: It was evident that byelaws need to be supported by appropriate technologies that can increase agricultural productivity for resource-poor farmers with diminishing land resources. For example, the soil and water conservation byelaw emphasises the use of agroforestry technologies which have multiple purposes and advantages, controlling soil erosion, improving soil fertility, providing feed for livestock, poles for staking and building, and other environmental services. The tree planting byelaw also encourage multipurpose trees, especially fruit trees that provide food and income, in addition to their other environmental services. An important aspect of the success in formulation and implementation of the soil erosion control byelaw was its link with NRM innovations. It is therefore as important to link any byelaw to NRM technologies that would provide sufficient incentives to farmers to implement the policies. In addition to technology innovations, mechanisms for encouraging collective action and farmers' innovations are key to promote and sustain community's interest and participation in NRM. Research and development organizations have a role to disseminate profitable technologies to farmers and provide minimum inputs that are needed to resolve some key constraints and bottlenecks.

4). Finding and promoting policy incentives: Many of NRM technologies needed for the implementation of the soil erosion byelaw require some minimum inputs. Based on their experience with disseminating of agroforestery technologies in the highlands of Kabale, Raussen et al. (2001) recommended a "minimum input strategy" to facilitate widespread adoption of agroforestry technologies. Other empirical studies in Ethiopia (Shiferaw and Holden 2000) showed that policies that link production subsidies with soil conservation could provide opportunities for combating soil erosion. Research could investigate the feasibility of developing a reward system to communities and farmers that are championing NRM issues and implementing the byelaws. This system could be integrated into local government development plans and budgets to provide inputs such as seeds of improved varieties, small livestock, seedlings of high value trees to those communities and farmers that are outstanding in NRM innovations. Such communities could be selected as priority areas for new government interventions and other development initiatives. A "land management fund" could be institutionalized in local government development plans and budgets. Other studies have found that given good knowledge about local resources, appropriate institutional, social and economic conditions, and processes that encourage deliberation and participation, rural communities can work together collectively to use natural resources sustainably over the long term (Pretty, 2003). It is therefore important to provide incentives that encourage community participation in NRM and policy process.

5). Building effective networks of influence To be effective, R&D professionals need to stay close to the policy process, and exploit opportunities that come along to get local community byelaws translated into political decisions or policies. Reaching and influencing policy-makers depends on a number of key issues including: building effective networks of influence, identifying and supporting NRM champions at various levels of local government who champion NRM initiatives and demonstrate keen interest for advancing policies that promote NRM. These political and community leaders consistently played an important role in any policy and community initiatives. The NRM forum coordinated by AFRENA for the dissemination of of agroforestery technologies could be broadened to other NRM and policy issues. The emergence of the coalition for effective extension delivery (CEED), a coalition of major NRM R&D organizations in Kabale is a right step in this direction.

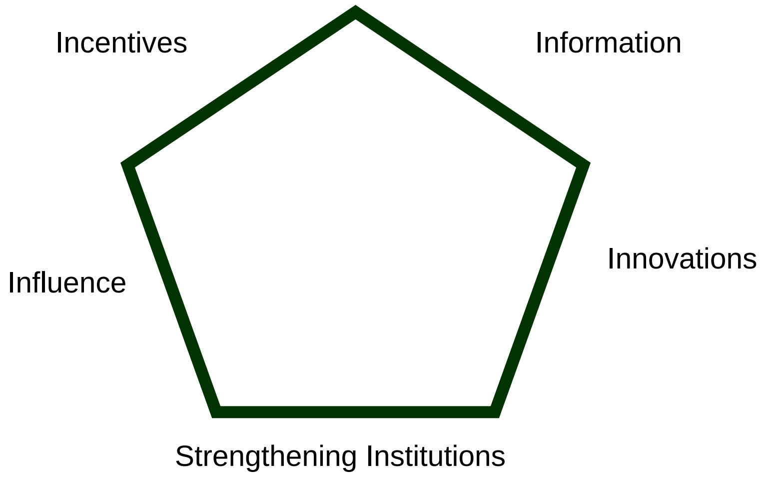

Figure 4: The Five "INs" Model for policy change in NRM

Conclusion

Results of this action research suggest that with current decentralization in Uganda, show that there are significant opportunities that research and development can utilize to influence policies, and to translate research results into policy and decision-making of wider communities to accelerate wider-scale adoption and dissemination of NRM technologies. The paper has highlighted mechanisms that research and development organizations can use to influence policy action and facilitate the participation of local communities in policy processes for natural resources management. Lessons learned suggest that to be able to influence policy, research and development need to adopt and support the policy process. The paper suggests a five "IN's" model for facilitating and influencing policy change: strengthening local *institutions*; providing *information*; linking byelaws to NRM *innovations*; finding and promoting *incentives*, and building a network of *influence*.

One key challenge is, however, how to sustain such processes and linking with national level policy structures. In order for the byelaws committees to become part of the policy making process, there is need to work towards mechanisms to institutionalise such participatory processes for policy formulation and implementation. The decentralization policy in Uganda offers good opportunities for achieving such participatory processes for policy change. Many districts and other decentralized local governments have legislative and executive powers to formulate and implement their own policies and byelaws in NRM. They need support from research and development organizations for using effective ways of engaging local communities in the formulation and implementation of byelaws. At the national level, there are some opportunities that can be realized. Many national level institutions and programmes such as the National Environmental Authority (NEMA), the National Agricultural Advisory and Development Services (NAADS) and nationwide and international NGOs and civil society organizations within and outside Uganda could provide a fertile ground for scaling up such participatory policy action research processes for sustainable natural resources management. Understanding and assessing the outcomes and the impacts of these processes on the status of natural resources, and rural livelihoods in the pilot communities remains an important consideration that requires a longer-term perspective. It is also important to assess the sustainability and uptake of strengthening local institutions for NRM policy formulation and implementation at higher policy level.

The work described in this paper constitutes a promising beginning. Although it is difficult to estimate, about 5 million poor rural people in Uganda live in similar physical environments (taken as the nearby districts of

Kabale, Kisoro, Bushenyi, Mbarara, Rukungiri, Ntungamo, and eastern districts of Kapchorwa, and Mbale), at high population densities, relying on rainfed arable cultivation on steep slopes and valley-bottom wetlands. If the other highlands areas of Tanzania, Ethiopia, Rwanda, Madagascar are included, then the project is representing the conditions of at least 50 million people who live in the highlands areas, where social capital has been eroded. However, it is important to note that influencing policy is a long and complex process that needs perseverance, and a sustained programme of interventions and lobbying by different institutions and actors.

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References

Barret, L.B.; Palce, F. and Aboud, A.A. Eds. 2002. Natural resources management in African agriculture: Understanding and improving current practices: Wallingford: UK. CAB International.

Carney, D. 1998. Sustainable Rural Livelihoods: What Contribution Can We Make?, Department for International Development, London;

DFID (Department for International Development). Not dated. Sustainable Livelihoods Guidance Sheets. Section 5: POLICY REFORM. http:// www.livelihoods.org

Dick, B. 2002. Action learning and action research: Doing good action research" Southern Cross University, Australia

Egulu, B. and P. Ebanyat, 2000. Policy processes in Uganda and their impact on soil fertility. Managing Africa's Soils No 16, IIED, London

FARA (Forum for Agricultural Research in Africa), 2003. Building Sustainable Livelihoods through Integrated Agricultural Research for Development. Securing the future for Africa's children. Volume 1. Programme Proposal. Sub-Saharan Africa Challenge Programme Submitted to the Interim Science Council of the Consultative Group on International Agricultural Research, August 2003

Garrity, D., D.C. Catacutan, and E. Quebaltin, 2000. Managing natural resources locally. An Overview of Innovations and ten basic steps, ICRAF South East Asian Regional Research Program.

Idachaba, F. 2001. Agricultural policy process in Africa: Role of policy analysts. ECAPAPA Monograph Series 2. Entebbe: Eastern and Central Africa Programme on Agricultural Policy Analysis.

James, R.; P.Francis and G. Ahabwe Pereza, 2001. The Institutional Context of Rural Poverty Reduction in Uganda: Decentralisation's Dual Nature. LADDER Working Paper No.6 November 2001 http://www.uea.ac.uk/dev/odg/ladder/

Keeley, J. 2001. Understanding and influencing policy processes for soil and water conservation. Pp. 281-291. In C. Reij and A. Waters-Bayer. Farmer Innovation in Africa. A source of inspiration for agricultural development. London: Earthscan Publications.

Lawrence, A., J. Barr and G. Haylor, 1999. Stakeholder approach to planning participatory research by multi-institutional groups . Network paper No 91

Mbabazi, P., R. Bagyenda and R. Muzira, 2003. Participatory assessment of land degradation and soil loss in Kabale

Means, K., C. Josayma, E. Neilsen and V. Viriyasakultorn, 2002. Community-based forest resource conflict management. A Training package. Vol.1&2. Food and Agriculture Organization of the United Nations, FAO-Rome.

Norse, D and J.B. Tschirley, 2000. Links between science and policy making. *Agriculture, Ecosystems and Environment* 82: 15-26

NRSP (Natural Resources Systems Program NRSP.), 1999. Call for proposals. Strategy for Research on Renewable Natural Resources, Natural Resources Systems Programme. Department for International Development.

Omamo, S. W. 2003. Policy Research on African Agriculture: Trends, Gaps, Challenges. The Hague: ISNAR Research Report. 21.

Pound, B., S. Snapp, C. McDugall and A. Braun. (eds), 2003. Managing Natural Resources for Sustainable Livelihoods. Uniting Science and Participation. London: Earthscan Publications and the International Development Research Centre.

Pretty, J.N., 1995. Regenerating agriculture. Policies and practices for sustainability and self-reliance. Joseph Henry press, Washington DC.

Raussen T., Ebong G. and J. Musiime, 2001. More effective natural resource management through democratically elected, decentralised government structures in Uganda. *Development practice* 11 (4):

Reason, P. and H. Bradbury, (eds), 2001. Handbook of action-research: Participative inquiry and practice. London: Sage Publications

Sanginga, P.C., Martin, A. and R. Kamugisha, 2004. Strengthening social capital for improving policies and decision making in NRM. Final Technical Report to DFID Natural Resources Systems Programme NRSP) Project

Sanginga, P.C., Kamugisha R. and A. Martin, 2004. Strengthening Social Capital for Minimizing Conflicts in Multiple Common Pool Resources Regimes: Lessons from Uganda Paper prepared for the panel on Social Capital and Conflict Resolution: Learning Process Strategies for Common Property Resource Management, at the 10th Bienal International Symposium of the International Association of Study of Common Property (IASCP), Oaxaca-Mexico August 9-12, 2004.

Sayer, J. & B.M. Campbell, 2001. Research to integrate productivity enhancement, environmental protection, and human development. *Conservation Ecology* 15 (2): [online] URL: http://www.consecol.org/vol5/iss2/art1

Scherr, S, G.Bergeron, J. pender and B. Brabier, 1996. Policies for sustainable Development in fragile lands: Methodology overview. International Food Policy Research institute, Washington, DC.

Scoones, I. 1998. Sustainable Rural Livelihoods: A Framework for Analysis. IDS Working Paper No. 72; Brighton, Institute of Development Studies.

Scoones, I and Thompson, 2003. Participatory processes for policy change. PLA notes 46. February 2003

Shiferaw, B and S.T. Holden, 2000. Policy instruments for sustainable land management: the case of highland smallholders in Ethiopia. *Agricultural Economics* 22: 217-232

Thomson, Anne M. 2001 Sustainable livelihoods approaches at the policy level. Paper prepared for FAO e-conference and Forum on Operationalising Participatory Ways of Applying a Sustainable Livelihoods Approach. http://www.livelihoods.org/pip/pip/tho2-fao-doc

Tyler, S. 1999. Policy Implications of natural resource conflict management Pp. 263-280. In Cultivating Peace. Conflict and Collaboration in Natural Resources Management. Edited by D. Buckles, International Development Research centre, Ottawa, Canada.

Uphoff, N. and C.M. Mijayaratna, 2000. Demonstrated benefits of Social Capital: The productivity of farmers organizations in Gal Oya, Srilanka. *World Development* 28(11) 1875-1840

Vincent, L. 2003. Participatory Research, Natural Resource Management and Rural Transformations: More Lessons from the Field. Pp. 142-168 In Pound, B., S. Snapp, C. McDougall and A. Braun. Eds. 2003. Managing Natural Resources for Sustainable Livelihoods. Uniting Science and Participation. Earthscan Publications and the International Development Research Centre. London.

Woolock, M. and D. Narayan, 2000. Social Capital: implications for development theory, research and policy. *The World Bank Observer*, Vol. 15 (2): 225-249.

Community NRM and Its Linkage to Poverty in Uganda

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Abstract

At community level, by-laws and other regulations are commonly used to manage natural resources. However, there is limited research on how communities enact these regulations and what determines awareness and compliance with these regulations. A survey of 273 communities was conducted in Uganda with an objective of analyzing the determinants of enactment, awareness and compliance with community Natural Resource Management (NRM) regulations. Presence in the community of programs and organizations with focus on agriculture and the environment increases the probability to enact and to be aware of NRM regulations. Compliance with regulations enacted by village councils was greater than compliance with regulations passed by higher legislative bodies, suggesting the important role played by decentralization in NRM. Several dimensions of poverty are associated with lower compliance with tree planting and protection requirements. This supports the poverty-natural resource degradation trap hypothesis, and suggests that measures to reduce poverty can also improve NRM.

Introduction

Uganda achieved remarkable economic growth and poverty reduction in the past decade, with absolute poverty declining from 56% of the population in 1992 to 35% in 1999/00 (Appleton, 2001a). However, there is concern about whether this favorable trend is being sustained, and whether it is reaching most of the rural areas. Between 1999/2000 and 2002/03, poverty rates again increased (to 38%) in Uganda (UBOS 2003a), while income inequality also increased as the highest income quintile was the only one to experience improvement in per capita incomes between 1999 and 2003 (Ssewanyana, et al. 2004). Lagging agricultural performance is one of the important factors limiting economic growth and poverty reduction. Agricultural productivity in general has stagnated or declined for most farmers since the early 1990s (Deininger and Okidi, 2001).

The persistence and unequal distribution of poverty poses a major challenge requiring well-targeted policies and strategies to address. The government seeks to reduce absolute poverty to below 10% in 2017 using a broad framework called the Poverty Eradication Action Plan (PEAP). As articulated in the PEAP, poverty reduction will be achieved by developing the agricultural sector since the majority of the poor live in rural areas. The government has made concerted efforts to improve agriculture through its Plan for Modernization of Agriculture (PMA) framework, which is one of PEAP's major programs. One of the major challenges facing agricultural modernization is land degradation. Soil nutrient depletion and soil erosion are the most critical forms of land degradation in Uganda (Zake, et al., 1997; NEMA, 2001). The rate of soil fertility depletion in Uganda is among the highest in sub-Saharan Africa (Smaling, et al. 1993), and in some areas, such as the steeply sloping highlands, soil erosion is a major problem affecting 60% to 90% of the total land area (NEAP 1992).

Degradation of other natural resources is also severe. About 9% of the central forest reserves and 43% of local forest reserves areas are degraded (Forest Department, 2002). Wetlands, which cover 30,000 km^2 or 13% of Uganda's land surface face rampant encroachment and over harvesting (Bakema and Iyango, 2004). About 3% of the total wetlands area has been reclaimed. Water and fishery resources also suffer significant degradation due to surface water pollution and siltation, fish over-harvesting, illegal fishing, and eutrophication.

Since the rural poor heavily depend on land and other natural resources, degradation of these resources is likely to affect them the most. It is therefore important for the government to have a clear understanding on how the rural poor are contributing and responding to natural resource degradation. Understanding the linkages between poverty and natural resource degradation will help to better achieve the objectives related to natural resource management in the PEAP's poverty reduction strategies.

Empirical evidence shows that community resource management can increase efficacy, legitimacy and sustainability of natural resource management (NRM) (Western and Wright, 1994). There is still relatively little empirical work that has analyzed the factors that determine participation in community resource management (Zantell, Knuth, 2004). This paper differs from most related studies since it analyzes the determinants of enactment and compliance with community bylaws and other NRM regulations. Most past research on collective NRM did not focus on analysis of the legal instruments that are used in community NRM.

Since awareness and legal education are key to compliance with legal instruments (NEMA, 2001), we also analyze the determinants of awareness of legal instruments. Enactment and enforcement of bylaws and other regulations vary considerably across communities, and this contributes to major differences across communities in natural resource conservation or degradation. Understanding the differences in enactment and compliance with such bylaws and the reasons for these differences is the main purpose of this study.

THEORY AND CONCEPTUAL FRAMEWORK

At the community level, the need for addressing NRM collectively is critical. Efforts by one farmer to adopt improved land management may be undermined if other farmers do not adopt such technologies since actions of one farmer may have spillover effects beyond the farmers' boundaries. For instance, if one farmer occupying a small share of the watershed area plants trees to control erosion, such action may not be effective if other farmers do not control soil erosion in their farms (Garrity, 2000). In southwestern Uganda, some farmers seeking fertile soil undermine terraces that have accumulated nutrients over years. This leads to increased erosion not only in fields of the farmer destroying the SWC structures but also in fields of other farmers in the catchment. Hence incentives for individual farmers may not be adequate to address land degradation problems in a community without collective action or regulation. Community NRM depends on many factors that are not easy to discuss exhaustively (Agrawal, 2000; Poteete and Ostrom, 2003). These variables can be grouped into four conceptual variables: (i) institutions (central and local government policies and institutions, and customary institutions); (ii) market access (size of the market; access to roads, information and resource management and harvesting technology; etc); (iii) demographic variables (population density, heterogeneity in terms of endowment of physical and natural capital, income, education, livelihoods, political, ethnicity and other cultural attributes); and (iv) natural resource stock and condition (Agrawal and Yadama, 1997; Poteete and Ostrom, 2004; Ostrom, 1999).

INSTITUTIONS

Institutions are humanly devised restrictions that shape human behavior (North, 1990), thus greatly influence the impact of other variables on NRM. In this research, we will test the effectiveness of instruments used by communities to manage natural resources. We will examine three dependent variables: whether an NRM bylaw was enacted at the village (LC1)[1] level; the level of awareness of NRM regulations enacted at various levels of government (including local bylaws); and the level of compliance with NRM regulations. We expect NRM regulations to contribute to less degradation of natural resources if the community complies with such regulations. Some of the institutional variables are exogenous to the community; that is, they are not decided by the community but influence enactment, awareness of and compliance with regulations. The exogenous institutional variables are discussed below:

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[1] The government hierarchy is divided into five levels in Uganda, including the central government, district governments (Local Council 5 or "LC5"), county ("LC4"), sub-county ("LC3"), parish ("LC2") and village ("LC1"). According to the Local Government Act, the local levels at which legislative as well as administrative decisions are made are at the LC5, LC3 and LC1 level.

Presence of programs and organizations

One of the conditions for successful community resource management is institutional supply, which is determined by presence of community members or organizations that have substantial leadership or other assets (Ostrom, 1990).[2] Government programs and Non-government Organizations (NGO) dealing with agriculture and the environment in communities are likely to influence positively community NRM. In Uganda, government programs and NGOs (hereafter referred to as P&NGO) that have a stake in NRM are given representation in the local environmental and natural resource committees. In turn the organizations are required to sensitize and assist local people to use sustainable and improved resource management strategies and to observe environmental by-laws and other regulations (Lind and Cappon, 2001). This has given the organizations an important role in influencing land management at the local level. For example, Sserunkuuma, et al., (2004) observed that participation in agricultural extension and training in eastern Uganda increased farmers' adoption of soil and water conservation practices. Jagger and Pender (2003) and Nkonya, et al. (2004) also found that some land management practices were more likely to be used where households were participating in P&NGO focused on agricultural and environmental issues. We thus expect communities with P&NGO that focus on agriculture and environment to be more likely to enact bylaws and become more aware of the existence of and compliance with NRM regulations since such P&NGO tend to advocate for NRM bylaws, sensitize farmers about such bylaws and educate them on the benefits of complying with the bylaws (Lind and Cappon, 2001).

P&NGO that focus on financial services are likely to improve farmers' access to financial services, which in turn could help community members to be better able to invest in soil and water conservation measures that require large financial outlays. By relaxing credit constraints, financial services also can reduce people's discount rates, thus helping to facilitate investments and collective action (Pender, 1996). For example, Sserunkuuma, et al., (2004) noted that access to credit increases compliance with bylaws governing use of irrigation water in eastern Uganda. However, in an imperfect labor market as is the case in Uganda, access to credit may have a negative effect on NRM as communities with access to credit may invest in non-farm activities, which compete for labor with NRM (Scherr and Hazell, 1994; Pender and Kerr 1998; Clay, et al. 1998). Due to this, some households in the communities with access to credit may not fully depend on agriculture for their livelihoods, hence would have lower incentive to conserve the natural resource base. We therefore expect access to credit to have an ambiguous effect on NRM and hence on enactment of NRM bylaws and on compliance with NRM regulations.

Land tenure

Privatization of natural resources, titling and registration has been argued by many to increase land investment and efficiency of their use (Swynnerton 1954; Dorner 1972; Feder and Onchan 1987; Harrison 1987; Feder, et al. 1988). However, a growing body of literature calls this assumption into question, particularly in the African context (Shipton 1988; Atwood 1990; Migot-Adholla, et al. 1991; Place and Hazell 1993; Platteau 1996; Feder and Nishio, 1999; Holden and Yohannes, 2002; Brasselle, et al, 2002). According to this literature, formal land titles may not be necessary or sufficient to ensure tenure security or access to credit. Land privatization and titling may also influence NRM by affecting the marketability of land, which may increase access to land of those households that are willing or able to invest in NRM or other productivity enhancing measures (Besley 1995) or increase farmers' willingness to make irreversible investments in land since such sunk costs can be recovered (Pender and Kerr, 1999). Increased marketability of land may also increase the collateral value of land and hence may increase access to credit (Feder, et al., 1988). The impact of titling and tenure in general also depends on access, preexisting production systems and production potential, adjudication criteria and procedures and the design of support institutions for the tenure systems (Lawry, 1990). Regardless of the

[2] Other conditions are: credible commitment of resource users and mutual monitoring. In turn these conditions depend on number of decision makers, number of participants necessary to achieve collective benefits, discount rate and similarities of interest (Ostrom, 1990).

impacts of land titles, insecure natural resource tenure (whether or not this is due to lack of titles) is generally expected to influence NRM negatively (and hence may reduce enactment of and compliance with NRM regulations) as farmers with insecure tenure have less incentive to invest. A contrary result may obtain, however, if households are able to increase tenure security by investing in natural resources (Besley 1995; Sjaastad and Bromley 1997; Otsuka and Place 2001). In that case, the incentive to invest in NRM may be greater where tenure is insecure.

Some studies have shown that customary tenure is likely to entail more rights, responsibilities and restrictions that do not obtain in the freehold and leasehold tenure systems (e.g. Tripp, 2004; Khadiagala, 2004a, Khadiagala, 2004b; Lawry, 1990). Under customary laws in most Ugandan ethnic groups, parents are expected to bequeath their land to their children. This creates a special attachment to land held under customary laws and puts on parents a responsibility of ensuring that the land is still productive when they bequeath it to children. Thus the expected impacts of the land tenure system on NRM are ambiguous.

Customary institutions

Following North (1990), customary institutions include customary law, cultural traditions, norms, taboos, superstitions, land tenure[3] and other regulations that exist in a community. In Uganda, as elsewhere in Africa, these institutions differ significantly across ethnic groups (Bikaako and Ssenkumba, 2003) but tend to be uniform in one given ethnic group. Hence, we will represent the customary institutions by ethnic group variables. Ethnicity also influences NRM in aspects other than customary institutions. For example, different ethnic groups may have different consumption preferences (for leisure as well as food and other goods), which may influence their NRM decisions. Some ethnic groups may be more cohesive and hence more able to organize collective action. Different ethnic groups may pursue different livelihoods with different implications for the opportunity cost of time and interest in particular NRM activities. Since there are about 56 ethnic groups in Uganda, we group them into fewer major ethnic groups to reduce the number of variables. We categorize the Bantu people[4] into three groups following their common history and cultural characteristics:

- The Baganda who belong to the Buganda kingdom. The Baganda include the Bantu people in the Lake Victoria crescent region
- Banyakitara, i.e. people of the Bunyoro Kitara, Ankole and Tooro kingdoms. The Banyakitara will include the Bakiga, Banyoro, Banyankole, Bafumbira, Batooro, and other Bantu people in western Uganda
- The eastern Bantu people will include the Basoga, Bagishu, Bagwere, Banyole and other Bantu people in the eastern Lake Victoria shores, i.e. Busia, Bugiri, Jinja, Iganga, Mbale, Pallisa, Sironko,and part of Tororo.

We group the Nilotic -- the non-Bantu people along the Nile river -- into three major categories: the eastern, northern, and west Nile non-Bantu people.[5]

- The non-Bantu eastern people are the Iteso, Kumam, Sebei, Sabiny, Japadhola, etc;
- The northern non-Bantu people include the Langi and Acholi; and
- The west Nile people include the Alur, Kakwa and Lugbara.

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[3] The customary land tenure system has already been discussed but is mentioned here to remind readers that it is one of the customary institutions.

[4] The Bantu belong to the great family of Negroid tribes (Niger-Congo) living in central, east-central and southern Africa (Webster 1913). The non-Bantu people in Uganda are the Nilo-Saharan and Nilotic (people along the Nile River), namely Langi, Acholi, Alur, Kakwa, Lugbara, Karamajong, Iteso, Sebei, Sabiny, etc (Ehret, 1971).

[5] For details of the grouping of the Nilotic ethnic groups, visit: http://countrystudies.us/uganda/21.htm

Since the customary institutions are not explicitly recognized by the central and local governments, it is possible that community members may attempt to legitimize their customary institutions by enacting bylaws with outcomes on NRM similar to those of their customary institutions. However, customary institutions such as taboos, norms and superstitions are likely to lead to natural resource conservation outcome hence obviating the need to enact formal bylaws but increasing compliance with existing bylaws that are consistent with such customary institutions. For bylaws that are not consistent with customary regulations, community members are likely to comply with their customary regulations. Additionally, community members are likely to ignore bylaws that do not have an equivalent customary regulation (Gibson, 2000).

As observed by Ntambirweki (1998), contemporary Ugandan communities have been heavily influenced by Christianity, Islam and foreign cultures. The influence of foreign culture on local cultural values tend to be greater in communities where Christianity or Islam came first or was well-received and in areas closer to major urban centers. Areas closer to urban centers attract immigrants who increase the socio-cultural heterogeneity, which in turn may impede collective action (Baland and Platteau 1996; Poteete and Ostrom, 2004). The Baganda live in the most urbanized central region around Lake Victoria (UBOS, 2003b). Hence, we expect the weakest observance of customary institutions among the Baganda. Thus we will use the Baganda ethnic group as the control group to which the other ethnic groups will be compared.

Demographic factors

Demographic factors include human population statistics, socioeconomic variables, which depend on occupation, education, income, wealth, and place of residence. Sociologists often use socioeconomic status to predict behavior (Columbia Encyclopedia, 2001). The demographic factors considered in this study are: poverty, human population density, human capital, and village wage rate.

Poverty

There is no consensus among scholars on the impact of poverty on NRM. One view argues that natural resource degradation contributes to declining agricultural productivity and reduced livelihood options, thus worsening poverty and food insecurity, while poverty and food insecurity in turn contribute to worsening resource degradation by desperate households lacking alternatives to degrading their natural capital stock (Durning 1989; Leonard 1989; Cleaver and Schreiber 1994; Pinstrup-Andersen and Pandya-Lorch 1994). Poverty may reduce incentives to invest in resource conservation and make collective action more difficult to attain by increasing individual discount rates (Pender, 1996).

Another school of thought asserts that there is no necessary linkage between poverty and resource degradation. If markets are perfect, land and other resources will be allocated to their most profitable uses and all investments yielding a positive net present value will be made (Singh, et al. 1986). However, in an imperfect markets setting, the nature of poverty is important in determining the impacts on NRM and degradation. The communities that are not poor by welfare criteria such as minimum levels of consumption may face “investment poverty” that prevents them from making profitable investments in resource conservation and improvement (Reardon and Vosti 1995).

A third view on impact of poverty on NRM is that poverty may promote greater affinity to conserve natural resources since the poor depend more on natural resources than the well-off. Furthermore, poorer households have lower opportunity costs of their labor, which can promote labor intensive NRM investments (Clay, et al., 1998; Pender and Kerr, 1998) and facilitate collective action in NRM (Gebremedhin, et al., 2004). Based on these three schools of thought, we expect poverty to have an ambiguous impact on enactment of and compliance with NRM regulations.

Human population density and wage rate:

Several empirical works have shown that human population has an ambiguous impact on NRM (for example Allen and Barnes, 1985; Agrawal and Yadama, 1997). One view is that as population increases, scarcity of natural resources increases. Consequently, the value of land and other resources relative to labor increases, prompting farmers to conserve their natural resources (Boserup, 1965; Tiffen, et al., 1994). This may induce greater collective action to protect natural resources as well as intensification of agriculture on private land (Pender, 2004). High population density is likely to decrease wage rate, making it affordable to use labor intensive NRM practices -- hence facilitating compliance with NRM regulations. On the other hand, if village wage rate is high, local community councilors may be reluctant to enact a bylaw that they know would be costly for the community members to comply with. As population continues to grow, the ability to attain effective collective action may decline however (Poteete and Ostrom, 2004). At very high population density, diseconomies of scale and moral hazard behavior may set in (Ibid). For example, Gebremedhin, et al., (2004) observed that high population density may lead to attempts by community members to "free-ride" on efforts of others. High population density may also lead to severe scarcity and consequent breakdown of collective action. Thus there may be an inverted U relationship between population pressure and collective action in NRM (Pender, 2001).

Human capital

Human capital includes knowledge and skills embodied in people, such as education, health, experience and knowledge. A higher level of education and knowledge may increase people's awareness on future benefits of complying with NRM regulations, thus leading to better NRM. However, education may increase the value of labor, which in turn reduces probability to use labor-intensive soil and water conservation technologies. Education may also increase non-farm opportunities, which would lead to competition for labor with farm activities (Scherr and Hazell, 1994) and give people more "exit options," thus a tendency to undermine collective action (Bardhan, 1993). Human health is expected to influence positively NRM since agricultural practices are typically manual hence require a healthy person to perform them effectively (Bloom, et al., 2004).

Natural resource stock and condition

Abundance of resources in high potential areas or places that have not been severely degraded may reduce the incentive for community members to practice natural resource conservation (Ostrom, 1999). High resource potential is also likely to create more productive activities that may increase the opportunity cost of labor for NRM (Ostrom, 1999). This in turn could have a negative impact on the likelihood to enact and comply with NRM regulations that require substantial labor input. Holding other factors constant, high resource potential is also likely to increase the value of the resources. Thus degradation of such resources leads to more costly losses and hence the need to comply with conservation regulations. However, higher agricultural potential increases the benefit of using land in a degrading way since the short-term benefits may be high.

In the case of low resource endowment, communities are likely to experience scarcity that could force them to enact and comply with regulations for conserving the limited resources. Severe degradation may also prompt communities to enact and comply with regulations aimed at controlling degradation if such degradation has not reached a point where the community members deem is beyond repair. However, communities in low resource potential areas may have to practice extensive agricultural production in order to meet their subsistence needs. This could lead to cultivation or grazing on fragile lands that may trigger severe land degradation. Fuelwood needs and other forest product needs in marginal areas may also exceed the biomass production, which in turn could lead to deforestation. All this could make it difficult to enact and comply with NRM bylaws. Thus natural resource stock and condition have ambiguous theoretical impacts on enactment and compliance with NRM regulations.

In this study, the natural resource stock and condition will be represented by the agricultural potential which is represented by the length of the rainy season (crop growing season) and distribution of the annual rainfall (Ruecker, et al., 2003).[6]

Market access

Access of the village to markets, infrastructure and services affect the value of agricultural products by affecting local prices or access to information (e.g., access to roads, transportation, harvesting technology, and extension services). As market access increases the value of natural resources increase. Hence the incentive to comply with regulations for soil conservation also increases. Market access also gives greater exit options to farmers who fail to comply with community regulations and restrictions (Pender and Scherr, 2002; Bardhan, 1993; Poteete and Ostrom, 2003). If institutions regulating natural resource are weak or absent, access to roads and other forms of communication decreases the transactions costs of resource harvesting. This suggests that access to roads and other forms of communication could accelerate natural resource degradation (Young, 1994; Chomitz, 1995; Agrawal and Yadama, 1997; Poteete and Ostrom, 2003). However, law enforcement agents also use the same means of transportation and communication to enforce natural resource regulations. Hence it is likely that enforcement of regulations in remote areas may be weak. For example, Banana, et al., (2001) observed that exploitation of forest resources in Uganda was less around the capital city Kampala than farther away because the forest department did not have enough resources to travel to remote areas to enforce forest harvesting regulations. Hence, market access is expected to have an ambiguous effect on enactment, awareness of and compliance with regulations, for similar reasons that agricultural potential has ambiguous impacts.

Methods

Data collection

This study uses primary data collected at community level (local council 1 (LC1), which is the lowest administrative unit in Uganda). A total of 270 communities were randomly selected from 45 of the 56 districts of Uganda.[7] A semi-structured instrument was used to collect data from 10 – 15 key informants who were purposively selected to provide information on institutions, natural resource governance and management and labor issues on behalf of the entire community. Typically the key informants selected were: the village chairperson or secretary, secretary for environment, secretary for agriculture, women and youth, and other key informants. Inclusion of leaders ensured that authoritative respondents discuss issues pertinent to management of natural resources. Presence of women and youth ensured that the vulnerable groups they represent were involved in the discussion.

Data analysis

Statistical and econometric methods are used to analyze the determinants of enactment, awareness and compliance with bylaws that affect NRM. We use a probit model to analyze the determinants of probability to enact bylaw since the dependent variable of this model is dichotomous (have enacted or not enacted bylaws). To ensure that the dependent variable is endogenous to the community, we set it equal to one only when the bylaw was enacted by the LC1 in the past 10 or less years. We set the age of the bylaw at ten years to correspond with the beginning of the decentralization policy implementation by the current Museveni regime in 1992 (Onyach-Olaa, 2003). We assume that the incumbent councilors are likely to have played a vital role in enactment of bylaws that are 10 or fewer years old. Any bylaw enacted by the LC1 in 1991 or earlier or by a legislature outside the community, was regarded as exogenously enacted.

[6] We could not use the community level natural resource degradation indicators as explanatory variables since they are potentially endogenous to the community.
[7] For details of the three surveys, see Nkonya, et al., 2005 and Pender, et al., 2004 and Nkonya, et al., 2004.

To analyze awareness of and compliance with existing regulations, we use four ordinal levels: 1 = "no one is aware" that the legal instrument exists; 2 = "some are aware" when less than 50% of the community members are aware that the legal instrument exists; 3 = "majority are aware" when 50% to 90% are aware that the legal instrument exists; and 4 = "all are aware" when more than 90% are aware that the legal instrument exists. In the case of compliance with the legal instrument, 1 = "no one complies" when no one in the community complies with the legal instrument; 2 = "some comply" when less than 50% of the community members comply; 3 = "majority comply" when 50% to 90% comply; and 4 = "all comply" when more than 90% comply. Since these categories are ordered, we use an ordered logit model to analyze the determinants of these dependent variables. We analyzed the awareness of and compliance with only two legal instruments -- no bush burning and the requirement to plant and protect trees -- because these were the only instruments with a sufficiently large number of observations to warrant reliable statistical analysis. Additionally, not all four levels of awareness of these bylaws were reported. For example, no community reported to have "no one is aware" of the existence of the no bush burning or tree planting and protection bylaws. Only two communities out of the 94 that enacted the no bush burning bylaw in the past ten years reported that only a minority of community members are aware of this regulation. Likewise, only seven out of the 64 communities that enacted the tree planting and protection regulations reported that only a minority of the community members were aware of this regulation. Hence we will use probit model to estimate the determinants of awareness of these bylaws since only two levels (majority are aware and all are aware) have enough observation to produce reliable results.[8]

The levels of compliance with the tree planting and protection bylaw had similar problems of small number of observations for the "no one complies" and "minority comply" levels. Thus we will also estimate the determinants of compliance with tree planting and protection bylaw using a probit model.

The general reduced form empirical model to be estimated for the determinants of enactment, awareness of and compliance with bylaws is as follows:

$Prob(LAW = 1) = f(Inst_i, P, HR_i, Mkt, ETHN, Pop, WAGE, APO, TENURE, e_i)$ …………… (1)

$Prob(AWARE = 1) = f(Inst_i, P, HR_i, Mkt, ETHN, Pop, WAGE, APO, TENURE, e_i)$ ………… (2)

$Prob(COMPTREE = 1) = f(Inst_i, P, HR_i, Mkt, ETHN, Pop, WAGE, APO, TENURE, e_i)$ …… (3)

Where: LAW = is a vector of dummies representing NRM bylaws enacted by a community in the past ten years

Inst = a vector of formal exogenous institutional variables, i.e. P&NGO present in community with focus on agriculture, environment or rural finance services;

P is a measure of poverty. We will test the impacts of two measures of poverty on NRM: (a) poverty gap (P_1), which is the difference between the poverty line (z) and the real private consumption per adult equivalent (y_i), i.e. ($z - y_i$) and (b) severity of poverty (P_2), which is the average value of the square of depth of poverty for each individual.

HR = vector of human resource variables in the community, namely proportion of literate adults and health status of community (the proxy used for the health status is the share of household in a community that do not have adequate food throughout the year),

Mkt = vector of market access variables measured as the potential market integration (estimated travel time to the nearest five markets, weighted by their population (Wood, et al., 1999) and distance to all-weather road.

ETHN = A vector of ethnic groups (Baganda (central region Bantu people), Banyakitara (western region Bantu people), northern non-Bantu people, west Nile people, eastern Bantu people, and eastern non-Bantu people).

Pop = population density in the community

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[8] To avoid dropping some observations, the category "majority are aware" was combined with the category "all are aware" and assigned a value of 1. The category "some are aware was assigned a value of 0. No community reported the category "no one is aware."

WAGE = wage rate in the community in Uganda Shillings (Ush) per day.

APO = vector of agricultural potential, i.e. agro-ecological characteristics affecting agricultural productivity (e.g., annual rainfall or length of growing period). We follow the classification by Ruecker, (2003), who classified Uganda APO as high unimodal rainfall, medium unimodal rainfall, low unimodal rainfall, low bimodal rainfall, medium bimodal rainfall and high bimodal rainfall. The APO dummies were strongly correlated with the ethnic groups. To address this concern, we grouped the APO zones into two categories: high agricultural potential (bimodal high, bimodal medium and unimodal high rainfall) and low agricultural potential if community is in the bimodal low, unimodal medium and unimodal low rainfall;

TENURE = The dominant form of land tenure in the community, whether customary, leasehold, freehold or *mailo*.[9] There were only a few communities that reported to have freehold and leasehold land tenure systems. Additionally, the *mailo* land tenure was highly correlated with Baganda ethnic group. To address both problems, we grouped land tenure into only two groups: customary and non-customary tenure;

AWARE = Vector of level of awareness of bylaws (AWARE = 1 if all are aware and AWARE = 0 otherwise);

COMPTREE = Compliance with tree planting and protection bylaw (COMPTREE = 1 if all comply and COMPTREE = 0 if otherwise); and e_i = a vector of error for the equations estimated, $e_i \sim N(0,1)$

For the specification of the ordered regression (logistic) model for compliance with no bush burning bylaw, consider a latent variable COMPLY* as the level of compliance for legal instrument.

$COMPLY^* = f(Inst_i, P, HR_i, Mkt, ETHN, Pop, WAGE, APO, TENURE, e_i)$ ……………….(4)

Where: e_i = a vector of error for the equations estimated, $e_i \sim$logistic.

Other variables are as defined in equation (1)

$COMPLY = 1 \text{ if } COMPLY^* \leq b_1$

$COMPLY = 2 \text{ if } b_1 \leq COMPLY^* \leq b_2$

$COMPLY = 3 \text{ if } b_2 \leq COMPLY^* \leq b_3$

$COMPLY = 4 \text{ if } COMPLY^* > b_3$

Where b_i is a threshold parameter for each level of compliance, which is estimated along with the coefficients of the explanatory variables.

The ordered regression assumes that only the intercept, and not the coefficients of the independent variables, changes as the level of the dependent variable changes (this is called the "parallel regression assumption" (Long, 1997)). We used the Brant (1990) test to determine whether or not this assumption holds for equation (4). We failed to reject the null ($Prob>\chi^2 = 0.491$) that the coefficients of the independent variables are constant as level of compliance with no bush burning law changes. Hence we used the ordered logit to estimate equation (4).

We performed a Wald test to determine the variables that we could drop to improve the statistical performance of the models. The coefficients of the wage rate and human health were jointly not significant different from zero at p=0.10 in any model, hence were dropped from the models.

[9] *Mailo* tenure refers to land in central Uganda that was originally granted with freehold title to representatives of the Baganda king and other elite groups by the British colonial government. This land was provided in square mile units (the origin of the term "mailo land"). Over the years, most this land has been occupied by long term tenants, whose rights have been increasingly recognized by the government. The 1998 Land Act protects the use rights of long-term lawful or *bona fide* occupants of *mailo* land, and gives such occupants the right to obtain freehold ownership status. Despite this, few *mailo* occupants have obtained freehold status of occupied *mailo* land, and the issue of competing claims and rights over this land continues to be unsettled.

As noted earlier, compliance with NRM regulations depends on level of awareness about their existence. This implies the error terms of the three models are not independently distributed. It would therefore be ideal to estimate these models using a system of equations to improve the efficiency of the estimates. However although maximum likelihood estimation is potentially feasible with two or three dependent variables, it is cumbersome for models with more than two variables. We therefore estimate single equations independently.[10] The next section discusses the results of the analysis, starting with descriptive analysis and then econometric results.

Results

DESCRIPTIVE STATISTICS

Bylaws, ordinances and statutes affecting NRM

This section reports the perceptions of community leaders on the NRM regulations that are in force in the community.[11] It is possible that national statutes and district ordinances may have been enacted that community leaders are not aware of; such laws (if they exist) would not be reported in our results. The most common NRM regulations perceived by communities in Uganda are regulations limiting tree cutting and requiring tree planting when trees are cut, prohibition of bush burning (commonly used to clear bush for agricultural production), requirements to invest in soil and water conservation (SWC) measures on steeply sloping farmland, and prohibitions against polluting water bodies or encroaching upon and draining wetlands (Table 1). Prohibitions against bush burning are most commonly perceived to have been enacted by the central government, while restrictions against polluting water bodies or encroaching wetlands are most commonly enacted by the district government. Regulations related to tree protection and planting and SWC are perceived to have been enacted by different levels of government, including the LC1, sub-county, district, central government, and (especially in the case of tree regulations) the former colonial government.

Table 1: Relationship between legal instrument and legislature

Legislature	Tree laws	No bush burning	SWC	Don't pollute or encroach water bodies or Wetlands
Sample size	97	91	29	26
	% of communities reporting to have regulation			
LC1	25	24	24	19
Sub-county	3	9	14	4
District	16	9	24	77
Central government	35	44	34	00
Colonial government	21	11	3	00

Table 2 shows a strong association between awareness of legal instruments and compliance with such instruments, as expected. This supports the National Environmental Management Authority's (NEMA's) emphasis on the importance of education and awareness creation about environmental laws and policies.

[10] Despite correlation of error terms across equations, independent estimation of each equation only affects the efficiency of the estimation, and does not result in any bias or inconsistency, as long as the classical regression assumptions hold (e.g., that the explanatory variables are not correlated with the error term) (Davidson and MacKinnon 2004).

[11] Note that in the descriptive statistics section, we discuss both external and local legal instruments. Only the econometric results discussion on the probability to enact a bylaw at community level exclusively discusses local bylaws.

Table 2: Relationship between level of awareness and compliance with legal instruments

Compliance	Some are aware	Majority are aware	All are aware
Nobody complies	45.00	3.02	4.41
Some comply	40.00	34.85	32.35
Majority comply	10.00	54.55	38.24
Everybody complies	5.00	7.58	25.00
Average compliance	13.00	42.90	44.20

Note: No community reported compliance with a regulation that they are unaware of.
This is expected since it is illogical to comply with a regulation that one is not aware of.

ECONOMETRIC RESULTS

For each model discussed in the methodology section, we ran two sets of regressions each time using one of the two measures of income poverty, namely severity of poverty, and depth of poverty (poverty gap). The tables report regression coefficients for one case only (i.e., depth of poverty), but the sign and statistical significance of significant coefficients are also reported for the regressions using severity of poverty instead.

Factors affecting enactment of local bylaws

The factors that are significantly associated with enactment of NRM bylaws at community level are, population density, land tenure and presence of P&NGO with focus on agriculture and natural resources (Table 3). Controlling for other factors, the non-Baganda ethnic groups are more likely to enact NRM bylaws than the Baganda. This is perhaps due to the socio-cultural homogeneity of these groups, an aspect that could enhance collective action (Agrawal and Gibson, 1999; Poteete and Ostrom, 2004). It is also possible that the Baganda, who mainly grow perennial crops do not need most of the common regulations such as those prohibiting bush burning and planting trees since the banana-coffee system predominant in the Buganda area is not compatible with bush-burning, which is a common practice in areas with predominantly annual crops. The Baganda also plant trees in their coffee-banana farms not because there is a regulation requiring them to do so but rather due to the robusta coffee-banana farming system. Shading is one of the ecological requirements of robusta coffee (Baggio, et al., 1997). These aspects obviate the need to enact regulations for controlling bush burning and cutting trees.

We observe a U-shaped relationship between probability to enact NRM bylaws and population density, which reaches a minimum at around 1000 people per $km.^2$ Since this is a very high population density that is not commonly observed in rural areas, in most cases relationship between population density and enactment of NRM bylaws is negative, though non-linear.[12] These results contradict the hypothesis of an inverted U shaped relationship between population pressure and collective action to manage natural resources, as found by Gebremedhin, et al. (2004) in northern Ethiopia, and Pender and Scherr (2002) in Honduras. However, similar observations to ours are reported by Ostrom (1999), who observed that group size is likely to increase transaction costs of collective action.

Land tenure has a significant impact on the probability to enact NRM bylaws. Communities that have predominantly customary land tenure are less likely to enact NRM bylaws than those holding land under other tenure systems. This is likely due to the presence of customary laws on NRM that serve the same purpose as the LC1 NRM bylaws, such that there is no need of passing additional bylaws. For example, parents are required by customary laws and norms to conserve their land in such a way that it would be productive when they bequeath it to their children. As discussed earlier, customary institutions also prohibit community

[12] There were only 18 out of 270 communities that had population density above 1000 people per $km.^2$ These communities were refugee camps in northern Uganda and in Bundibugyo and a couple of rural townships.

members from polluting or degrading wetlands and forests. The Buganda king also requires his subjects to have a *matooke* (plantain banana) plot to ensure they have enough food for their families and to have trenches on steep slopes.

Table 3: Determinants of enactment of NRM bylaws by community[1] (Probit regression)

Variable	Coefficients
Ln(distance to all-weather road in km)	0.076
Potential market integration (pmi)[2]	-0.000
High agricultural potencial	-0.092
Ethnic groups (cf Baganda)	
Northern non-Bantu people (Langi and Acholi)	1.051++
Banyakitara (Western Bantu people)	0.829*+
Bantu eastern people (Basoga, Bagishu, Bagwere, Banyole, etc)	0.822+
Non-Bantu eastern people (Iteso, Kumam, Sebei, Sabiny, Japadhola, etc)	1.073*++
West non-Bantu Nile people (Lugbara, Alur and Kakwa)	1.067*++
Ln[Population density (people/km^2)]	-0.001*-
Square[ln(Population density)]	0.000**++
Poverty gap in community	0.992
Share of adults in community who are able to read and write	-0.012
Customary land tenure	-0.611*-
Number of P&NGO with focus on:	
Agriculture and environment	0.213***+++
Rural financial services	0.084
Constant	-1.741**--
Number of observations	234
% of communities that had enacted any NRM bylaw in the past 10 years	11
Prob > χ^2	0.001

Legend: * p<.1; ** p<.05; *** p<.01 When one of the independent variable is poverty depth
+ p<.1; ++ p<.05; +++ p<.01 When one of the independent variable is poverty severity and associated coefficient has positive sign
- p<.1; -- p<.05; --- p<.01 When one of the independent variable is poverty severity and associated coefficient has negative sign

1. Bylaws enacted by the community local council (LC1) ten or less years ago.
2. Estimated travel time to the nearest five markets, weighted by their population (Wood, et al., 1999).

The presence of P&NGO focusing on agriculture and NRM increases the probability to enact NRM bylaws, as expected. This suggests that the advocacy for enacting NRM bylaws done by P&NGO operating in communities is effective in promoting enactment of such bylaws. The results also support Ostrom (1990), who noted that social capital embodied in P&NGO enhances effective community resource management.

Determinants of awareness of NRM regulations

The major factors associated with awareness of NRM regulations are distance to an all-weather road, ethnicity and presence of P&NGO (Table 4). Distance to all weather roads has a negative association with the level of awareness of no bush-burning and tree planting and protection regulations, suggesting that road development facilitates access to information. The Lugbara and Alur communities in west Nile are less aware of the tree planting and protection requirement than the Baganda. This is despite a requirement of the British American Tobacco Corporation that tobacco growers in this region must plant trees to replace those cut for tobacco curing.

Table 4: Determinants of awareness of NRM legal instruments (Probit model)[1]

Variable	Awareness of regulation	
	No bush burning	Plant & protect trees
Ln(distance to all-weather road in km)	-0.716***---	-0.741*-
Potential market integration (PMI)[2]	-0.003	-0.003
High agricultural potencial	0.262	-0.394
Ethnic groups (cf Baganda)[3]		
Northern non-Bantu people (Langi and Acholi)	1.726	-0.240
Banyakitara (Western people)	0.101	-0.129
Eastern Bantu people (Basoga, Bagishu, Bagwere, etc)	-0.586	-1.598
West Nile people (Lugbara, Alur and Kakwa)	-1.016	-3.474*---
Ln[Population density (people/km^2)]	0.001	-0.003
Square[ln(Population density)]	0.000	0.000
Poverty gap in community	-4.959	-3.201
Share of adults in community who are able to read and write	-0.837	-0.136
Customary land tenure	-0.402	1.479
Number of P&NGO with focus on:		
Agriculture and environment	-0.021	0.672**++
Rural financial services	0.361**++	0.005
Bylaws enacted by Community council? (yes=0, no=0)	0.407	-0.175
Constant	2.480**	1.571
Number of observations	74	50
Prob > χ^2	0.008	0.187

Legend: * p<.1; ** p<.05; *** p<.01 When one of the independent variable is poverty depth
\+ p<.1; ++ p<.05; +++ p<.01 When one of the independent variable is poverty severity and associated coefficient has positive sign
\- p<.1; -- p<.05; --- p<.01 When one of the independent variable is poverty severity and associated coefficient has negative sign

1. Awareness about legal instruments was rated as follows: 1 = no one is aware, 2 = some are aware; 3 = majority are aware; 4 = all are aware
2. Estimated travel time to the nearest five markets, weighted by their population (Wood, et al., 1999).
3. The dummy variable non-Bantu eastern people was dropped as it failed by 100% to predict awareness of bylaws.

As expected, the number of P&NGO with focus on agriculture and the environment is positively associated with more awareness of regulations to plant and protect trees. This shows that these P&NGO participate in both facilitating enactment and awareness creation of the NRM regulations. The number of rural financing institutions also is associated with higher awareness of no bush burning regulations, though the reason for this is not clear and this impact is not strong.

Determinants of compliance with NRM regulations

The eastern Bantu communities are less likely to comply with no bush burning prohibitions than the Baganda (Table 5). This could be due to the predominantly perennial cropping system of the Baganda that is not compatible with the bush-burning practice. Both the depth and severity of poverty are associated with less compliance with tree planting and protection regulations. The results support the view that there is poverty - natural resource degradation trap, which raises concerns about greater resource degradation in poor areas (at least related to trees).

Table 5: Determinants of compliance with NRM legal instruments[1]

Variable	Compliance with regulation	
	No bush burning bylaw (ordered Logit)	Plant and protect trees
Ln(distance to all-weather road in km)	0.105	0.015
Potential market integration (pmi)[2]	-0.001	-0.002
High agricultural potencial	-0.161	1.050**++
Ethnic groups (cf Baganda)		
Northern non-Bantu people (Langi and Acholi)	0.302	0.282
Banyakitara (Western Bantu people)	0.906	-2.980*-
Bantu eastern people (Basoga, Bagishu, Bagwere, Banyole, etc)	-2.628**--	-1.747
Non-Bantu eastern people (Iteso, Kumam, Sebei, Sabiny, Japadhola, etc)	-0.018	-0.006
West Nile people (Lugbara, Alur and Kakwa)	-0.767	-0.711
Ln[Population density (people/km^2)]	-0.001	-0.000
Square[ln(Population density)]	0.000	0.000
Poverty gap in community	-10.177	-17.825**-
% of adults in community able to read and write	0.954	3.325***+++
Customary land tenure	0.217	1.546
# of programs & organizations with focus on:		
Agriculture and environment	0.018	0.072
Rural financial services	-0.310	0.520*+
Bylaw enacted by community council? (yes=1, no=0)	1.139**+	1.719***+++
Brant test of parallel regression assumption (Prob > χ^2)	0.582	-
Number of observations	87	63
Prob > χ^2	0.015	0.017

Legend: * p<.1; ** p<.05; *** p<.01 When one of the independent variable is poverty depth
+ p<.1; ++ p<.05; +++ p<.01 When one of the independent variable is poverty severity and associated coefficient has positive sign
- p<.1; -- p<.05; --- p<.01 When one of the independent variable is poverty severity and associated coefficient has negative sign

1 Compliance with legal instruments was rated as follows:1 = no one complies; 2 = some comply; 3 = majority comply; 4 = all comply

2. Estimated travel time to the nearest five markets, weighted by their population (Wood, et al., 1999).

Literacy is significantly positively associated with compliance with tree regulations. This suggests that well educated communities are likely to understand better the benefits of conserving trees, or perhaps are more able to plant trees or have less need to cut them, due to other sources of income. Since lack of education is also a poverty indicator, the results give more evidence that poor communities are likely to degrade resources more than well-off communities.

The number of P&NGO focusing on rural financial services has a positive association with the level of compliance with tree related legal instruments. This may be due to the ability of such P&NGO to ease financial constraints that may inhibit such long-term investments.

The level of compliance with regulations is also affected by the level of government that enacted the regulation. The level of compliance with tree planting and protection and no bush burning regulations is significantly higher if the regulation was enacted by the LC1 than if enacted by legislative bodies outside the community. These results support the arguments of Ostrom, (1990) and Okubal and Makumbi, (2000) who observed that legitimacy and ownership of legal instruments increases their compliance.

Conclusion

Our research shows that programs and organizations (P&NGO) that focus on agriculture and the environment increase the probability to enact bylaws and increase awareness of such instruments at community level. The results suggest the need to design workable policies and strategies to make P&NGO more effective and sustainable in supplying the critically limiting Natural Resource Management (NRM) institutions and building limited skilled human capacity in rural areas of Uganda (Banana, et al., 2001; Lind and Cappon, 2001; Onyach-Olaa, 2003) and Africa in general. For example, it is important to create incentives for NGOs' to operate in remote areas, where they are less present (Jagger, and Pender, 2003).

We observe a higher level compliance with bush burning and tree planting and protection regulations if these instruments are enacted by the community council than when they are enacted by external legislative bodies. These results imply the importance of empowering communities to enact bylaws as stipulated in the Local Government Act of 1997. However, the need to increase the skilled human resource to manage natural resources in rural areas remains one of the daunting challenges of local governments in Uganda and Africa in general. Additionally, enforcement of bylaws in Uganda and other countries in the region is done by local councilors who are elected officials. Hence the local councilors may be unwilling to enforce bylaws that may offend the electorate, as this could lead to losing votes if they seek re-election. The same problem affects statutory regulations, which are also enforced by local councilors.

Our descriptive results show that compliance with NRM regulations increases as the level of awareness about them increases. This suggests that one of the major causes of low compliance with some of the regulations is lack of awareness, rather than defiance. These results therefore support the strong emphasis that the National Environmental Management Authority (NEMA) puts on environmental law education. Awareness of bush burning and tree planting and protection regulations is also greater in areas closer to all-weather roads, perhaps due to better access to information in such areas. This underscores the importance of developing roads and markets to increase access to information.

Empirical evidence from this research suggests that promoting literacy could increase compliance with NRM regulations. This suggests that continued investment in education could contribute to more sustainable NRM, as well as helping to reduce poverty in Uganda (Appleton 2001b) and Africa in general (Schultz, 1999).

The customary land tenure system decreases the likelihood of enacting NRM bylaws as compared to other tenure systems. This may be due to the existence of customary norms that promote improved NRM, making formal bylaws less necessary. Our study did not collect enough customary institution data to verify this. This implies the need to study more comprehensively the customary institutions that affect NRM to better understand how they could be used to strengthen the enactment, enforcement and compliance with local and central government legal instruments. There is also need to examine the implications of the 1998 Land Act and other legal instruments on customary institutions. For example, even though the 1998 Land Act recognizes the customary land tenure system, it does not explicitly recognize the customary laws, probably because they are not documented systematically and comprehensively. The constitution also requires that for any law to be legal and effective, it must be written. This invalidates customary laws since most of them are not written and are orally passed from one generation to another.

Our results suggest that income poverty decreases compliance with tree planting and protection regulations. Other measures of poverty, including lack of education and access to financial services also are associated with less compliance with tree planting and protection regulations. Our results therefore give credence to the natural resource degradation – poverty trap and imply that efforts to reduce poverty could also help to improve natural resource management.

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References

Agrawal, A., G. and Yadama (1997), 'How do social institutions mediate market and population pressures on resources? Forest Panchayats in Kumaon India', Development and change 28:435-465.

Allen, J.C. and D.F. Barnes (1985), 'The causes of deforestation in developing countries', Annals of the Association of American Geographers 75:163-84.

Appleton, S. (2001a), 'Poverty reduction during growth: the case of Uganda', Mimeo, Center for African Studies, Oxford University, U.K.

Appleton, S. (2001b), 'What can we expect from Universal Primary Education?' In R. Reinikka and P. Collier (eds.), Uganda's recovery: the role of farms, firms, and government. The World Bank, Washington, D.C.:371-406.

Atwood, D.A. 1990. 'Land registration in Africa: The impact on agricultural production', World Development 18(5): 659-671.

Baggio, A.J., P. H. Caramori, A. Androcioli Filho and L. Montoya. 1997. **'**Productivity of Southern Brazilian coffee plantations shaded by different stockings of Grevillea robusta**',** Agroforestry Systems 37(2): 111 - 120

Bakema, R.J. and L. Iyango (2001),'Engaging local users in the management of wetland resources. The case of the national wetlands program, Uganda', Uganda Wetland Program (NWP), Kampala Uganda.

Baland, J.M and J. P Platteau (1996), Halting degradation of natural resources: Is there a role for rural community? Oxford: Clarendon Press.

Banana, A., W. Gombya-Sembajjwe, and J. Bahatí (2001), 'Explaining deforestation: The role of forest institutions in Uganda forests', A Policy Brief. Kampala: UFRIC, Makerere University, Kampala Uganda.

Bardhan, P. (1993), 'Analytics of the institutions of informal cooperation in rural development', World Development, 21(4): 633-639.

Bikaako and Ssenkumba (2003), 'Gender, land and rights: Contemporary contestation in law and policy and practice in Uganda', in Wanyeki, L.M. ed., Women and land in Africa – culture, religion and realizing women's rights. Zed books: 232-277.

Bloom, D., D. Canning, and J. Sevilla, (2004), The effect of health on economic growth: A production function approach. *World Development* 32(1), 1-13.

Boserup, E. (1965), The conditions of agricultural growth. New York: Aldine.

Brant, R. (1990), 'Assessing proportionality in the proportional odds model for ordinal logistic regression', Biometrics 46:1171-1178.

Brasselle, A-S, F. Gaspart, J-P Platteau. (2002),'Land tenure security and investment incentives: puzzling evidence from Burkina Faso.' Journal of Development Economics: 67(2): 373-418.

Chomitz, K. (1995), 'Roads, land, markets and deforestation: A spatial model of land use in Belize', Paper presented at the first open meeting of the human dimensions of global environmental change community. Duke University, Durham North Carolina.

Clay, D.C., T. Reardon, and J. Kangasniemi, (1998), 'Sustainable intensification in the highland tropics: Rwandan farmers' investments in land conservation and soil fertility', Economic Development and Cultural Change 46(2): 351-378.

Cleaver, K.M. and G.A. Schreiber (1994,) Reversing the Spiral: The Population, Agriculture and Environment Nexus in Sub-Saharan Africa. The World Bank, Washington, D.C.

Columbia Encyclopedia. (2001), Columbia Encyclopedia, 6th edition. New York: Columbia University Press

Deininger, K. and J. Okidi (2001), 'Rural households: Incomes, productivity and nonfarm enterprises', In Reinikka, R. and P. Collier, eds., Uganda's Recovery: The role of farms, firms, and government, Washington, D.C., The World Bank

Dorner, P. (1972), Land reform and economic development. Kingsport, Tennessee, USA: Kingsport Press.

Durning, A. (1989), 'Poverty and the environment: Reversing the downward spiral', Worldwatch Paper 92. Worldwatch Institute, Washington, D.C.

Ehret, C. (1971), Southern Nilotic history: Linguistic approaches to the study of the past, Evanston: Northwestern University Press.

Forest Department (2002), Forest Nature Conservation Master Plan. Volume 1. Forest Department, Kampala, Uganda

Feder, G., and A. Nishio. (1999), 'The benefits of land registration and titling: Economic and social perspectives.' Land Use Policy 15: 25-43.

Feder, G., and T. Onchan. (1987), 'Land Ownership Security and Farm Investment in Thailand..', American Journal of Agricultural Economics, 69: 311-20.

Feder, G., T. Onchan, Y. Chalamwong, and C. Hongladaron. (1988), Land policies and farm productivity in Thailand. Baltimore: The Johns Hopkins University Press.

Garrity, D. (2000), 'The farmer driven landcore movement: Institutional innovation with implications for extension and research', in Cooper P. J. M and G.L Denning. Scaling up the impact of Agro Forestry Research ICRAF, Nairobi Kenya: 7-9.

Gebremedhin, B., J. Pender, and G. Tesfaye. (2004), 'Collective action for grazing land management in crop-livestock mixed systems in the highlands of northern Ethiopia', Agricultural Systems 82: 273-290.

Gibson, C., A. McKean, and E. Ostrom. (2000), 'Explaining Deforestation: The Role of Local Institutions', in Gibson, C., A. McKean, E. Ostrom eds., Forests, Trees and People Program, Food and Agriculture Organization Forest, trees and people program – Forest department Working Paper No. 3, Rome, 9-27.

Harrison, P. 1987. The Greening of Africa. London: Paladin Grafton.

Jagger, P., J. Pender. (2003), 'Impacts of programs and organizations on the adoption of sustainable land management technologies in Uganda', Environment and Production Technology Division EPTD), Discussion Paper # 101. International Food Policy Research Institute (IFPRI), Washington D.C.

Khadiagala, L.S. (2002a), 'Justice and power in the adjudication of women's property rights in Uganda', Africa Today 49(2):101-121.

Khadiagala, L. S. (2002b), 'Negotiating law and custom: Judicial doctrine and women's property rights in Uganda', Journal of African Law 46:1-13.

Lawry, S. W. (1990), 'Tenure policy towards common property natural resources in Sub-Saharan Africa', Natural Resources Journal 30:403-404

Leonard, H.J. (1989), Environment and the Poor: Development Strategies for a Common Agenda. Transaction Books, New Brunswick, New .Jersey.

Lind, J., J. Cappon. (2001), Realities or Rhetoric? Revisiting the Decentralization of Natural Resource Management in Uganda and Zambia, Acts Press Nairobi, Kenya.

Long, S. (1997), Regression models for categorical and limited dependent variables. Advanced quantitative techniques in the social sciences, Sage publications Thousand Oaks.

MigotAdholla, S., P. Hazell, B. Blarel, and F. Place. 1991. 'Indigenous land right systems in sub-Saharan Africa: a constraint on productivity?', World Bank Economic Review 5(1): 155-75.

NEAP(National Environmental Action Plan) (1992), 'Land tenure and land management in Uganda. Report of the Task Force on Land Management', Kampala, Uganda: Ministry of Natural Resources.

NEMA (National Environment Management Authority) (2001), State of the Environment Report for Uganda 2000. NEMA, Kampala, Uganda.

Nkonya, E., J. Pender, P. Jagger, D. Sserunkuuma, C. Kaizzi and H. Ssali. (2004), Strategies for Sustainable Land Management and Poverty Reduction in Uganda. Research Report No. 133, International Food Policy Research Institute, Washington, D.C.

Nkonya, E.M., John Pender, E. Kato, S. Mugarura, and J. Muwonge. (2005), 'Community resource management and its linkage to poverty in Uganda', Collective Action and Property Rights (CAPRi) Working paper #41. Washington D.C., International Food Policy Research Institute (IFPRI), North. D. 1990. Institutions, institutional change and economic performance, Cambridge University press. London.

Ntambirweki, J. (1998), ‘The evolution of policy and legislation on wetlands in Uganda’, Mimeo, Faculty of Law, Makerere University, Kampala Uganda.

Onyach-Olaa, M. (2003), ‘The challenges of implementing decentralization: recent experiences in Uganda’, Public administration and development 23:105-113.

Okubal, P., and M. Makumbi (2000), ‘Rethinking natural resource degradation in semi-arid Africa – implications for policy. Toroma Uganda Case study’, Mimeo, Overseas Development Institute (ODI), London.

Ostrom, E. (1990), Governing the commons: The evolution of institutions for collection action. Political economy of institutions and decisions, Cambridge University Press, New York.

Ostrom, E. (1999), ‘Self governance and forest resources’, Center for Forest Research (CIFOR), Ocassional Paper #20, Bogor, Indonesia.

Otsuka, K. and F. Place. (2001), ‘Issues and theoretical framework’, In K. Otsuka and F. Place (eds.), Land Tenure and Natural Resource Management: A Comparative Study of Agrarian Communities in Asia and Africa. Baltimore: Johns Hopkins:3-33.

Pender, J. (2001), ‘Rural population growth, agricultural change and natural resource management in developing countries: A review of hypotheses and some evidence from Honduras’, in N. Birdsall, S. Sinding, and A. Kelley, eds., Population Matters: Demographic Change, Poverty and Economic Growth in Developing Countries. Oxford University Press. London.

Pender, J. (1996), ‘Discount rates and credit markets: Theory and evidence from rural India’, Journal of Development Economics, 50: 257-296.

Pender, J., P. Jagger, E. Nkonya, D. Sserunkuuma. 2004. ‘Development Pathways and Land Management in Uganda’, World Development, 32(5):767-792.

Pender, J., P. Jagger, E. Nkonya and E. Kato. (2004), ‚Livelihood and Land Use Options in Northwestern Uganda’, Mimeo, International Food Policy Research Institute (IFPRI), Washington D.C.

Pender, J. and J. Kerr. (1998), ‘Determinants of farmers' indigenous soil and water conservation investments in India's semi-arid tropics’, Agricultural Economics 19, 113-125.

Pender, J. and J. Kerr. (1999), ‘The effects of land sales restrictions: Evidence from south India’, Agricultural Economics 21, 279-294.

Pender, J., and S. J. Scherr. (2002), ‘Organizational development and natural resource management: Evidence from Central Honduras’, in R. Meinzen-Dick, A. Knox, F. Place, and B. Swallow eds., Property Rights, Collective Action and Technologies for Natural Resource Management. Johns Hopkins University Press.

Pinstrup-Andersen, P. and R. Pandya-Lorch. (1994), ‘Alleviating Poverty, Intensifying Agriculture, and Effectively Managing Natural Resources’, Food, Agriculture, and the Environment Discussion Paper #1. International Food Policy Research Institute (IFPRI), Washington, D.C.

Place, F. and Hazell, P. (1993), ‘Productivity effects of indigenous land tenure systems in sub-Saharan Africa’, American Journal of Agricultural Economics 74(3):360-373.

Platteau, J.P. 1996. ‘The evolutionary theory of land rights as applied to sub-Saharan Africa: A critical assessment’, Development and Change 27:29-86.

Poteete, A., and E. Ostrom. (2003), ‘In pursuit of comparable concepts and data about collective action’, Collective Action and Property Rights (CAPRi) Working Paper #29. International Food Policy Research Institute (IFPRI) Washington D.C.

Poteete A., and E. Ostrom. (2004), ‘Heterogeneity, group size and collective action: The role of institutions in forest management’, Development and Change 35(3):435-461.

Reardon, T. and S. Vosti. (1995), ‘Links between rural poverty and the environment in developing countries: Asset categories and investment poverty’, World Development 23(9): 1495-1506.

Ruecker, G., S.J. Park, H. Ssali and J. Pender (2003), ‘Strategic targeting of development policies to a complex region: A GIS-based stratification applied to Uganda’, ZEF Discussion Papers on Development Policy, Discussion Paper No. 69, Center for Development Research, University of Bonn.

Scherr, S. and P. Hazell. (1994), 'Sustainable agricultural development strategies in fragile lands', Environment and Production Technology Division Discussion Paper No. 1, Washington, DC: International Food Policy Research Institute.

Schultz, T.P. (1999), "Health and schooling investments in Africa", Journal of economic perspectives 13(3):67-88.

Shipton, P. (1988), 'The Kenyan land tenure reform: misunderstandings in the public creation of private property', In: R.E. Downs and S.P. Reyna (eds.), Land and Society in Contemporary Africa, Hanover, N.H.: University Press of New England:91-135. .

Singh, I., L. Squire, and J. Strauss. (1986), Agricultural Household Models: Extensions, Applications and Policy. Johns Hopkins, Baltimore.

Sjaastad, E. and D.W. Bromley (1997), 'Indigenous land rights in sub-Saharan Africa: appropriation, security and investment demand', World Development 25(4): 549-562.

Sserunkuuma, D. N. Ochom and H. Ainembabazi (2004), 'Collective Action in Canal Irrigation Systems Management: The Case of Doho Rice Scheme in Uganda', At http://www.ifpri.org/2020/nw/nwpapers/dohabr200306.pdf. Accessed on April 21, 2004.

Ssewanyana, S., J. Okidi, D. Angemi, and V. Barungi. (2004), 'Understanding the determinants of income inequality in Uganda', Economic Policy Research Center (EPRC) mimeo, Kampala Uganda.

Swynnerton, R.J.M. (1954), A plan to intensify the development of African agriculture in Kenya. Nairobi: Government Printer.

Tiffen, M., M. Mortimore, and F. Gichuki (1994), More people – less erosion: Environmental recovery in Kenya. London, UK: Wiley and Sons.

Tripp, A.M. (2004), Women's movements, customary law, and land rights in Africa**:** The case of Uganda. African Studies Quarterly 7(4) (Online): ttp://web.africa.ufl.edu/asq/v7/v7i4a1.htm

Uganda Bureau of Statistics (UBOS). (2003a), 'Uganda National Household Survey 2002/2003. Report on the Socio-economic Survey', UBOS, Entebbe Uganda.

Wanyeki, L.M. (2003), Women and land in Africa – culture, religion and realizing women's rights. Zed books.

Webster Dictionary (1913), Webster's Revised Unabridged Dictionary at http://www.dictionary.net/Bantu accessed on March 31, 2005.

Western, D. and R.M. Wright (1994), Natural connections: Perspectives in community-based conservation. Washington D.C.: Island Press.

Wood, S., K. Sebastian, F. Nachtergaele, D. Nielsen, and A. Dai (1999), 'Spatial aspects of the design and targeting of agricultural development strategies', Environment and Production Technology Division Discussion Paper 44. Washington, DC: International Food Policy Research Institute.

Young, K. (1994), 'Roads and the environmental degradation of tropical montane forests', Conservation Biology 8(4):972-6.

Zake, J. Y., M.K. Magunda and C. Nkwiine (1997), 'Integrated soil management for sustainable agriculture and food security. The Ugandan of case', Paper presented at the FAO workshop on Integrated soil management for sustainable agriculture and food security in Southern and Eastern Africa, Harare, Zimbabwe Dec. 8-12, 1997.

Zantell, B.A., and B.A. Knuth. (2004), 'Participation rhetoric or community based management reality? Influences on willingness to participate in a Venezuelan freshwater fishery', World Development 32(5):793-807.

Searching for Effective Credit Schemes for Smallholder Farmers: Experience of the African Highlands Initiative (AHI), Southern Ethiopia

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Abstract

Availability of credit opportunities is known to enhance technology adoption and house hold capacity to intensify their production systems. However various credit systems tested in Ethiopia have failed, as farmers were not willing to repay the credit in time. The problem could be associated with the institutional capacity to reinforce the payment or the difficulty farmers faced to profit from the credit investment they received. Tobit model was used to identify factors influencing credit repayment performance of smallholder farmers. Two categories of credit, i.e. cash and kind, were provided to 23 farmers in AHI Areka benchmark site. Follow up of credit uses, repayment and data collection were undertaken for three consecutive years (2001-2003) since the provision of credit items. The most important factors significantly affected credit repayment performance were type of credit provided, age and education level of the beneficiaries. The results suggest that future credit interventions in the area should take into account these socioeconomic variables. Special care should be taken to change farmers' perception of mixing up credit with free aid.

Introduction

In Ethiopia, an agrarian country, agriculture plays a major role in the economy, which accounts for about 45.5% of GDP, 85% of the employment and 94% of the county's export (NBE, 2002). Like in many other developing countries, the economy of Ethiopia is characterized by heavy dependence on agricultural sector, traditional type of farming practices, high labor to capital ratio, low adoption of improved farm technology, poor infrastructural facilities and low level on-farm productivity. These characteristics are outcomes of or causes for low level of farm income and low rate of capital formation in agriculture. Thus, to break the above-mentioned vicious circle, farm sector demands policies that may encourage financial support in terms of agricultural credit or otherwise. Agricultural credit can play a catalytic role in improving adoption of farm technology, improving farm productivity, improving farm income, improving saving rate, accelerating capital formation and, thus, improving the prosperity of the farm sector.

Boloso Sore woreda, where this research was conducted, is characterized by high population density, low agricultural productivity and diverse production constraints. Low yielding crop varieties, traditional farm implements and oxen shortage are few among major production constraints. Different development organizations (both governmental and nongovernmental) have so far made interventions in various areas of development to improve the livelihood of the population. On the other hand,, the living conditions of the farming community have shown declining trend over time.

Earlier negotiation with the respective communities revealed that possible solutions to the draught power problem should include credit provision for livestock purchase, expansion of ox sharing arrangements and introduction of improved farm implements (Getahun *et al*, 1991). As a result NGOs and ministry of agricultural development have done remarkable efforts in this regard. Until 1985 the Wolaita Agriculture Development Unit (WADU) provided agricultural inputs on credit basis. The Ministry of Agriculture distributed inputs like fertilizer and seeds to the farmers. Redd Barna, an NGO, operated in the Woreda for ten years, made much more efforts to address this problem through credit schemes. However, all these considerations become unsuccessful due to the complexity of the social dynamics, less coordinated and unorganized efforts of different stakeholders. It was with this background that AHI initiated several collaborative research activities to mitigate development problems in Gununo Peasant Association (PA) of the Woreda, including the attempt to identify appropriate credit schemes for future possible intervention. In particular, credit schemes for livestock such as oxen, cows, sheep and other income-generating was considered. Identification of the appropriate scheme could be used as supportive tool towards facilitating system intensification through alleviating the shortage of oxen power and offer alternatives for income generation.

Overview of Rural Credit Provision in Ethiopia

Informal credit institutions are those without formal requirement for their establishment and operate outside the jurisdiction of the Central Bank. They include commercial lenders (such as private moneylenders, pawn bankers and merchants), non-commercial lenders (such as friends, relatives and neighbors), mutual help associations (such as iqub, iddir, mahiber, etc.), cooperatives and non-governmental organizations (NGOs). Informal credit in rural areas is characterized by fragmentation, rationing and high interest rates (Shiferaw and Holden, 1997). The commercial informal lenders are suckers of the rural peasants (Idilegnaw, 2000). Non-commercial lenders also lack coherence to meet the credit needs of farm sector.

Formal credit institutions are those that are set up legally and regulated and controlled by the Central Bank. Bekele (2000) indicated that the Development Bank of Ethiopia (DBE) was given exclusive mandate to address rural credit needs before 1986. In June 1986, the Commercial Bank of Ethiopia (CBE), which was previously concentrated its credit operation on urban commercial activities, was given additional responsibility to meet rural development credit demand. The Ethiopian Insurance Corporation (EIC) was also given responsibility to put in place a limited scheme of insurance for selected crops and livestock and to support the credit policy in close consultation and collaboration with the DBE and the Ministry of Agriculture (NBE, 1986).

Since the market reform of 1991, financial institutions have been guided by the market signals to extend loan funds to their clients. Agricultural input loans are provided in kind mostly in the form of fertilizers and improved seeds. Input loans are guaranteed by the regional governments and administered jointly by them and the CBE. Farmers received credit via the district agricultural offices. In the input loan provision system that was introduced in 1996, input supply and credit are dealt within one transaction. That is the regional government borrows directly from the banks and relies on its administrative machinery and peasant organizations to disburse and collect the loan. Farmers have to apply to the district agricultural office by paying a 25 % down payment of the input prices, with the balance due after harvest. Borrower farmers paid a 10.5% interest rate on the input loan. Loan repayments are effected immediately after harvest. Farmers are notified by PA leaders and extension agents to settle their debt before the specified due date. If farmers fail to repay within the normal repayment schedule, administrative enforcement starts to operate. To strengthen the enforcement, loan collection committees are established at different administrative levels. Members of the committees include administrators, government officials, police force and elder farmers.

Experiences of Credit Provision in the Woreda

Different organizations have been involved in credit provision for different services/businesses in the Woreda. Among these interventions, credit for government extension program was very functional in most PAs since 1994. This credit program was for crop production, cattle fattening, sheep and goat fattening and poultry improvement. NGOs, which provided credit, were Redd Barna, South Cooperatives Development Project (SOCODEP), UNDP, FARM Africa and Omo Micro Finance Institution. These organizations concentrated on credit provisions for agricultural input, oxen, dairy goat and cash for small-scale income generation. The government credit that flows through agricultural office participated interested farmers with the down payment of 25 % before they are supplied with inputs. The remaining amount with interest at the rate of 10.5% is paid after the crop is harvested. Development agents (DAs) usually carry out collection of loan repayment. Here, in principle, the duty of DAs purely had to be technical support only but they were involved in loan repayment collection, which had a negative repercussion on farmers' perception of extension.

Redd Barna organized women groups and assisted the group to set up their regulations for saving and credit. Members borrowed the money from the group for small-scale income generation activities. However, the group collapsed with the phase out of the Project. FARM Africa project also formed women groups and set a rule for money contribution. The group provided credit and saving services for the members and follows up the collection of repayments. The aim of this saving and credit group was to provide improved dairy goats for the members. This has also become of no benefit as it was ceased with the withdrawal of the project.

Omo Micro Financing Institution is a newly introduced organization where communities that provide cash credit for identified group of farmers including 35-49 members. Credit is channeled through committee elected and each member has to repay the loan with in a maximum of 12 months period.

Experience has shown that loan repayment performance of both governmental and non-governmental credit institutions is very poor. The Omo Micro Financing Institution is the exception to this because of its strong supervision and follow-up activities, though subjected to high cost of credit administration compared others. Credit provision for draught oxen has been under operation by different organizations such as FAO, SOCODEP, Redd Barna and UNDP. But it was frailer due to lack of effective regulation, unwillingness of beneficiaries to repay the credit (willful default) and lack of organized and skilled body to collect the repayment. The other outshining problem was the perception of farmers considering credit provided as free aid. This has jeopardized the efforts of these organizations in repayment collection.

Feasible credit scheme has to be technically, financially and politically viable (Kanshahu, 1996). It has been investigated that the credit interventions in the Woreda have not experienced success because of at least one of these reasons. Credit provision should result in sufficient benefit to the community and to the people, which include the employment creation, growth of production, expression of technological know-how, better living condition and increased foreign exchange earning.

Methodology

Areka benchmark site (Gununo) is located at about 22 kilometers away from the capital of Wolaita zone (Sodo) in Southern Ethiopia. The altitude ranges from 1980 to 2100 meters above sea level. The area has a bimodal rainfall distribution extending from January (early February) to October mainly concentrated in months between April and September. The mean annual rainfall and temperature are 1330 mm and 21^0c, respectively. Natural vegetation is very limited because of intensive agriculture. Eucalyptus tree is dominating in the area and still thrilled by farmers for its multiple uses as source of cash income, construction material and fuel wood. The area is characterized by high population density (around 523 people/km^2) that reduced average individual land holding to less than 0.5 hectare. It experiences occasional dry spells but critical food shortage periods virtually every year.

AHI provided different credit alternatives in January 2000 to alleviate the existing limitation of livestock, improve income of the community and evaluate the effectiveness of different credit provision methods (Table1). Thus, different credit items were provided to farmers of different social groups based on group collateral. Different stakeholders including Areka Agricultural Research Center, Woreda Office of Cooperatives, Woreda Office of Agriculture, PA leaders and Farmer Research Group (FRG) leaders were involved in selection of participating farmers (beneficiaries). A total of 23 beneficiaries were engaged in the study. Both cash and kind credit were given to farmers based on their interest and prior feasibility assessment. The maximum time given for all types of credit to be repaid back totally was three years.

Table 1: Different credit alternatives provided for various social groups

No.	Credit alternatives	Unit	Amount per head	No. of beneficiaries
1	Cash credit	Birr	552.20	11
2	Kind credit			
	▪ Cow	No.	1.00	4
	▪ Ox (one for two)	No.	0.50	4
	▪ Sheep	No.	1.00	4
	Total			23

Source: own record

ANALYTICAL METHOD

In this study, Tobit model was used to examine factors affecting repayment performance of farmers. Mathematically, the model can be expressed as:

$Y_i = \beta_i X_i + U_i$, if $\beta_i X_i + U_i > 0$………………………………. (1)

= 0, otherwise

Where Y_i = the observed dependent variable, in this case the amount of credit repaid. X_i = explanatory variable

β_i = a Kx1 matrix of parameters to be estimated

U_i = an independently and normally distributed error term with mean zero and constant variance

The maximum likelihood method is used to estimate the parameters of the model.

Variables Description and Hypotheses

The Tobit model specified above suggests that the dependant variable, which is defined as the amount of credit repaid, depends on the following explanatory variables.

CRTYPE: The type of credit provided affects payback period. Cash is the most liquid asset and believed to generate earlier income that could enhance repayment. Thus, cash credit is hypothesized to be repaid earlier than kind credit.

AMOUNT: Amount of money given on credit is important factor affecting credit repayment performance. Larger amount of money provided enables farmers to generate more income that enhances their repayment capacity. Hence, a positive relationship is hypothesized between credit repayment performance and amount of money given on credit.

GENDER: Role of gender in decision-making and resource utilization influences farm income. In rural areas, men farmers have better access to and control over resources. It is, therefore, hypothesized that gender of the farmer being male has positive influence on repayment performance of farmers.

AGE: Age has a positive influence on repayment performance it is related to the accumulated experience of money management. Therefore, a positive relationship between age and repayment performance is hypothesized.

EDU: Education enables farmers to understand befits of rural credit. It is hypothesized that education of the farmer has a positive impact on repayment performance.

HHSIZE: The greater the size of the household, the more the family is pressurized to fulfill basic requirements of all family members. This may take most of the income generated by the household lowering repayment capacity. Hence, household size is hypothesized to be negatively related to repayment performance.

FARMSIZE: Farmers with larger farm size generate more income, which provides a better capital base and enhances repayment capacity. So, a positive relationship is expected between farm size and repayment performance.

TLU: Livestock ownership is a key indicator of wealth. Farmers' ownership of livestock in terms of Tropical Livestock Unit (TLU) is expected to have a positive effect on loan repayment performance.

Results

The purpose of cash credit was to enhance the income generating capacity of women and men farmers through creation of alternatives for off-farm income particularly petty trade. Kind credit was targeted to improve the asset position of both poor, medium and rich women and men through alternative arrangements. It included cows, oxen and sheep. Oxen credit was based on the form of shared ownership between two farmers. The reason behind this is to use the local knowledge of farmers in livestock ownership and protect the animal from being sold by individual decision. Moreover, shared ownership is from of ownership that helps farmers to own livestock by pooling their limited capital which otherwise is not possible.

Factors Influencing Loan Repayment

Poor repayment performance has still continued to be major problem of credit scheme in the area. This can be attributed to a number of socio economic factors. The major one is dependency perception of farmers that needs to be changed, inherited from continual food aid. This requires efforts to upgrade farmers' awareness about the objective of credit activities. Table 2 shows the estimated results of factors affecting loan repayment performance of farmers.

The type of credit provided was the most important factor significantly affected loan repayment performance at less than 5% significance level. Credit provided in terms of cash was repayed back at more rate than that of kind. Amount of money given on credit, irrespective of the purpose, has negatively affected credit repayment performance. This could be due to the fact that farmers spend the money in unproductive ventures and fail to pay back it due to limited financial capacity. Gender of the beneficiaries (farmers) being men has positively affected loan repayment performance. The reason for this could be that men farmers had better access to resources and services than women farmers that enhances their capacity to generate more income than women generate. Age of the farmer has positive influence on loan repayment performance. This is because of the unwillingness of younger farmers to settle their debt. Moreover, younger farmers were more resistant or willful defaulters as compared to older ones. Education level of farmers has influenced loan repayment performance negatively unlike to the most accepted theory that education has positive influence on loan repayment performance. In the study area, educated farmers were moving to towns and distant places for search of causal jobs. They also tend to change their places whenever there is repayment schedule. By manipulating repayment collectors (group leaders) they have managed to escape many repayment schedules. As a result, repayment performances of educated farmers became very poor.

Table 2: Estimate results of factors influencing loan repayment performance using Tobit regression model.

Variable	Coefficient	Standard error	T-ratio
Constant	94.029	86.959	1.084
CRTYPE	-165.205	54.259	-3.045**
AMOUNT	-0.089	0.143	-0.632
GENDER	7.582	46.476	0.163
AGE	1.825	1.516	1.204*
EDU	-1.903	1.584	-1.202*
HHSIZE	1.897	7.715	0.246
FARMSIZE	-16.702	15.238	-1.096
TLU	14.835	15.482	0.958

Source: Own computation

Some Specific Benefits of AHI's Credit Scheme

AHI's credit scheme was used as an entry point for promoting AHI's research activities on complex natural resource management issues in the site. It increased the value of AHI's intervention and farmers' trust towards the project itself that enabled mutual planning and implementation of a number of research activities at farm level. Apart from this major benefit, other specific benefits obtained by farmers from credit include the following:

Increased income: Some farmers who have got credit earned profit that helped them buy productive assets like milking cows.
Improved food security status: Some farmers become able to feed their family from profits earned from petty trade as a result of cash credit, sales of milk and butter from cow credit and increased production resulting from draught oxen. (present the case of a farmer?).

Besides the common default problem, AHI's credit scheme study faced the following difficulties.

1. Some farmers who have received cash credit diverted the money for consumption purpose such as for food, house construction and social obligations.
2. Loss of animals bought from credit provision due to mortality and theft.
3. Loss of money (non profitability) from petty trade.
4. Lack of experience in income generating activities.
5. Limited opportunities for off farm income sources.
6. Limited effort by willful defaulters to convince other beneficiaries who are willing to settle their debit so that they are also discouraged and become not willing to repay.
7. Some farmers' perception that the loan would be forgotten or cancelled or considered as aid or relief.

Conclusion

It has been shown that farmers have developed dependency perception that diluted their understanding about the benefits of credit and benefits they may have got by investing innovatively. Though source of fund outside the farm was crucial for increased farm productivity, farmers in the area tend to mix up credit with free aid. The reason may be the effect of aid provision in the area for the last many years. That could be the reason why credit interventions in the area in the past experienced failure. Thus, rising farmers' awareness about the possible benefits, liabilities and sources of external funds wasis the major challenge of development in the area.

Results of the analysis have shown that farmers who have received cash credit had better and timely repayment performance than those who have taken kind credit. This could be because of the fact that it takes longer period for kind credit particularly livestock credit to generate income out of it. However, farmers indicated that kind credit is more important for them since it builds their asset position. Once income generation is started, it is likely to lift up the living standard of farmers. Freeman *et al.* (1996) pointed out that there should be clear distinction between credit used as investment capital, such as the purchase of a cow, and credit used for working capital such as expenditures on improved feed or veterinary services in their study of the role of credit in the uptake of improved dairy technologies. It is, therefore, advised not to concentrate only on short-term repayment performance. There should be some grace period until farmers start to generate income out of the invested capital. Hence, it is not ethical to evaluate cash credit and credit provided for livestock like oxen on similar basis. Younger farmers repaid credit less than older farmers. This implies that more attention should be given to older and stable farmers for better repayment and expected impact.

References

Edilegnaw Wale. 2000. "The Challenges in Search for Efficient and Sustainable Rural Credit Institutions and Their Policy Implications in Ethiopia." In: Workneh Negatu, Legesse Dadi, Abebe Haile Gabriel and Solomon Bellete (eds.). Institutions for Rural Development: Proceedings of the 4^{th} Annual Conference of the Agricultural Economics Society of Ethiopia. 23-24 November 1999, Addis Ababa, Ethiopia.

Freeman, H.A., M.A. Jabbar, S.K. Ehui and N. Gebreselassie. 1996. "The Role of Credit in the Uptake of Improved Dairy Technologies." Ethiopian Journal of Agricultural Economics, 1(1):1-17.

Getahun Degu, W. Mwangi, Tenaw Workayehu and B. Grisley. 1991. Areka Area Mixed Farming Zone, North Omo: Diagnostic Survey. Research Report no. 15. IAR, Addis Ababa, Ethiopia.

Kanshahu, Audace.1996. Planning and Implementing Sustainable Projects in Developing Countries: Theory, Practice and Economics. AgBe Publishing, Alkmaar, Holland.

NBE (National Bank of Ethiopia). 1986. Credit Regulation, NBECR/1/86. Addis Ababa, Ethiopia.

NBE (National Bank of Ethiopia) 2002. Annual Report for the Year 2000/2001. Economic Research Department of NBE, Addis Ababa, Ethiopia.

Shiferaw Bekele and Stein T. Holden. 1997. "Peasant Agriculture and Land Degradation in Ethiopia: Reflections on Constraints and Incentives for Soil Conservation and Food Security." Forum for Development Studies, No. 2:277-306.

Attacking Structural Constraints with a Social Systems Approach

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Abstract

Development projects are typically driven by "pet ideas," hidden assumptions and unfounded beliefs about human nature. We try to use our "common sense" and received wisdom to attack entrenched and complex problems. Development activities have a short-term and local focus that makes it difficult to identify and attack structural constraints. Thus our efforts although well meaning have limited impact; they may even exacerbate problems. This paper discusses the importance of a wider social systems approach involving historical, institutional, macroeconomic and socio-political dimensions and shows what tools are needed to implement this approach. Sustained development comes with active engagement of civil society, productive investment by the private sector and an enabling environment created by the government. Smaller-scale projects can feed into larger scale trends through networks, associations, communications and sound analyses. Projects need to be grounded in development theory and experience. For example, enterprise development projects require careful market analysis and links with the private sector; market analysis starts with an understanding of demand and market systems. Natural resource management projects need a clear understanding of local and wider policies regulating access to and control of resources, as well as cultural and socio-political structures that shape practices on the ground. The most important element of the social systems approach is the ability to think broadly and holistically about problems and solutions. Implementation requires flexibility, adaptative learning and wide consultation. Specific tools include app recitative inquiry, institutional analysis, social mapping and policy analysis.

How Can Smallholder Farmer–Market Linkages Increase Adoption for Improved Technological Options and NRM Strategies

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Abstract

The paradigm of involving farmers in research is based on strong evidence that enhancing farmers technical skills and research capabilities, and involving them as decision-makers in the technology development process results in innovations that are more responsive to their priorities, needs and constraints. Linking the technology development process to market opportunities has the potential to promote links between investment in natural resources, markets, and adoption of technologies. Market orientated agriculture for reducing poverty and environmental degradation needs to centre on three related paradigms; strengthening biological processes in agriculture (to optimise nutrient cycling, minimise external inputs and maximise the efficiency of their use); building farmer's capacities (to learn and innovate focused on improving livelihoods and the management of natural resources); and developing forward and backward linkages (between natural resources, production and markets). Starting with identification of market opportunities, natural resource management (NRM) issues are often raised during the process, for example, investment in soil fertility, leading to an iterative cycle of participatory action research with communities. In a multi-stakeholder coalition, CIAT and its partners are working in Malawi, Mozambique, Tanzania and Uganda to explore and understand how market orientation leads to improved NRM at the farm level. This paper uses case studies from Kabale in south western Uganda to highlight and discuss examples where identifying potential markets for existing and new products has led to increased investment in NRM and how developing innovative

Institutional and Policy Challenges: Implications of Various External and Local Policies on Natural Resource Management in West Kenya

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Abstract

The policy context in which agricultural institutions operate is shaped by national policy matters, donor agencies, the private sector and in some cases, farmer organizations setup. The policies can stimulate the institution to improve performance, build stronger links and address the needs of resource poor farmers effectively, or the policies can be a hindrance to the institutions operations. Kenya Government has formulated a number of policies as outlined in a number of sessional papers. The agricultural policy sessional Paper No. 1 of 1994 concerns increasing food production through extensive and intensive farming. To achieve this, several factors are considered and include: the prevailing political and economic conditions, external and domestic markets; and policies relating to the natural resources: land water and forests which directly or indirectly affect agricultural production; and have a bearing on the implementation of agricultural projects in general and therefore on the overall small holder agricultural development. This paper discusses the implication of existing local and external policies and social reforms in the dissemination of NRM technologies at the African Highlands Initiative (AHI) benchmark site in western Kenya, and the challenges involved. Various formal and informal institutions (Non Government (NGOs) and Community based organizations (CBOs)) disseminate agricultural information and technologies within AHI benchmark site. The Institutional setups and challenges influence agricultural information and technology dissemination endeavors, bearing in mind that wide spread sharing of agricultural information and technology dissemination is a prerequisite to increased agricultural production. The paper also discusses capacity building of the CBOs and the relevance of the social networks within the CBOs in relation to agricultural information and technology dissemination.

Policy Issues that Affect Natural Resource Management in the Watershed Areas of Ginchi, Ethiopia

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Abstract

Effective natural resource management (NRM) requires favorable policy at the community and governmental levels to ensure sustainable and environmental friendly utilization. This calls for a need to investigate the previous and existing policy environments and their impacts on NRM. This study was, therefore, conducted with the main objective of identifying policy issues that affect natural resource management in the watershed site of Ginchi, Ethiopia. As an approach to data collection, some of the key PRA tools such as group discussions, key informant interviews and transect walks were used. A team of researchers from different disciplines was involved in data collection.

The findings indicate that there were government and local policies implemented so far to manage natural resources and improve their utilization. The noticeable policy was a soil conservation policy formulated and applied by the government in the seventies. The major policy objective was to control soil losses, and maintain and improve soil fertility. The strategy used to implement this policy was community mobilization. The policy instrument applied during implementation was constructing physical structures, such as soil and stone bunds, and terraces. In the later years, the policy was not favorably accepted by most of the farmers and it led to the destruction of physical structures. According to the feedback from the farmers, the policy was not participatory and it was mainly top-down with out the participation of the beneficiaries. Farmers' land preparation practices were not taken into consideration and even the intervention sites should have been identified and prioritized. The farmers said, the intervention was also implemented even in non-problem areas. Moreover, the strategy used to implement the policy was labor demanding, cumbersome and time consuming. The strategy was also engineered theoretically and it has rather aggravated soil erosion than control it. Local policies were also initiated by the community to manage natural resources in the watershed areas. The policy objectives were reclaiming wastelands, maintaining farm lands and minimizing disputes between the neighboring farmers. The local policy instrument implemented was planting trees on wastelands and avoiding planting of Eucalyptus trees on farmlands and their borders. This study has assessed the impacts of the current land policy on NRM. According to the current land ownership policy, land is owned by the government and the farmers are given only the usufruct right. Initial results indicated that the impact of this policy was that the farmers were not encouraged to invest in NRM such as planting trees on degraded lands and building physical soil control structures on their farm lands. The local community should be encouraged to maintain and manage communal resources by formulating local policies, bylaws and regulations. Recognition of local policies and support is required from district level government bodies to maintain sustainability of collective actions. NRM policies designed at different levels of government structures need to be participatory involving strategic stakeholders, mainly the community.

Chapter 3:

Fostering Systems Intensification and Diversification

Intensification Pathways from Farmer Strategies to Sustainable Livelihoods: AHI's Experience

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Abstract

The bond between natural resources and communities has almost always been filial, though imbalance between utilization and conservation exposed farmers in Africa to extreme poverty and further resource degradation. Subsistence farmers in Eastern Africa are faced with serious decline in soil productivity. They categorize themselves in relation to number & composition of animals, perennial crops, land size and productivity, health and social positions. General strategies towards sustainable livelihoods include enabling their children have proper education, introduction of family planning methods and improvement of agricultural productivity. The last strategy has proven elusive, with few innovations being adopted despite various R&D attempts of both government and non-government institutions. AHI teams across the region have tested various scenarios of participatory and integrative ways to enhance integration of technologies. Farmer research committees (FRC), planning with development agents and scientists, initially focused conservatively on crop varieties. Members now supply seed of selected varieties to others, while researchers learned their selection criteria. With growing confidence, farmers embarked on more complex issues. Multipurpose elephant grass on contours was enthusiastically taken up, followed by farmer experiments with herbaceous and agroforestry legumes. Farmers describe interacting effects: new fodder sources improved dairy production; maize stover is retained for soil fertility; mixing early- and late-maturing maize varieties opened a niche for a legume relay. Some farm-level constraints provoked border conflicts (e.g. construction of soil bunds), which demanded collective management and negotiation of waterways towards developing initial confidence to address higher community issues. The FRCs vision changed to self-reliance through enhanced local innovation, to placing technical demands on the public sector, and to assisting other communities. In this paper, lessons learned across AHI sites about systems intensification scenarios and the roles of research are also discussed.

Introduction

Communities depend on natural resources as a source of their livelihood, including endless array of services for production, utilization, comfort and convenience. The bond between natural resources and communities has almost always been filial, while dynamic and complex, and there can be no divorce from this conjugal bond (Mesfin, 2003). However, due to unbalanced action between utilization and conservation of these natural resources in Africa, farmers and pastoralists are exposed to extreme poverty and further resource degradation.

In contrast to situations elsewhere, per capita food production continues to decline in Africa (World Bank, 1986). Important driving forces are commonly given as climate (frequent drought in SSA), decrease in farm sizes due to population pressure, decline in soil productivity, unfavorable policies, pests and diseases, inappropriate technologies and/or inadequate extension services. Sanchez et al. (1997) argued that increasing food insecurity and poverty in the region is an outcome of soil fertility depletion, and improving the land resource base through integrated nutrient management should be considered as an investment in natural resource capital.

National and international agricultural research institutions, despite their struggle to reverse the situation, are under pressure to justify their research priorities and modify their approaches in light of food security and natural resource management challenges. Currently, there is no consensus on how to increase real incomes and productivity of smallholders while sustaining the resource base. However, it is recognized that doing so is a more complex task than developing improved technologies solely (Eicher, 1987), in part because small farmers appear reluctant to invest in technologies that do not promise quick and reliable payoffs that satisfy their immediate needs. An integrated farmer-led research agenda is therefore needed where the farmer invests time and some limited resources on partnership and technology development.

Participatory research (PR) approaches provided an opportunity for researchers, extension, development workers and policy makers to understand more about farmers' complex circumstances, problems, needs and priorities. One of the pivotal contributions of PR approaches is the enhancement of inter-disciplinarity among researchers particularly, using an applied systems approach and other diverse disciplinary contributions towards solving complex NRM and livelihood issues (Amede et al. 2004).

This paper synthesizes experiences in the evolution of farmer-led integration of new system components to further sustainable intensification in Eastern and central Africa. The pilot program is hosted by the national agricultural research institutes (NARIs) and the various partners in this process have received support from African Highlands Initiative (AHI[1]), where in contrast to a discipline-oriented reductionist approach and the researcher-led approach originally applied in much FSR-E, the use of participatory tools and integrated strategies has been fostered. The specific objective is to encourage farmers to innovate and build their capacity for collective action in designing, testing and scaling-up technologies and processes that lead to improving the land resource base. The systems intensification research followed a step-wise approach that comprised detailed understanding of the clients and the system, identification of appropriate entry points, promotion of integrated natural resource management agenda, synthesis of dispersed recommendations and information in forms of decision tools to facilitate the decision making capacity of communities and their institutions to respond to the current opportunities and challenges.

Understanding the Clients and Systems

Given the steep slopes, intensive cropping and high rainfall intensity in most of the sites, decline in soil fertility is very apparent. The research teams employed several participatory techniques (Stroud, 1993, Pretty et al., 1995) in order to (1) develop the capacity of farmers and researchers in the area of integrated research, (2) foster partnerships among stakeholders, and (3) foster a change from commodity-oriented to a more holistic and participatory approach where farmers were in the forefront throughout the processes of technology development, dissemination and impact assessment.

At the initial stage of AHI, farmers demanded improved inputs (mainly fertilizers and seed). Later, they conducted varietal trials on major food crops (wheat, teff, beans and maize) and high value crops (coffee), and learned to maintain more than one option selected based on their own criteria. The interest for new technologies enhanced the demand side. Selection criteria varied with the technology, socio-economic strata, gender, market access and others. For example, for teff, the staple bread crop in Ethiopia, women's major selection criterion was colour (white grain fetches more money than red, and is preferred for cooking the local enjera bread), while men considered yield and lodging resistance as the main criteria. By building on that experience farmers started to try more technologies, to innovate, adapt and integrate them into their situations and, in the process, to derive many examples of "win-win" technologies that are useful for various cadres of farmers. Notably, not all were subjected to formal experimentation. In some sites, the researcher's role was therefore changing to introducing new ideas rather than design and control of experimentation, to monitoring with the aim of understanding farmers' innovations and evaluations, and to support scaling up. Based on a stratified wealth ranking and social analysis (Table 1), partner farmers were encouraged to work with scientists in participatory NRM research.

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[1] The African highlands initiative was conceived as a collaborative program of the national agricultural research institutions (NARIs) of the ASARECA countries and the International Agricultural Research Centres (IARC) to facilitate the marriage between better livelihoods for farmers and sustainable use of the resource base in the East African Highlands.

Table 1. Farmers' descriptions of indicators and categorisation of wealth groups, *Gegecho zone*, 1997. (Amede et al., 2001)

Wealth Strata	Indicators of wealth stratum (Rich to poor)
I	They never face food shortage. Have enough money to buy clothes and other necessary commodity. Own more than 4 '*timad'* (about 1 ha) of land, 2 oxen, 3 milking cows, 3 sheep, 1 donkey and a number of chickens. They have also many matured (unprocessed) enset plants in their homesteads. They have many coffee plants.
II	They have enough food to eat (but not for a long time). Have a minimum of one ox, one milking cow, half hectare of farmland, 1-2 sheep, a donkey and chickens. Some are traders. Have few matured enset plants. Have coffee plants (but not as many as the first strata).
III	Have half hectare of land. They share/possess in common (usually two people) an ox, a cow and a donkey. They can have 1-2 sheep. Have immature (few) enset plants and coffee. Keep few chickens. In general they are engaged in trading maize, travelling to nearby towns to buy maize and sell it in their locality.
IV	They have very small plots (usually less than 0.3 hectares) of land, few coffee and enset plants (their enset plants are very young, i.e. 1-2 years old). They own some sweet potato and a few chickens. The main income source is retail trading of maize flour, ginger, vegetables, salt, tobacco, etc.; they buy and sell only within their locality.
V	These are the poorest of the poor. They lost their land because they could not return money borrowed. They grow no crop, and are daily labourers. The women prepare enset, fetch water, cut and carry grass for others. Men collect fuel wood and sell in nearby small towns, cut and split trees, and sell their labour to get daily food. These are weak (sick or old) and landless people.

Various social groups could adopt or reject technologies based on their own perceptions, experiences, risk carrying capacity and perceived benefits. As presented in Table 2, resource-poor farmers resisted the adoption of soil conservation bunds as it would take up land from their small holdings while the rich farmers resisted adopting it due to its very high labour demand.

Table 2. Perceptions and preferences of various social groups on different soil fertility management options in Ethiopian Highlands (Amede et al., 2001).

Practice	**Rich**		**Poor**	
	Advantage	**Disadvantage**	**Advantage**	**Disadvantage**
Incorporation of crop residue	Soil fertility improvement; Yield increase	Shortage of animal feed	Soil fertility improvement	Fuel shortage
Soil bund	Reduce runoff	High labour demand; U-turn difficult	Erosion control	Take up land
Mulching	Conserve moisture	Reduce fodder	Conserve moisture	Attract termites
Legume cover crops	Soil fertility improvement	No feed value	Protect soil from run off and sun	Competes for land (food)

ENTRY POINTS AS DETERMINANTS OF EXPERIMENTATION AND ADOPTION

Although research in natural resource management needs to take a holistic view as well as acknowledging the complexities and diversity of farming systems, research with farmers should focus on clear issues, addressing critical problems that they have identified and prioritized (Amede et al., 2001). Hence it is important to choose and implement problem-solving entry points on which the possible adoption and dissemination of other NRM technologies by the community would depend on. Researchers involved in AHI used 'entry points' as a strategy to quickly get engaged with the farmers by providing some 'best bet' technical solutions to priority problems. The entry points used differ with social categories and agro ecologies. Detailed analysis of social categorization in Areka (Table1) showed that for relatively resource rich farmers, who have fertile plots and many animals to produce enough manure, high yielding crop varieties were the most preferred entry points, while for the resource poor farmers with degraded land and have limited access to manure preferred soil fertility improving interventions as best entry options (Amede et al., 2001).

EXAMPLES OF SUCCESSFUL ENTRY POINTS WITH WIN-WIN EFFECTS FROM AHI SITES

Case 1: Sweet potato, a major food source planted all year round as a sole or intercrop under maize is damaged by sweet potato butterfly. Controlling the pest is one strategy for increasing household food security. By planting sticky vines of desmodium around sweet potato fields, farmers reduced pest incidence. They have also used desmodium as a protein source for dairy cows (together with carbohydrate-rich elephant grass). This technology became popular among the communities.

Case 2: Farmers used to remove maize stover and wheat straw from outfield plots to use as fuel wood and as mulch for homestead crops. About 80% of the maize stover was used as a source of fuel wood (Amede et al., 2001). By planting Eucalyptus trees three years ago, farmers gained access to better quality fuel wood and this allowed them to now incorporate crop residues in the outfields. Mulch for the enset fields was obtained from the newly planted adjacent banana plants and on-farm trees (e.g. *Cordia*).

Case 3: Enset (the false banana) is the traditional homestead crop that receives the highest proportion of organic resources, mainly from manure and household refuse. The traditional belief is that enset cannot be productive unless it is supplied by organic residue year after year. Some farmers have now started a new strategy by planting enset in the main field. They have designed this change as a driving force (attractant) to transport organic resources to the main and outfields, which have been depleted for years by continual nutrient mining.

Case 4: The farmers who constructed physical soil bunds have integrated the planting of elephant grass (previously a completely unknown species here) to strengthen them. This technology rapidly became very popular, even outside the participating community, for minimizing soil erosion and for increasing the feed capital for the dry season. Farmers think that Elephant grass also reduces the population of maize stalk borers, the most prevalent pest in the area. Researchers will follow this up with further monitoring.

Case 5: Tephrosia and *Canavalia* are effective legume cover crops to restore soil fertility. Farmers started to integrate these LCCs as short-term fallows. *Tephrosia* was adopted in part because of farmer interest in its reputation for controlling mole rats, a general pest on many crops. Farmers in Gununo used to invest at least 4 hours to dig out and kill just one or two mole rats.

Case 6: *Sesbania* is a multipurpose tree adopted in many east African countries for feed and fuel. In 2000, farmers in Gununo chopped *Sesbania* leaves and young branches, applied them to sweet potato fields and obtained a substantially higher tuber yield. As sweet potato plants stay on the farm for a longer period than any other annual crop, there is ample time for nutrients to be released. In the following year, the farmers raised more than 500 seedlings and planted them as farm fences as a future source of organic fertilizer. Farmers who purchase fertilizer are expecting a 50% reduction of input costs by using *Sesbania* in biomass transfer.

Case 7: Earlier investigations showed that when early and mid-late maize varieties are grown in mixtures, there is a complementary effect that commonly gives higher yield than either variety alone (Amede, 1995). Farmers have benefited from this technology in two ways: firstly, the early maturing maize component was ready to be consumed as a green cob a month before any other variety was ready and, secondly, farmers obtained a niche to integrate either LCCs or other food crops into the system without affecting maize yield.

Some farmers could consider the temporary free provision of inputs (fertilizers and seeds), while introducing technologies as entry points at the beginning of the project, as a major benefit and this misconception about the project objectives might hinder its sustainability and create bias on the analysis of the attribution of changes in practice and attitudes to the PR approach (Amede etal, 2004).

IMPLEMENTING INTEGRATED APPROACHES

Despite the huge investment in agricultural research by African national programmes and international agricultural research institutions, past efforts have not been sufficient to affect the life of small-scale farmers given a generally reductionist approach lacking orientation towards conservation, development, policy and client participation. Researchers need to have a better understanding of, and integrate the socio-economic, organizational, and cultural issues for various individual and collective resource endowment categories, given that small scale farmers in SSA manipulate and integrate farm components hoping to maximize returns in relation to a complex environment. AHI has therefore promoted a change of researchers' "mind sets" to increase social and economic inputs into the traditional biophysical orientation, advance component/discipline approaches by infusing a systems perspective to achieve multiple goals or outputs by strategic combinations of technologies, and to reverse the trend whereby researchers determine research outputs to that where farmers conduct research and researchers monitor, contextualize the information for a wider range of users, and take up second generation research issues (Stroud, 2000).

After the arrival of the AHI partnership in the region, strategic research in the area took a new direction mainly aimed at increasing the capacity of farmers to analyze the production constraints and find solutions together with researchers. Here, the team involved with AHI is currently targeting integration and natural resource management by involving other partner institutions to a greater degree, having a better understanding of the social group dynamics and the resource endowment of socio-economic strata, fostering a high level of farmer participation and control in the research and development processes, and taking a "larger view" by encouraging involvement of a number of specialists who work beyond their component aiming to improve the system through better integration.

RESEARCH PROCESSES BY RESOURCE-POOR FARMERS

The two wealth groups III and IV (Table 1) are considered by the community as relatively poor, and represent about 70 to 75% of the Gununo community. The main production constraint for these groups mentioned during PRA (PRA report Areka, 1997) was decline in land productivity (also mentioned as the most pressing problem of the whole community). Those farmers who belonged to wealth ranks III and IV did not own livestock; hence they did not have access to manure for their crop fields. To secure the homestead security crops (the root crops enset and taro), farmers have for many years exported crop residues from the outfield (maize, wheat) to the homestead. This traditional nutrient mining led to a buildup of organic matter in the homestead and an extreme depletion in the outfield. Farmers in these categories lacked cash to bring in external inputs (inorganic fertilizers, organic residues, improved varieties) and also lack internal farm inputs (oxen for plowing and seed). Hence, they usually offer their farm for share cropping to fellow farmers who have more resources. One point worth bearing in mind with share cropping is that while those working the land will want to maximize their harvest, they are less likely to be interested in future productivity and therefore invest less in land care (Amede et al., 2001). Moreover, their land is steep (> 20% slope) and is highly vulnerable to soil erosion with prevalent high intensity of rainfall. These multiple agents lead to some portion of the farm becoming abandoned.

The entry point used with this group was to employ strategic soil and water conservation measures. In the first year, each farmer constructed about 15m of soil conservation bund, the approximate width of individual farm outfields. They strengthened these bunds by planting elephant grass, multipurpose trees and pigeon pea on the top and sides. In one case, Mr Demeke (26 years old) planted wheat on the lower side of his steep land before constructing soil bunds, but reaped a very poor harvest despite applying 25 kg DAP/ha. However, when he built a soil bund and then replanted the plot with wheat, his yield increased tenfold. He attributed this to the new construction, which prevented both seeds and fertilizer from being washed away (Amede et al., 2001). This impressed farmers in the following year to construct bunds about seven times longer, dividing their land into as many as eight plots following the contour. As the soil bunds were accompanied with forage grasses, farmers produced a high amount of dry season feed estimated to cover at least 35% of their feed demands. After minimizing the soil loss in these ways, farmers asked for soil improvement systems to increase soil organic matter and to improve nutrient stock and availability.

Since not all farmers own animals, crop residue management and legume cover crops (LCCs) were suggested by farmers and researchers for testing as potential alternative interventions for this farmer category (Table 3). After one season of farmer field schools with LCCs, farmers chose one or more of the seven candidate species (*Trifolium, Stylosanthus, vetch, Canavalia, Mucuna, Crotalaria* and *Tephrosia)* based on their own criteria (Amede et al., 2001). Most farmers of this group voted for *Crotalaria* as it performed well both on good and bad soils. The other measure they took was to stabilize gullies draining water from neighboring fields, firstly by stone blocks to reduce the velocity of run-off and then by planting indigenous trees.

After increasing livestock feed resources through growing grasses and legumes on the soil bunds, farmers asked for credit and bought young calves, partly for fattening and selling, partly to grow into milk cows, and also for recycling feed as manure. They have also planted more Eucalyptus trees to get more cash and fuel wood to reduce negative trade-offs.

The evolution of improved integration among the different farm components was very fast for this group, mainly because their production system relies heavily on internal resource flows and rarely involves external inputs.

Table 3. Matching system niches with resource endowment categories to intensify production systems.

Endowment Category		Niche for Intensification
POOREST: Limited land, wage laborers, less diversified, no livestock, no inputs	→	Low input labor; legumes & MTPs; higher value cash crop (*CBD coffee)*
MIDDLE: More land, own labour but limiting, some cash crops, some livestock, some trading	→	Livestock feed system, intensify manure use, increase diversification - range of options (*inorganic x organic, legume covers, improved crop management)*
MOST: Excess land & rent, hire labor, large livestock, buy inputs, well diversified	→	Wood lots, experiment on behalf of others; pay higher wage rates?, micro-enterprise development, livestock feed system, S&W conservation *(soil bunds with grass & compost)*

RESEARCH PROCESSES BY RESOURCE-RICH FARMERS

These groups are composed of relatively rich farmers who own animals, have managed to produce enough food to cover the household food demand, and are in position to buy external inputs (fertilizers and improved seeds). However, access to new varieties was limited.

At the initial stage of AHI, the priority intervention that this group demanded from researchers was improved inputs (mainly fertilizers and seeds). The farmers conducted varietal trials on four major food crops (wheat, teff, beans and maize) after researchers brought candidate improved varieties from national and international research institutions with proven adaptation record to similar agroecologies. Farmers tested at least six varieties from each species and selected more than one variety from each species based on their own criteria. Selection criteria varied with the crop, socio-economic strata and gender. For example, for teff (*Eragrostis abyssinica*, the staple bread crop) women's major selection criterion was colour (white grain fetches more money than red, and is preferred for cooking the local *enjera* bread), while men considered yield and lodging resistance as the main criteria. With those varieties introduced to the farming community in 1997, researchers are currently monitoring the fate of selected varieties. As a follow up strategy farmers were provided, at their own request, with training in seed systems to enable them to multiply the promising varieties, share them with non-participating fellow farmers and sell to neighboring communities.

Coffee remains as the major cash crop in the region despite recent decreases in price. However, yields had reduced due to coffee berry disease (CBD), the farmers' major concern. The farmers of these groups demanded pesticides in the short term and CBD resistant coffee varieties in the long term. After getting the support of the researchers to solve the pressing production problems (CBD resistant varieties) and witnessing an effective soil erosion control measure from their neighboring farmers (Wealth ranks III and IV), these groups promoted their interest in better integrated farming systems and development of 'win-win' technologies – those that increase productivity and improve NRM.

STRATEGIES TO CATALYZE INTEGRATED NATURAL RESOURCES MANAGEMENT

In some of the sites, like Areka, farmers have long been involved in government and non-government development programs that have tended to be ephemeral and/or based on crisis management. Research has often been peripheral to these programs and farmers largely have been seen as recipients. One successful example often cited is the Wollaita Agricultural Development Unit (WADU), which was integrated but costly apparently, too costly to sustain and to repeat elsewhere. Development and research organizations are looking for new models to foster an "upward spiral" where the local poor can sustainably improve their livelihoods while maintaining and improving their resource base. Although the work done is largely driven by research interests with the aim to make an impact, the general philosophy is to foster more holistic, integrated and participatory methods as a means to the end. Integrated natural resource management (INRM) at a farm or landscape level can become realistic if (and only if) researchers have sufficient knowledge about the group dynamics and processes, and the driving forces of intensification.

Improving farm productivity has generally remained a challenge mainly because of non-adoption of improved technologies for various reasons. Inclusion of farmers in the research process has been discussed above as a positive step towards increasing adoption. In addition, research methods have been changed. Researchers adopted a "team" and multidisciplinary approach towards solving the farmer-felt problems. They introduced not one, but numerous technologies targeted towards solving soil fertility, income, food and feed problems simultaneously. They incorporated the needs of men, women and various wealth-endowed categories, and fully involved them in an open process for designing trials, choosing and evaluating technologies, and evaluating the programme.

Farmers started to try more technologies, to innovate, adapt and integrate them into their situations and, in the process, to derive many examples of "win-win" technologies that are useful for various cadres of farmers. Notably, not all were subjected to formal experimentation. The researcher role is therefore changing to one of introducing new ideas rather than design and control of experimentation, to monitoring with the aim of understanding farmers' innovations and evaluations, and to support scaling up.

Strategically, different driving forces determine the mode of systems intensification in subsistence farming systems. In general, main determining factors (driving forces) dictating the direction of intensification in the East African highlands are market, climate, land quality, household status and policy. In areas where market access is bad, such as in Areka, (due to inaccessibility, poor policies or otherwise) farmers tend to depend on internal resources. For example, farmers of wealth groups I and II used to buy inorganic fertilizers, but in the year 2000, the price of maize dropped from 100 to 40 Ethiopian birr per 100 kg due to excess production in a year of good rainfall distribution. At the same time, the price of improved seed was about 350 birr and fertilizer 200 birr per 100 kg – an economically unattractive ratio. The following year almost all farmers in Gununo decided not to buy external inputs but to rely on farm-based resources. This proved to be a driving force towards sustainable intensification. With the improved partnership with research and the improved cohesiveness of the community groups, farmers have adapted and combined technologies to achieve this end.

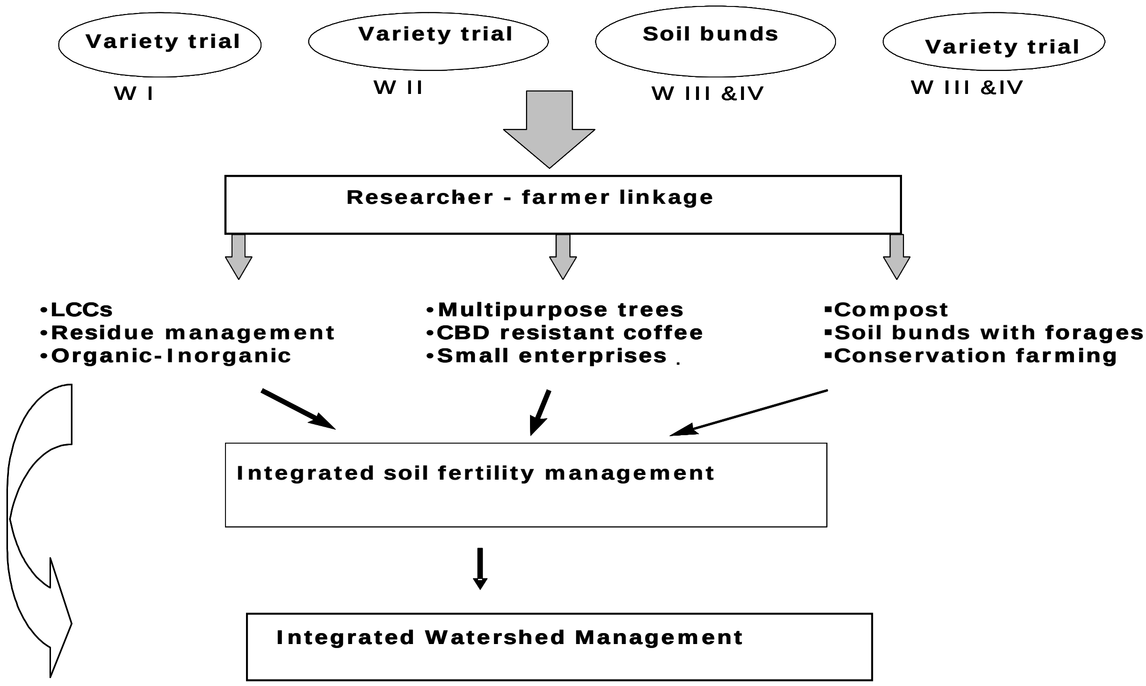

Figure 1. The evolution of participatory research from varieties to land management in Areka, Ethiopia

DECISION GUIDES FOR FACILITATING DECISION MAKING

Farmers and other stakeholders are beginning to recognize the need for information management tools which could help them in automating the process of turning the mountains of dispersed data available into useful information. Researchers stemming from various disciplines could give more than five different variants of recommendations and make the farmer more confused than ever to make decisions. In one case in Ziwai, Southern Ethiopia, researchers who consulted a maize farmer individually on how to maximize the use of maize crop residues suggested burning of the residue to control the maize stalk borer by an entomologist, feeding it to the animals by an animal scientist, incorporating it to the soil for improving soil fertility by a soil scientist and selling it as a cooking fuel by an economist (personal communication). In this case, the farmers would have made better decisions if the information was gathered, synthesized, analyzed in economic and social terms and suggested to the farmer for possible use.

Whether decision guides could help to facilitate decision making of farmers has been tested on legumes in East African Highlands (Amede and Kirkby, 2004). Food legumes remained to be important components of various farming systems of Eastern Africa, while the attempt to integrate fodder legumes and legume cover crops (LCCs) since 1930s became unsuccessful. Farmers remained reluctant to integrate fodder legumes and LCCs, despite recognizing their benefits as soil fertility restorers and high value feeds, mainly due to community/farmer specific socio-economic factors. Farmers' participatory research was conducted in Ethiopian Highlands to understand the processes of integration of legumes of different use into mixed subsistent farming systems. Participatory evaluation was first conducted on the agronomic performance and adaptability of eight legumes during the main and small growing seasons. Following the agronomic evaluation, the perception of farmers to legumes of different use, the socio-economic factors dictating choices and adoption, and potential niches for legume integration into the cropping systems were considered. The final decision of farmers for integrating a non-food legume into their temporal & spatial niches of the system depended on land productivity, farm size, land ownership, access to market and need for livestock feed. The potential adopters of LCCs and forage legumes were less than 7%, while 91% of the farmers integrated the new cultivars of the food legumes. After characterizing the farming systems of other benchmark sites, those indicators were used for development of decision guides to be used for integration of legumes into multiple cropping systems of East African Highlands.

The decision tools developed with one community in Ethiopia were validated in another community with comparable socio-economic characteristics in Kenya. The validation results showed that the decision guide fits well with the current priorities of farmers in general, but few modifications were needed, for example, in households where livestock is an integral component the probability of the household to allocate land for legume cover crops is very rare. Since the land holding in these areas is very small, manure from few animals could suffice to keep soil fertility over years. They favor food and feed legumes over LCCs. In situations when perennial multipurpose legumes (e.g. Calliandra, Sesabania) are grown, they could be grown any where in the farm following soil conservation ditches, a case which was not apparent in Areka. The degree of soil fertility of the farm dictates most of the decisions of farmers on where to place a crop within the farm and other issues come second.

FARMER RESEARCH COMMITTEES AS CHANGE DRIVERS

Farmer and community involvement has proved critical for building farmers' capacity to innovate and experiment and to gain sufficient confidence to continue in their own process of development. In the process of fostering the organization of the farmer research committees (FRC) as the initial interface for interaction, researchers have learned more effective ways of organizing and working with farmers, and for monitoring and evaluating impacts. The majority of the farmer research groups at benchmark sites supported by AHI are involved in experimentation with new technologies, promotion and sales of their preferred technologies, and organizing collective action in response to felt needs.

The FRC recognized that its members' vision has changed with the recent AHI-mediated experiences from one of dependence upon initiatives from outside institutions to one of self-reliance in solving problems. They are now jointly discussing not only short-term needs and solutions, but have recently listed their three main long-term strategies for food security as being: (1) reducing the population pressure through family planning, (2) increasing farm productivity through improving land resource base, and (3) exporting trained labor through education. This change to self reliance also includes placing demands for more options and technologies, placing technical demands on the community and policy makers, and actively assisting other communities in taking up technologies they have found useful. The FRC through sharing experiences is advancing and integrating the technologies well beyond what the researchers initially imagined; thus, dependency is gradually diminishing and the FRC is providing the continuity to the process, regardless of the level of researcher involvement and staff changes.

LINKING NRM WITH MARKET OPPORTUNITIES (CASES FROM INNOVATIVE WOMEN)

The success of many knowledge-intensive technologies like soil and water conservation in Ethiopia heavily depend on the combination of the interventions used to attract farmers to organize themselves, the type and value of the soil conservation stabilizers and the type and amount of the immediate benefits, preferably cash, farmers get out of the intervention. Farmers who were sustainably treating their steep land by constructing hillside terraces were those who planted high value shrubs, fruit trees, and fast growing forages. For example, Ayelech Fikre, an innovative farmer in central Ethiopian highlands was planting gesho (*Rehaminus perinoides*) also known as hops, which is used to brew local beer and for which there is a high demand in the local market (Million, 2001). When a visiting expert asked her ‘Who taught you to do all these different activities?’ she replied ‘The problem and the market’.

Another innovative woman was Mrs. Romas Haile from Tigrai, Northern Ethiopia (Personal communication). She is a widow, 67, and has no family labor. Her land was far away from the traditional irrigation command area. During recent construction of diversions and canals her farm was almost completely destroyed and covered by stone. On the other hand, she was happy that the water canal was crossing her farm. She decided to remove tones of debris away from her farm alone, which took her at least 3 months. She changed her wheat and barely field to a vegetable garden irrigating the field using buckets. Her net income increased from debt to about 2000 birr net per annum in the last two years. She is excited that she was able to intensify her farm and improve the productivity of her land through better management using farm residues.

Conclusion

In general, the success of agricultural intervention heavily depends upon the following ingredients:

- Careful selection of entry points, which are quick to solve the major problems of the farmers, which would encourage farmers to be engaged in the research partnership. The next step is to move into more complex issues such as soil and water conservation and organic resource management.
- Increased farmer knowledge on experimentation through facilitation of site visits, farmer to farmer discussions, field days, easy-to-understand brochures, subject matter class trainings, and drama among others
- Integration of ITK and local indicators in the R&D process throughout the research process
- Building mutual confidence among researchers, extension workers, and farmers through strong linkages
- Develop baskets of technological options that are appropriate to all social groups and are gender, and market-oriented
- Frequent supply of knowledge and planting materials, especially for new germplasm of most favored crops and animals
- Formation of FRCs to facilitate farmers’ participation and commitment, and evaluate various field experiments
- Supportive research management systems and organization to provide support to local actors, including community facilitation
- Continuity in engaging farmers and their groups, which has eadership and financial implications

References

Amede, T., H. Assefa, and A. Stroud (eds), 2004. Participatory Research in Action: Ethiopian Experiences. Ethiopian Agricultural Research Organization and African Highlands Initiative. 143pp.

Amede, T. and R. Kirkby, 2004. Guidelines for integration of legumes into the farming systems of East African highlands. pp, 26-43. Chapter 3. In: Bationo, A., Managing nutrient cycles to sustain soil fertility in Sub-Saharan Africa. Academic Science Publishers.

Amede, T., T. Belachew and E. Geta, 2001. Reversing the degradation of arable land in the Ethiopian Highlands. Managing African soils No. 23, IIED-London.

Amede, T. 1995. Yield gain and risk minimization in maize through cultivar mixtures in the southern Rift-valley, Ethiopia. Exp Agric. 31:161-168.

Eicher, C., 1987. Food security research priorities in sub-Saharan Africa. In: Menyonga, J.M., Bizuneh, T. and Youdeowei, A., 1987. Food grain production in semi-arid Africa, OAU/STRC-SAFGRAD.

Mesfin, Abebe, 2003. Some reflections on natural resources in Ethiopia with references to the Amhara national regional state. Pp 7-13. In. Amede, T. (ed). Natural resource degradation and environmental concerns in the Amhara National regional State, Ethiopia: Impact on food security. Ethiopian Soil Science Society.

Million, Alemayehu, 2001. Ayelech Fikre: An outstanding woman farmer in Amhara region, Ethiopia. In: C. Reij and A. Waters-Bayer Farmer Innovation in Africa. Pp 28-32.

Participatory Rural Appraisal Report, Areka, 1997. Areka, Southern Ethiopia. (Unpublished).

Pretty, J., I. Guijt, J. Thompson, and I. Scoons, 1995. A trainer's guide for participatory approaches. IIED, London

Sanchez, P., K. Shepherd, M. Soule, F. Place, R. Buresh, and A.M. Izac, 1997. Soil fertility replenishment in Africa: An investment in natural resource capital. SSSA special publication no. 51, 1-46.

Stroud, A., 1993. Conducting on-farm experiments. Cali, Colombia: Centro International de Agricultura Tropical. 118p.

Worldbank, 1986. Poverty and Hunger: Issues and options for food security in developing countries. Washington, DC.

Experiences of Participatory Use of Different Sources of Crop Nutrients for Improvement of Soil Fertility in W Kenya

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Abstract

Over 70 % of farmers in western Kenya are smallholders and have low crop productivity due to low soil fertility and limited financial resources to buy inputs. High costs of inorganic fertilizers have led to infrequent application of fertilizer to sustain productivity. Organic inputs such as animal manures are available in limited amounts and are low in quality. Realization of linkages between soil fertility, low household economy, and consequences of past interventions to enhance crop productivity led to a need for technologies which integrate alternative nutrient sources. The aim is for farmers to use organic inputs and inorganic fertilizers to enhance crop productivity and ultimately improve the rural food security. The KARI AHI R&D team used a participatory approach to demonstrate viable soil improving technologies incorporating legume cover crops (LCC), improved animal manures and inorganic fertilizers. Use of LCCs improved grain yield by 73% compared to where inputs were not applied. Use of inorganic fertilizers yielded 85% more. Using participatory monitoring researchers learned that farmers appreciated the LCC contribution to soil fertility improvement and showed willingness to adopt them. They were however limited in their knowledge on the contributions of LCC to soil fertility improvement. Participatory assessment also showed that besides nutrient contribution farmers were concerned about the compatibility of the legumes with their farming system, their seed availability, and trade-offs between their objectives. After discussions farmers' concerns were appreciated by researchers and incorporated into further testing of the technologies. In conclusion, introduction of appropriate LCC species that fit into farming systems is an alternative intervention for integrating nutrients to improve soil fertility and yields in Western Kenya.

Introduction

Soil fertility depletion in small holder farms is currently recognized as the fundamental biophysical cause of declining per capita food production in Africa (Sanchez *et al.,* 1997). In western Kenya, soils are typically low in inherent fertility. High population pressure on land has led to continuous cultivation and mining of soil nutrient reserves. High costs of mineral fertilizers has limited their use by farmers. Organic resources such as animal manures (FYM) are available in low amounts and are low in quality. Responses of maize a staple food crop in the region, to different soil amendments has been demonstrated (Ojiem *et al*., 2000).

The concept of integrating nutrients' utilizing all available organic and inorganic nutrient resources has become a dominant paradigm for research in smallholder farming systems of sub- Saharan Africa (Smaling *et al.*,1997). This ensures both efficient and economic use of scarce nutrient resources. Participatory approaches are thus required to demonstrate effects of soil amendments and enable farmers to experiment and share knowledge. There is need to have a continual interaction between farmers and researchers during technology testing to provide insights about potential adoption of new amendments such as legume cover crops. The challenge therefore is to impact the idea of integrating nutrients to farmers through participatory approaches and have them adapt and adopt alternative organic resources.

This paper highlights the effects of different soil amendments on maize grain yield through farmer research groups (FRGs) and the feedback on perceptions and preferences, which are useful in refining technology generation and transfer.

Methodology

Technology demonstration

Demonstrations were established in farmer fields in Ebusiloli in August 1999 and were run for two years. Five treatments (animal manure 10t.ha, animal manure (5 t/ha) + inorganic N (30kg/ha), legume green manure residue (GM), inorganic N (40kg/ha) + P2O5 (20 kg/ha) and farmers practice (control) were established in 24 farms in a randomized complete block design with each farmer acting as a replicate. Legume green manures were grown in rotation with maize during SR 99 and relay cropped during long rains season 2000. The legumes applied were *Mucuna prurience, Canavalia ensiformis* and *Crotalaria ochreleuca.* Maize was planted in all the plots and grain yield evaluated at the end of each growth cycle to assess response to the different soil amendments.

Farmer evaluations

Farmers conducted evaluations during different stages of the research process. A participatory rural appraisal was conducted together with farmers at the beginning of the research cycle to understand their production constraints.

Household interviews and focused group discussions

A household survey was conducted to identify adoption and impact factors at household levels. A sample of households participating in each of the technologies under experimentation was selected on the basis of farm types (identified by wealth ranking and gender). Household heads or family members versed with the trials were interviewed using a checklist.

Contingent valuation method (CVM) was used to evaluate farmers' willingness to apply green manure legumes. Farmers were asked about components of green manure technology they were willing to adopt and the related reasons. A sample of 6 farmers hosting the trials and 5 non-participating farmers were interviewed. Focused group discussion with 14 non-participating farmers were conducted

Survey

Two surveys were carried out after maize harvesting to establish components of the technologies that required modifications. A total of 25 farmers practicing in at least one of the soil amendments demonstrated were interviewed using a structured questionnaire. Their perceptions of the soil amendments, economic viability and social acceptability were sought

Data analysis was by descriptive and inferential statistics.

Results

Grain Yield

Maize yield in the control plots decreased from 0.6 tha-1in the first season to 0.3 t/ha in the 2nd season, (Table 1). Addition of both organic and inorganic amendments increased grain yields compared to the control plot. LCC improved grain yield by 73% compared to non- application of inputs. Additionally use of inorganic fertilizers yielded 85% compared to the control.

Table 1: Mean maize grain yield (tha-1) and nitrogen accumulation by different soil amendments 1999 and 2000 at Emuhaya division Vihiga district western Kenya.

Treatment	**Yield tha^{-1}**					
	Season 1 Grain	Season 2 Biomass	**Season 3** Grain	Total yield Grain	%N	N fertilizer KgNha^{-1}
Control	0.62	-----	0.37	0.92	---	0
Mucuna	0.65	3.58 ^{c}	1.65	2.3	2.4	45
Canavalia	0.53	5.17 ^{b}	1.57	2.1	2.6	45
Crotalaria	0.5	6.05 ^{a}	1.80	2.3	2.73**	63
Animal manure + 30 kg N	----	----	3.58	3.58	0.95	50
Animal manure(improved)	----	----	4.77	4.77	0.95	23
Inorganic N	----	----	4.60	4.6	---	40
c.v %	21.14	14.0			---	---
lsd(0.05)	-0.150	0.638			---	---

***Data from the organic database (Palm et al 2001)*

Farmer evaluation exercise

Evaluation of potential uptake of green manure legumes as a component of Integrated Nutrient Management was undertaken (table 2). Green legume manure is considered a low cost technology compared to exclusive use of inorganic fertilizers.

Table 2: Farmers perceptions of factors that affect potential uptake of green manure legumes in Western Kenya.

Criteria	% respondents n=11
High labor demand**	63.6
High biomass*	72.7
Multiple uses of legumes *	81.8
Unavailability of legume seed**	54.5
High yield of maize on the plot	100

** Factors likely to constrain uptake, *Factors likely to promote uptake

63.6% of the respondents foresaw that more labor would be required to establish, and incorporate the legumes. Establishment of green manure legumes at onset of short rains coincided with a period when farmers are busy preparing land and planting other crops.

Mucuna was perceived to require highest amount of labor due to its high biomass. 72% of the farmers preferred green manure legumes with high biomass as they were perceived to contribute more to improved soil fertility. *Crotolaria* was considered to require least labor. Majority of the farmers not hosting green manure experiments indicated that lack of legume seed could constrain their uptake of the technology. Legume species with more than one use were preferred, possibly as way of spreading risks and as means of attaining farmers' multiple objectives. *Crotolaria sp* can be utilized both as a vegetable and green manure legume. High crop yield, especially of maize was considered an important criterion in farmers' assessment potential of green manure legumes.

Survey results highlighted challenges that farmers experienced while implementing the technologies (Fig 1). Solutions were identified, discussed and agreed upon. Farmer perceptions were built into the process and influenced the design of next activities.

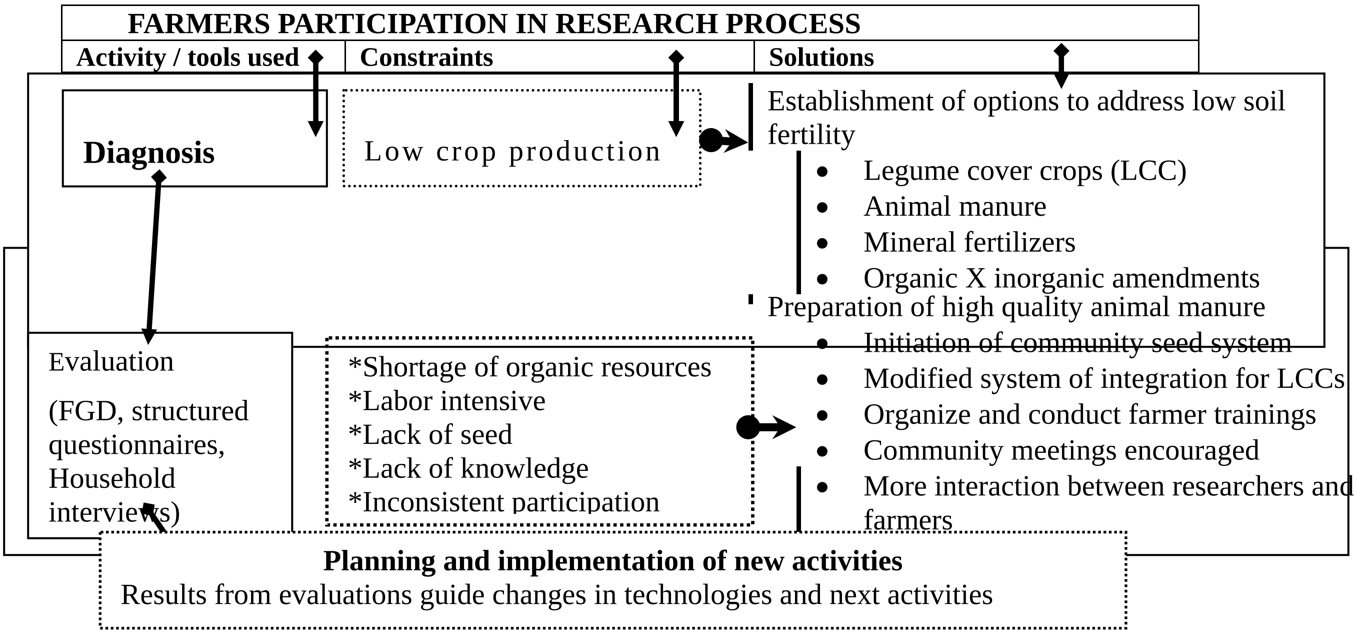

Figure 1: Major constraints and solutions identified during evaluations activities in Emuhaya, western Kenya

The survey indicated that the rotation - fallowing system experimented conflicted with farmers' objectives. Although some farmers fallow part of their farms during the minor season (short rains), the fallows are used for grazing. Available animal manures and other organic resources such as *tithonia* are low in quantity and offered inadequate supply of necessary nutrients for crop growth. Lack of sufficient information to enable farmers to utilize the different soil amendments fully was also highlighted as a constraint.

Solving identified constraints

Several activities were set up to address the constraints identified by farmers.

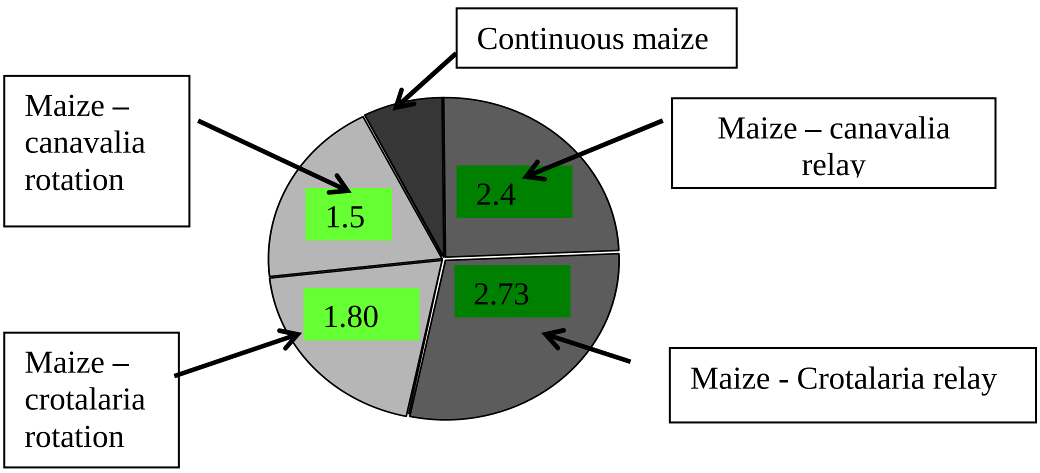

Figure 2: Yield response (kg/Ha)of selected gree manures under rotation and relay cropping at Emuhaya

Strategies for relay cropping LCCs in maize were evaluated. LCC were relayed in maize 4 weeks after planting. Maize yield and farmers perceptions were assessed and compared to the rotational system (Fig 2). When relayed into maize, the LCC gave a slight yield increase. When land size is a constraint, relaying GM with maize is likely to provide a suitable way of integrating legumes into the farming system. To provide legume seed sustainably, a local community managed legume seed system was put in place. Farmers were also trained on better methods of animal manure preparation and management. The effectiveness of improved manures was also demonstrated (Table 1).

Conclusion

Farmer participation, perceptions and concerns are key in defining the research agenda. Farmer participation through research groups enhanced a) information sharing between farmers and researchers b) constraint identification and modification of technologies to suit farmer's needs. It is envicioned that this would in turn influence innovation and adoption of the soil amendments demonstrated. However farmer experimentation should go hand in hand with training to ensure that proper information on the technologies is also imparted. Resulting trade-offs must also be considered.

References

Ojiem , J.O., J,G. Mureithi. And E. E. Okwuosa., 2000. Integrated management of legume green manure, Farmyard manure and inorganic nitrogen for soil fertility improvement in Western Kenya.In Mureithi, JG., Gachene, C. K., Muyekho, F. N.,Onyango, M., Mose, L. and Magenya, O.(Eds) *Participatory Technology Development for Soil Management by Smallholders in Kenya*. Proceedings of the 2nd scientific conference of soil management and legume research network project. Mombasa Kenya

Palm, C. A., C.N.Gachengo, R.J. Delve, G. Cadisch. And K. E. Giller, 2001. Organic inputs for soil fertility management in tropical agroecosystems.: Applications of an organic resource database. Agriculture, Ecosystems and Environment., 83, 82-42.

Sanchez, P.A., Shepherd,K.D., Soule,M.J., Place, F.M., Buresh, R.J., Izac, A.N., Mokwunye,A.U., Kwesiga, F.R., Ndiritu,C.G. and P.L. Woomer, 1997. Soil fertility replenishmentin Africa: an investment. In: *Replenishing Soil Fertility in Afri*ca. Buresh, R.J., Sanchez, P.A. and Calhoun, F (Eds), pp 1-46. SSSA Special publication Number 51, Soil Science Society of America and American Society of Agronomy, Madison, WI. USA.

Smaling, E.M.A., Nandwa, S.M and B.H. Janssen, 1997. Soil fertility is at stake. In: *Replenishing soil fertility in Africa* Buresh, R.J., Sanchez, P.A. and Calhoun, F (Eds), pp 47-61. SSSA Special publication Number 51, Soil Science Society of America and American Society of Agronomy, Madison, WI. USA.

Promoting Bean IPM Technologies through Participatory Research and Development Methods: Experiences with AHI Collaborating Farmers in Lushoto District, Tanzania

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Abstract

The history of research work on common beans (Phaseolus vulgaris L.) in farmers' fields in Lushoto District, Tanga region in north eastern Tanzania dates back to over 25 years. Farmers have identified suitable bean varieties and agronomic practices for their various circumstances. Current observations show that as the human population increased, the average household land size decreased from 0.7-1.2 to 0.2-0.8hectares and soils have increasingly become unproductive due to soil erosion and nutrient mining. Recently, unreliable weather conditions have rendered bean and other crops more vulnerable to damage by insect pests and diseases leading to poor crop yields, food insecurity and lowered incomes. When AHI started activities in Lushoto in 1998, farmers in Kwalei water catchment area requested for research assistance on a number of issues. SARI and CIAT had already worked extensively in the district, so it presented an opportunity to incorporate bean integrated pest management (IPM) into the farmer-led research program that was looking into other options to address soil and water conservation issues. The research teams promoted participatory pest management activities with farmer groups in Kwalei and 12 other village communities. Farmer groups participated in training, field experimentation and exchange visits to other practicing farmers. The excellent collaboration fostered by Lushoto Extension Services and SARI's research group with both AHI and the bean IPM projects supported by CIAT and ECABREN enhanced participatory dissemination of technologies. This experience showed that combining research with training and exposing farmer groups, helps to build farmers' and extensionists' confidence and keenness to learn, fine-tune and adapt more complex technologies like IPM, leading to wide-spread dissemination. There has been increasing demand from new farmer groups to get involved. Some of the notable outcomes are: Farmers are able to train others, organize their own demonstrations and field days, and contribute to the preparation and dissemination of extension materials at village level, leading to the evolving Village Information Centres-VICs. Once farmers learn from each other they adopt the technology without experimentation. The major lesson gained is that the participatory approach and processes have helped communities to develop strong confidence and sense of ownership. This creates an enabling environment for different partners to use the "social capital" (farmer groups) for other development activities.

Introduction

Studies at Kwalei catchment area have shown that the farming community ranked common beans second to maize as an important food crop (Lyamchai *et al*., 1998) (Table 1). Surplus bean grain is traded in the local markets. Other food crops in order of importance include bananas, sweet potato, cassava, yams, fruits, vegetables and round potatoes. Farmers have selected different bean cultivars based on a number of criteria including yield, marketability, palatability, thick broth, time to maturity, tolerance to different stresses (e.g. diseases, insect pests, drought, etc.), colour, cooking quality, etc. The most preferred bean cultivars were Soya, Lyamungu 85&90, Kabuku (Kibumbuli), Maharage Fito, Ukorogwe, etc. in that order.

Table 1. Farmer ranking of food crops at Kwalei catchment area

Crop	Scores (9 highest)	Rank (1 most important)
Maize	9	1
Beans	8	2
Sweet potato	6	4
Banana	7	3
Cassva	3	7
Yams (white flesh)	5	5
Yams (red flesh)	4	6
Vegetables	2	8
Wheat	0	10
Round potato	1	9

Source: Lyamchai *et al.* 1998

Farming systems

The focus of the farming systems in Lushoto district is in sufficient household food production and surplus to market for income. Farmers practice mixed farming system where crops and livestock are produced by the same household. Due to land shortage, most crops are intercropped except for tea which is grown as a sole crop. Common intercropping systems include banana and coffee based system, maize intercropped with beans, and a variety of horticultural crops (tomatoes, cabbage, carrots, potatoes, onions, okra, peas, spinach, eggplants, cassava, fruits, spices, etc.). Land allocation to different crops is mostly influenced by the economic importance, food preference by individual farmers and seasons. In Kwalei catchment area for example, cash crops are allocated 60% of the arable land and the area for tea and coffee has almost remained the same over the years. Recently however, most of the coffee bushes have been replaced by food crops due to high input costs and low market prices for coffee. Beans take up 10% of the arable land area (Table 2). The average under bean production ranges between 750-1250 kg/ha.

Table 2. Land allocation to different crops at Kwalei catchment area

Crop	**(%) land allocated**
Coffee/Banana	25
Tea	20
Maize	15
Tomato	15
Beans	10
Other crops	15

Source: Lyamchai *et al.* 1998

Main crop production constraints

Farmers reported that food crop production trends have declined in recent years. For some crops like maize, the decline has been at the expense of tomato production due to soil fertility degradation and land fragmentation. High human population pressure (450 persons /km^2) has been one of the major causes of land fragmentation in Lushoto (Meliyo, *et al*., 2004). Farmers have therefore, opted to invest soil fertility improvement measures to produce the more marketable vegetables including tomatoes, cabbages, common and snap beans, spices, etc. The decline in bean production was reported by farmers to be due to insect pests and diseases, poor farm practices, low yielding varieties, infertile soils and unavailability of farm inputs (such as quality seed, commercial pesticides and fertilizers) that are also associated with high costs (Table 3). In the case of beans, diseases include leaf diseases, root rots and nutritional disorders while the widespread insect pests are bean stem maggots, bean foliage beetle, bean bruchids, aphids, pod borers and sucking bugs. Other key constraints include low yielding varieties and poor cultural practices (inappropriate spacing, absence of pest scouting, untimely weeding and harvesting, lack of soil erosion and fertility improvement measures).

Table 3. Key constraints to bean production at Kwalei and resulting effects

Key constraints to bean production	Resulting effects
1. Incidences of insect pests and diseases	1. Poor crop yields
2. Low yielding bean varieties	2. Low household food and income
3. Poor cultural practices	3. Lack of livestock feed
4. Eroded soils	4. Poor human health
5. Low soil fertility	
6. Unavailability and high prices for farm inputs particularly seed, inorganic fertilizer and pesticides	

Source: Lyamchai *et al.* 1998

Background

Lushoto district is located in the north eastern highlands of Tanzania in Tanga region. The district covers the western part of the Usambara mountains at 40 22' and 50 08' south and 380 5' and 380 38' east of the Equator, with land area of 3500 km^2 (2000 km^2 is arable and 340 km^2 is forest reserve). The human population in 1988 was 357,531 at a 2.8% growth rate while estimates for 1998 were 471, 240. According to Pheiffer (1990), Lushoto district is in the humid-warm agro-ecological zone that lies between 800- 1500 metres altitude with an annual rainfall of 800-1700 mm. Most soils in the zone are classified as humic ferralitic. The main crops include tea, coffee, vegetables, fruits, spices, maize, beans, bananas, cassava, yams, sweet and Irish potatoes. Livestock farming (dairy cows and goats, piggery and poultry) and trading with agricultural products has gained widespread adoption in recent years.

Historical events show that Kwalei catchment in Lushoto district has since 1934 experienced 3 major famines, 2 locust infestations, 3 major human diseases including chicken pox, measles and meningitis, floods and drought (Lyamchai *et al.* 1998). The national research programme (Selian Agricultural Research Institute-SARI) and the Lushoto district extension services, the International Centre for Tropical Agriculture-CIAT and the African Highlands Initiative-AHI realized that participatory technology development and dissemination with farmers and active partners would be the most appropriate approach to empowering the farming communities in sustainable resource management.

Research work on common beans (*Phaseolus vulgaris* L.) in farmers' fields in Lushoto dates back to over 25 years (Karel *et al*. 1980). Farmers have identified suitable bean varieties and agronomic practices for their various circumstances. Current observations show that as the human population increased, the average household land size decreased from 0.7-1.2 to 0.2-0.8 hectares. This has led to high fragmentation of farm fields where households can own several small plots in varied distances. Such land is used intensively for the production of high value and short duration crops (beans, vegetables, spices, potatoes, fruits, etc.) and zero grazed animals (cows, goats, piggery, poultry, etc.) in place of the traditional coffee, tea, maize and bananas. Household members have also diversified their activities into trading with agricultural and other products and travelling out to seek employment elsewhere.

The intensively cultivated soils have increasingly become unproductive due to soil erosion and nutrient mining resulting from the removal of some of the contour bands, bushes and trees from the fields to avail more arable land for crops and pasture. Soil infertility is also due to the fact that most farmers have not been using organic or inorganic fertilizers (due to unavailability at the required time and high prices) to replenish soil nutrients after successive cropping. Soil erosion and nutrient mining is particularly dominant on the sloppy terrain in the district. Recently, the situation has been compounded by unreliable weather conditions that have rendered bean and other crops more vulnerable to damage by insect pests and diseases leading to poor crop yields, food insecurity and lowered household incomes. The major insect pests on beans include the bean foliage beetle (BFB)- *Ootheca* spp., bean stem maggots (BSM)- *Ophiomyia* spp., bean aphids (*Aphis fabae* and *A. craccivora*), bean bruchids (*Acanthoscelides* sp. and *Zabrotes* sp.), cutworms, pod borers, sucking bugs, etc. Diseases include bean anthracnose (*Colletotrichum* sp.), leaf rust (*Uromyces* sp.), angular leaf spot (*Phaeoisariopsis* sp.), bean common mosaic virus, root rots, etc. There are also various nutritional disorders depending on soil types at various locations (Bean IPM Project reports, Allen *et al*. 1996).

When the African Highlands Initiative (AHI) activities commenced in Lushoto in 1998, farmers in Kwalei catchment area requested for research assistance on a number of issues. Mlingano and Selian Agricultural Research Institutes (in Tanga and Arusha, respectively) and the International Centre for Tropical Agriculture (CIAT) had worked extensively in Lushoto district. This presented an opportunity to incorporate bean integrated pest management (IPM) into the farmer-led research program that was looking into other options to address soil and water management issues. The research teams promoted participatory pest management activities with farmer groups in the district. While AHI concentrated their efforts at Kwalei, Mbelei, Kwekitui and Kwamdoe, the bean IPM promotion projects involved farmers from Kwalei and 12 other village communities (Ubiri, Mbuzii, Nyasa, Mbelei, Kizara, Kwekitui, Kwangwenda, Mponde, Mombo, Mailitano, Soni and Vuga).

Farmer group representatives, district, and ward extension officers have participated in training, field experimentation and exchange visits to other practicing farmers in Kilimanjaro, Arusha and Manyara regions. Farmer groups in Kwalei, Mbuzii, Nyasa and Ubiri have hosted visiting bean IPM project participating farmers from Kilimanjaro and Mbeya regions (Bean IPM Project reports, July 2002, February 2003, June 2003). AHI and district extension personnel in Lushoto, and farmer groups at Ubiri and Kwalei have had the opportunity to share information and exchange knowledge with the bean IPM project donor representative (DFID Crop Protection Deputy Manager) in March 2003 (Bean IPM Project report, March 2003). In October 2004, the bean IPM project shared costs to facilitate 20 AHI participating farmer group representatives from Lushoto to conduct a 2 day visit to Babati bean IPM participating farmer groups after their learning tour of Arusha town markets. Babati farmer groups collaborated with Farm Africa in various agricultural production activities including intensified intercropping (such as beans + maize/sorghum + sunflower + pigeopea) and livestock production, all for food security.

The Lushoto farming communities have traditionally developed various strategies for management of pests and diseases in humans, domestic animals and crops. The national research programmes and partners in collaboration with farmers have also developed management strategies for crops, livestock, forestry, soil and water conservation, etc. These traditional and improved technologies have mostly been used by participants at specific pilot sites and have not been widely disseminated and adapted by neighbouring and other farming communities. A participatory group approach and different processes/methods were adopted in the current research activities to disseminate and promote bean integrated pest management (IPM) options from community to community while incorporating research outputs from other projects into the promotion exercise.

AHI and the bean IPM projects have shared costs involved in several farmer groups exchange visits by Lushoto farmer representatives to enable them share information and exchange experiences with other bean IPM practicing farmers in Manyara, Arusha, Mbeya and Kilimanjaro regions (Bean IPM project reports). Thus, bean IPM technologies developed in Lushoto particularly the use of botanicals *(Lushoto is mostly referred to as the home for herbs and spices!)* and other traditional products for pest management in crops (including sources of pesticides and organic fertilizers especially from such plants as *Vernonia*, *Tetradenia*, *Pycnostachys*, *Tithonia* species), livestock and human medicines have been shared and adopted by farmers in Arusha, Kilimanjaro, Manyara and Mbeya regions in Tanzania. In addition, such information and farmer technology adoption has crossed borders to Dedza district in central Malawi, Kisii district in western Kenya and Kabale in south western Uganda. The excellent collaboration fostered by Lushoto Extension Services, Mlingano and SARI research groups with both AHI and the bean IPM projects have greatly enhanced participatory group dissemination of IPM and other technologies to bean farming communities in Tanzania and the region at large.

Methodology

- *Participatory farmer research group approach*- Modified Farmer Field School-MFFS where each individual in the group including partners actively participate in different activities taking note of gender equity (men and women are involved in decision making, planning, training other farmers and partners, implementation of field activities including demonstrations/field days/visits, monitoring, evaluation, preparation of extension materials, dissemination of technologies and information)
- *Techniques used*- Formal and informal group training, planning meetings, field demonstrations, field days and exchange visits, sensitising and involvement of policy makers and other key partners, preparation and dissemination of promotional materials, setting up VICs, linking to different projects/NGOs/private sector and other service providers, displays and exhibitions, drama, choir, poems, radio, TV, and magazines/newsletters
- *Involvement*: Farmers, extension officers, local leaders, government policy makers, NGOs (TIP, Lishe Trust, etc.), other district focused projects (AHI and SECAP), private sector (Irente Farm, etc.), individual innovative farmers and other local service providers.

Justification for the above methodology

Farmers viewed collective group action as an effective and sustainable method to access information and technologies to solve the widespread bean pests, diseases, soil fertility and other production constraints at household and community levels. Local leaders and government officials have participated, supported and adopted the participatory group approach as an efficient, effective and sustainable means of reaching out to the rural small scale farmers to improve their capacity and empower them to own and manage their resources. Researchers and extension agents viewed the participatory group approach as effective in promoting the adoption of the complex and knowledge intensive IPM practice not only for beans but also for other farm and household production systems.

Results

Farmers are keen to learn by doing in their community groups. They are very careful in planning and conducting research, monitoring and evaluating the results. Farmers were also very flexible in changing their methodologies if things do not work out the way they were initially planned. Participating farmers were most willing to train others, exchange experiences, and share information and other resources. The participating farmers, farmers groups and active communities have identified pest problems and named them in their local languages (Table 4). In the course of research and experimentation, farmer groups have increased in number, diversified their farming systems by growing more high valued market crops, provided better care for their livestock (for example, production of vegetables, beans, potatoes and construction of animal shelters) and improved their household welfare. Farmers have also experimented with different bean genotypes including local selections (Table 5). More new farmers are continuing with evaluation and selection of more bean genotypes in their research groups and individual fields.

Table 4. Common pests and management strategies used by farmers and discussed in the training workshop in June 2003

1. Insect pests			
Local name	Common / Scientific name	Damage on plants	Management
Kiindi	Bean foliage beetle-*Ootheca* spp.	Feed on foliage and roots	Use botanicals Use wood ash and cow urine Cultural practices Use synthetic pesticides
Kifizi	Aphids- *Aphis* spp.	Growing points and transmission of viruses	As for *Ootheca* spp. Conserve natural enemies
Inzi wa maharage	Bean stem maggots – *Ophiomyia* spp.	Feed on within stems	Use tolerant bean varieties Use botanicals Cultural practices
Visaga	Bruchids	Seed in field and storage	Cultural practices Use botanicals
Futu	Caterpillars and pod borers	Foliage, pods and seed	Use botanicals and other traditional practices
Zukizi/Sota	Cutworms	Feed on seedlings	Use botanicals (e.g. *Euphobia* spp.- Muui or Mnyaa)
Kozwe	Snails	Feed on seedlings and pods	Use salt and botanicals
Mpasi/Ngeda	Grasshoppers	Feed on foliage	Baboons and Monkeys feed on them Smell from crushed elegant grasshoppers repels them from feeding on the crop
Shongo	Cereal stem borers	Feed on cereal stems	Some farmers use push-pull with elephant grass (Ngugu) Most farmers intercrop maize with legumes
2. Rats			
Nkuhe - Panya buku	Mole rats	Open bean pods and feed on seed	Use of smoke Use traditional traps (Ughogho) Use botanicals, e.g. *Tephrosia*- Mkaa or Utupa) Use rattax in baits
3.Diseases			
Ghojo	Wilt on tomatoes		Crop rotation Mixed cropping Use of fresh milk mixed with a filtrate from ash and water

Table 5. Some varieties and genotypes that Lushoto farmers have experimented with and selected or adopted for production

Local cultivars	Improved varieties and genotypes	Adopted/selected varieties and genotypes
EXLs 52, 55, 158, Kabuku (Kibumbuli), Maharage Fito, Ukorogwe	Soya, Lyamungu 85&90, G series- 21153, 23333, 8047, 1106, 22501, 11746, PAD 3, BAT 125, IKI (SINON), MLM 49, MLM 127, ZPV 292, IZO 201297, BESHBESH, Rojo, SUA 90, ZAA 12, Selian 94&97, Jesca, etc.	EXLs 52&158, Lyamungo 85&90, Rojo, SUA 90, Selian 94, G 21153, etc.

Women farmers participating in project activities have become very active and more of them have increasingly become interested in participatory group activities. A number of women have taken up key group leadership positions (Chairpersons, treasurers, secretaries). Some of these women are also local leaders in their villages (village chairpersons).

A number of dissemination processes/methods have been developed and used by different farmers and groups in target locations. These include training (formal and informal), field demonstrations, farmer meetings, exchange visits, involvement of local leaders/policy makers (District leaders including the Area Commissioner, District Agriculture and Livestock Development Office teams), NGOs (Lishe Trust, Traditional Irrigation Project-TIP), the private sector (for example, Irente Farm for bean seed production) and other service providers. Promotional materials have been developed with farmer participation and distributed to target offices and villages (leaflets, posters and field manuals). Other dissemination channels include drama, poems/songs, displays, visits, setting up village information centres-VICs). Some of the activities and technologies shared and exchanged during farmer group meetings and exchange visits are indicated in Tables 6.

Table. 6 Technologies shared by participating farmer groups in Lushoto, Hai, Arumeru, Babati, Mbeya, Dedza (Malawi) and Kisii sites

Site	Technologies shared
Lushoto	• Use of botanicals in bean pest, livestock and human disease management • Use of botanicals as sources of organic fertilizers (*Vernonia* spp.- Leaflet prepared) • Soil erosion and soil fertility management strategies (Fanya Juu, Fanya chini terrace construction) • Livestock forage establishment on terrace bands • Experimentation and selection of suitable bean cultivars, etc. • Integrated bean pest management strategies • Furrow construction and use of furrow irrigation for dry season high value vegetables, beans and fruit crop production • Bean seed production groups • Setting up and running village information centres (VICs)
Hai	• Mixed Crops and livestock farming (free and zero grazing) • Use of livestock products (urine, cowshed slurry, cow dung) for bean pest and soil nutrient management • Use of botanicals in bean pest, livestock and human disease management (e.g. *Tetradenia* sp., *Vernonia* spp., etc.) - Village focused armyworm forecasting and control - Integrated bean pest management strategies • Intercropping different crops in the same fields (maize, beans, sunflower, pigeonpea, etc.) • Use of Minjingu rock phosphate for soil nutrient management • Dry season livestock forage management • Setting up and running village information centres (VICs)

Arumeru	• Participatory breeding and selection of bean genotypes • Bean seed production groups • Use of animal products (cow urine and manure) for bean pest management • Integrated management of bean stem maggots
Babati	• Mixed crop and livestock production • Intensified intercropping for coping up with drought (beans, maize, sunflower, pigeonpea, *Dolichos*, sorghum, etc.) • Minimum cultivation and sub-soiling for soil water and nutrient conservation • Pigeonpea production for niche markets
Mbeya	• Bean and soy bean seed production groups • Use of botanical leaves (*Vernonia* spp., *Tephrosia* sp., etc.) and root (*Neuratenania* sp.) crude extracts for bean pest management • Bean production for the market • Dry season of bean leaf (spinach) production for high value vegetable market • Setting up and running village information centres (VICs)
Dedza	• Use of botanical leaf (*Tephrosia* sp., etc.) and root (*Neuratenania* sp.) crude extracts for bean pest management • Bean seed production groups • Dry season "Dambo" bean leaf, seed and grain production • Forest tree nursery production • Cultural ridge cultivation in all fields for soil erosion and water conservation • Establishment and use of green manures (e.g. *Mucuna*, *Tephrosia*, etc.)
Kisii	• Crop and livestock production (free range and zero grazing) • Forage production and push pull technology for cereal stem borers • Indigenous vegetable production • Setting up and running village information centres(VICs) • Bean seed production and distribution to community members • Bean seed selection for bean stem maggot and root rot tolerance • Involvement of adult education and primary school teachers in IPM technology dissemination

Farmers have accessed more improved bean (climbers and bush types) genotype seeds that enabled them to establish seed multiplication plots for improved pest tolerant bean genotypes. Some of these farmers (, e.g. Ubiri, Kwekitui, Kwalei, etc. communities) have been able to sell the seed and grain and increased household income. Such income has been used to pay school fees for the children and purchase household items

Farmers, researchers and the extension services have analysed and experimented with botanicals and animal products as sources of pesticides and fertilizers, e.g. analysis and use of *Vernonia* spp. leaves, wood ash, cow urine (insect pests) and fresh dairy milk (leaf diseases) (Tables 7 and 8).

Farmer to farmer knowledge sharing and exchange has proved to be faster than research to extensionist to farmer pathway. Farmers learn from fellow farmers and adopt, in some cases without experimentation, while most information from the researchers and the extension personnel has to be demonstrated and evaluated before adoption/rejection. Policy makers and local leaders (at district, ward and village levels) have supported and participated in technology development and dissemination (participation in group training workshops, farmer meetings, exchange visits, etc. to share ideas with farmers and other participants). This has influenced changes in national policy issues related to agricultural production (e.g. farmers in Tanzania have to organize themselves and form groups to receive agricultural information, credits, farm inputs, and other services)

Table 7. Some botanicals and other traditional materials commonly used by Lushoto bean IPM farmer groups and their different uses

Plant/Material	Local name (Kisambaa)	Pesticide use	Fertilizer use	Target pest
Vernonia spp.	Mhasha	Crude leaf extract + Chilli + water		Foliar/pod feeding pests including *Ootheca* spp. and aphids
Vernonia spp.	Tughutu	Crude leaf extract + water + soap	Chopped or pounded fresh or fermented leaves	Foliar feeding pests
Euphorbia sp.	Muui	White sap drops in water		Cutworms
Solanum incanum	Ndulele	Crushed fruits + water		Cutworms
Datura sp.	Mnanaa	Crude leaf extract + Chilli + water		Foliar feeding pests
Tithonia sp.	Alizeti pori	Crude leaf extract + water + soap	Chopped fresh leaves	Foliar/pod feeding pests
Ocimum suave	Mzumbasha	Crude leaf extract + Chilli + soap + water		Foliar feeding pests
Cow urine	Mkojo wa ng'ombe	Fermented urine + water + soap	Improves plant vigour after repeated use	Foliar/pod feeding
Fresh milk	Maziwa ya ng'ombe	Fresh milk + ash + water		Potato and vegetable leaf diseases
Wood ash	Majivu	Wood ash + various aromatic plant leaves e.g. *Tagetes* sp., *Cyprus* sp., *Eucalyptus* sp., etc.		Bruchids and weevils in stored grain

Table 8. Chemical analysis for NPK (data from ARI Mlingano) content in the leaves from *Vernonia* sp. and *Tithonia* sp.

Plant	**Nutrient content percentage of**		
	N	P	K
Vernonia	3.6	0.25	4.7
Tithonia	3.2	0.23	4.4

Conclusion

The experience in Lushoto and the other project sites have shown that combining research with training and exposing farmer groups through cross village and cross site visits, helps to build farmers' and extensionists' confidence and keenness to learn, fine-tune and adapt more complex technologies like IPM, leading to wide-spread dissemination within short periods. There has been increasing demand from new farmer groups to get involved. Some of the notable outcomes are: Farmers are able to train others, organize their own demonstrations and meetings, and contribute to the preparation and dissemination of extension materials at village level, leading to the evolving Village Information Centres-VICs. Farmers indicated clearly their intention to retain the knowledge that they were generating through these activities at village level. They sensitised their village leaders to set aside premises for keeping the promotional materials and all available reports and information (named village information centres- VICs). All community members can access such information easily and at minimum or no cost compared to searching for the same from extension officers and district offices. The same information can be used by the local schools and as a reference for the village community in future. The communities are happy to manage the information and knowledge relating to their local area and that from other communities that relate to their activities and can be shared.

The cross village and cross site visits organised and conducted through costs sharing between the bean IPM projects, AHI, national programmes and other partners have shown that such visits are cost effective and help to motivate participating groups. It has been observed that once farmers learn from each other they adopt the technology without or with minimum experimentation. The major lesson gained here is that the participatory group approach and processes developed and promoted with farmers and partners have helped communities to develop strong confidence, opened farmers to learn and experiment on more solutions to various local production constraints and created a strong sense of ownership of their resources including the knowledge that they generated. This has created an enabling environment for different partners to use the "social capital" (farmer groups) for other development activities. Some of the farmer groups in the four countries (Malawi, Tanzania, Kenya and Uganda) have united to form community based associations/organisations (CBAs/CBOs) that are helping members to access various services (information, credits, farm inputs, training, etc.) from different partners. Partners, particularly the NGOs, other ministries and the private sector are supporting the community farmer group approach because it is providing them with a platform for delivering such services like information on credits, inputs, markets, health and education services

Researchers and extension agents can now let go some of the key responsibilities in R&D because some of the participating partners including the NGOs and the private sector have shown keenness in taking up key roles that address farmers' needs. Some of these partners have comparative advantages and capacity to support such activities as dissemination of varieties and other technologies to farming communities, training (for farmers, researchers and extension personnel), support to farmer cross visits, credit and input facilitation and even subscription to basic research that meets farmers' needs in areas that are under their development mandate. The national governments, NGOs and other rural development projects in the region are using project farmer groups to plan and implement rural development activities at target sites.

References

Allen, D.J., Ampofo, J.K.O., C.S. Wortman, 1996. Pests, diseases, and nutritional disorders of the common bean in Africa: A field guide. Cali Colombia. International Centre for Tropical Agriculture; wageningen, The Netherlands: technical centre for Agricultural and Rural Cooperation, 1996, 132 p. (CIAT publication ; no. 269) ISBN 958-9439-55-1 *(English and Kiswahili versions)*

Karel, A.K., Ndunguru, B.J., Price, M., Semuguruka, S.H., and B.B. Singh, 1980. Bean Production in Tanzania. Pages 122-154, *in:* Proceedings of a regional workshop on Potential for Field Beans in Eastern Africa, 9-12 March 1980, Lilongwe, Malawi. Centro Internacional de Agricultura Tropical, CIAT, Apartado 6713, Cali, Colombia.

Lyamchai, C., Owenya, M., Ndakidemi, P., Massawe, N., Lyimo, S. and R. Ndondi, 1998. A Participatory Rural Appraisal (PRA) in Kwalei Catchment, Lushoto District, Tanzania. August 1998. African Highlands Initiative, Selian Agricultural Research Institute (SARI), Arusha, Tanzania. 79pp.

Meliyo, J.L., Mansoor, H.A., Masuki, K.F. and J.G. Mowo, 2004. The Baga characterization: A step for successful scaling out of technologies. In: Proceedings of the African Highlands Initiative Conference on- Integrated natural resources management practice: Enabling communities to improve mountain landscapes and livelihoods, 12-15 October 2004, Nairobi, Kenya. World Agroforestry Centre, P O Box 30677, ICRAF Campus, Nairobi, Kenya.

Minja, E.M., Ampofo, J.K.O. and H.A. Mziray, 2002. Bean Farmers' Day at Lushoto. Northern and Southern Tanzania bean farmer day held at Lushoto, Tanga, northern Tanzania. Farmer group activity reports for the DFID Crop Protection programme (CPP) Bean IPM Promotion Project in eastern and southern Africa. Lushoto, June 2002. Booklet for distribution to village information centres (VICs) in

bean growing areas in eastern, central and southern Africa, 22p., CIAT, PO Box 2704, Arusha, Tanzania
Minja, E.M., Ampofo, J.K.O., Mowo, J.G. and H.A. Mziray, 2003. Integrated pest management training workshop report: Training of bean farmers and village extension officers, Lushoto district, Tanga region, north eastern Tanzania. Farmer group activity reports for the DFID Crop Protection programme (CPP) Bean IPM Promotion Project in eastern and southern Africa. Lushoto, February 2003. Booklet for distribution to village information centres (VICs) in bean growing areas in eastern, central and southern Africa, 23p., CIAT, PO Box 2704, Arusha, Tanzania
Minja, E.M., Ulicky, E. and H.A. Mziray, 2003. Hai and Lushoto- Crop Protection Programme (CPP) Visit. Farmer group activity reports for the DFID Crop Protection programme (CPP) Bean IPM Promotion Project in eastern and southern Africa. March 2003. Booklet for distribution to village information centres (VICs) in bean growing areas in northern Tanzania. 18p. CIAT, PO Box 2704, Arusha, Tanzania
Minja, E.M., Ampofo, J.K.O., Mziray, H.A. 2003, Mowo, J.G. and T.M. Kizuguto, 2003. Integrated pest management training workshop report: Training of bean farmers and village extension officers, Lushoto district, Tanga region, north eastern Tanzania. Farmer group activity reports for the DFID Crop Protection programme (CPP) Bean IPM Promotion Project in eastern and southern Africa. Lushoto, June 2003. Booklet for distribution to village information centres (VICs) in bean growing areas in eastern, central and southern Africa, 15p., CIAT, PO Box 2704, Arusha, Tanzania
Pfeiffer, R. 1990. Sustainable Agriculture in Practice- The Production Potential and Environmental Effects on Macro-contour lines in the West Usambara Mountains of Tanzania. PhD Dissertation, University of Hohenheim, German. pp. 195.
Leaflet: Use *Vernonia* spp. for increased production. CIAT Arusha, P O Box 2704, Arusha, Tanzania.

Participatory Research on Adaptation of Food Barley (*Hordeum Vulgar L*) Varieties in Ginchi Watershed, Ethiopia

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Abstract

For a better understanding of farmers' circumstances and effective adoption of agricultural technologies, it is vital to involve farmers in a participatory research approach for technology gerneration. Therefore, to assess farmers' opinions and initiate joint evaluation of technologies, an on-farm food barley (Hordeum vulgare L.) adaptation trial was conducted in 2001 and 2002 at Galessa watershed site (3000 m.a.s.l.), Ethiopia. Four improved barley varieties ('Dimtu', 'HB 42', 'Shege', and 'ARDU 12-60B') and the local farmers' cultivar, 'Baleme' were compared under two fertilizer levels (21/23 and 41/46 kg/ha of N/P_2O_5*) in 2001 and 2002. Fields were sampled at different positions on the slope, disease scores, and yield parameters were collected. Concurrently, farmers ranked the varieties based on their own selection criteria although the concomitant farmers' selection criteria and the evaluating farmers' group differed from farm to farm. Findings indicated that position on the slope significantly influenced yield parameters, the best being homestead fields and frost-free low-lying outfields. Low-lying outfields responded most to higher fertilizer rates although responses from others were also significant. All the varieties including the local cultivar significantly responded to the higher fertilizer rate. There were some varietal differences noted across years or environments. Stability analysis indicated that the local cultivar was most stable with high mean yield. Generally, 'Baleme', 'ARDU 12-60B', and 'HB 42' were varieties with better overall mean grain yields although the best performing varieties vary across the site groups. The overall farmers' ranking also resulted in the following varietal preferences: 'Baleme', 'Dimtu', 'Shege', 'ARDU 12-60B', and 'HB 42' but varying across site groups. Highly significant (*$P< 0.01$*) and moderate correlations were found between farmers' ratings and certain parameters such as stand %, grain yield, and biomass yield, with a correlation coefficient (r) values of 0.38, 0.33, and 0.33 respectively, while relationships with other parameters were insignificant. Data illustrates farmers' affinity towards total biomass production rather than solely grain yield, indicating that the production of animal feed is equally important as the grain yield for human consumption. Generally the study elucidated three important points. First, in a situation where there appears to be farmers' preference interaction with site groups and variation in varietal responses, diversity is the answer to exploit opportunities and averse risk. Therefore, the improved varieties can optionally be used along the local cultivar, 'Baleme', in their appropriate sites. Secondly, there is a need for developing frost tolerant and stable varieties with high grain and straw yields. Finally, the poor fertility of the soil demands appropriate soil ameliorating or fertility management practices since it is the most important yield limiting factor than varieties are.*

Introduction

The highlands of Ethiopia are characterized by steep slopes, degraded soils, occasional drought and frost, that demand greater efforts for livelihood and natural resource improvement. In such high altitude areas of the country where other cereals usually fail to flourish, barley is the only cereal that comes first in the livelihood of the society. Therefore, research endeavors to increase the productivity of barley have a significant role in meeting the society's needs. Since the commencement of barley research in Ethiopia in 1955, many improved barley varieties have been released and proven to be relevant for improved productivity and livelihood in certain agro-ecologies. However, as in many other agricultural research fields, critiques were given on the research approach followed for being a centralized, top-down mode of operation, which lacked representation in testing sites, farming systems, and considerations of the socio-economics and other farmers' circumstances.

Although there have been some efforts to incorporate feedback in technology generation through the extension wing, socio-economic survey results, and farmers, participation of stakeholders was minimal and not well established to impose better technology adoptions to improve the livelihoods of the agrarian poor. Therefore, the growing awareness that efficient adoption of technologies depend on the extent to which technology generation is participatory, which is unlike the conventional ' technology transfer ' strategies of R & D that necessitated research activities to be interactive. As a result, research approaches evolved from on-station based, towards using a Farming System Research (FSR) approach, where systems theory is applied and farmers and their circumstances are taken into account (Amede et al. 2004). The FSR approach is holistic and aims to address multi-objectives and diverse stakeholder issues within the context of multiple scale settings such as watersheds, catchments, landscapes, and river basins. The participatory component in FSR assigns equal weight to people's perceptions and needs along with the biophysical processes (Rhoades 1988; Thijssen 2003). A participatory approach that promotes sustainable agricultural development and enhanced natural resource management has been advocated and efforts are being made in different parts of the world since the late 1980s.

Background

With augmented participation, success stories in different parts of the world with respect to improved adoption, directing research focuses, improved NRM, capacitating farmers' knowledge, and others have been reported (Mulatu et al. 2001; Forson 1997; Witcombe et al. 1999; Riley et al. 1997; Thijssen 2003; Farrington 1988).

As part and parcel of these attempts, the Galessa watershed area between an altitude range of 2820 m – 3080 m, was among the 'pilot' sites identified in Ethiopia where the new approach was to be tested and relevant methodologies to be developed in collaboration with the African Highland Initiative (AHI). The topography of the watershed site is disorganized where the habitats reside on the top and the major arable lands are outfields in the middle of the slope. There are also few low-lying cereal outfields but most of the area is waterlogged (during the main rainy season) and meant for grazing. Barley is the major cereal crop grown in the area and farmers dwell on one major local cultivar 'Baleme'. Since the launching of AHI program, different strategies and methodologies have been employed to integrate the research activities with the community. During AHI's second phase, the approach followed was that of a multi-disciplinary team that uses system perspective and participatory approach for technology development where farmers and interested groups were exposed to a number of technology options, to choose, test, modify, and adopt in their own fields (Assefa et al. 2004). Accordingly, based on the constraints identified by PRA surveys, inventory of available options were made and farmers were exposed to the different technologies. The constraints identified were lack of improved barley varieties and poor soil fertility status and options to address these constraints were assessed. Therefore, to identify suitable improved food barley varieties and their production packages, to acquaint and capacitate farmers with the new technologies and production techniques, and to identify farmers' selection criteria and understand farmers' production circumstances, an on-farm adaptation trial of improved food barley varieties and their production packages was carried out in the watershed.

The paper presents results of the joint evaluation of improved food barley varieties and their production packages with farmers made in the site during 2001 and 2002 cropping seasons.

Methodology

Design

The activity was carried out with barley FRG (Farmers' Research Group) established in 2001. It was a researcher-designed and farmer-managed trial in a split-plot design with 5 and 7 replications in 2001 and 2002 respectively. Main plots were assigned to two fertilizer levels, half and full the recommended rate (21/23 and 41/46 kg/ha of N/P_2O_5 respectively). Sub-plots were assigned to five varieties, four improved ('Dimtu', 'HB 42', 'Shege', and 'ARDU 12-60B') and one local cultivar, 'Baleme', on a plot size of $25m^2$ each where $9m^2$

was harvested to measure yields. Larger sub-plot sizes were used to allow implementation of farmers' planting method, broadcasting and covering by oxen drawn plow. The varieties 'Dimtu' and 'Shege' are tolerant to low fertility conditions than the other improved varieties and 'HB 42' and 'ARDU 12-60B' are developed for favorable environments.

Site selection and trial management

Fields were sampled systematically from different parts of the slope. The need for adequate representation of barley fields and simplicity required replications to be made across farmers' fields since replicates performed contemporarily by different farmers in the same location and can be considered as replications in order to analyze trials (FAO, 2002). Barley fields in the locality were considered as homestead fields, outfields in the middle of the slope, and low-lying outfields where 3, 5, and 4 fields respectively were selected from each during the two seasons. The four low-lying outfields later segregated into two frost-free and two frost-prone fields due to the unpredicted frost incidence. Except for the aforementioned experimental variables (fertilizer and varieties), management practices were at the discretion of the individual farmer.

Data collection

Cropping pattern, physical features of the selected fields, cultural practices and the weed control measures taken by the farmers were recorded in discussion with the individual farmers. Quantitative data on the major barley diseases such as scald (*Rhynchosporium secalis* Oud.), net blotch (*Helminthosporium teres* Sacc.), spot blotch (*Helminthosporium sativum* Pum.), plant height, grain yield, biomass yield, hectoliter weight, thousand kernel weight, days to heading, and stand % were taken by researchers from nine fields. Qualitative data on farmers' selection criteria, varietal preference, and their reaction to fertilizer use were collected based on field performance evaluation at the heading stage of the crop during farmers' field day and farmers' mini group visits from eight fields. Farmers compared the fertilizer effect based on the field performance of the crop while varieties were evaluated based on some varietal traits, although the members of the evaluating farmers group differed from field to field. The researchers acted as facilitators during the field evaluation while the farmers (owners of the respective fields) were responsible for explaining how they managed the trial and responded to the queries raised during the discussion.

Data analyses

Farmers' comments, selection criteria, and ranking were summarized based on the records taken at field evaluations. Biomass and grain yields data were corrected for stand % prior to ANOVA and stability analyses. Farmers' ranking scores (1 – 5) were transformed to rating scores (5 – 1) where rate 5 being best and rate 1 being least. Uncorrected data for stand % were used for correlation analysis. Analyses was conducted using PROC GLM, PROC MIXED, and PROC CORR procedures of the SAS program (SAS, 1987). The Eberhart-Russel linear model was used for stability analysis of the varieties (Eberhart et al. 1966) by considering the two years and two fertilizer levels as four separate environments. The parameter considered for stability analysis was biomass yield since the separate analysis based on environmental data indicated significant differences among genotypes. Bartletts test of homogeneity of variances indicated the homogeneousness of the error variances. The Eberhart-Russell linear model employed was:

$$y_{ij} = \mu + \beta_i I_j + \delta_{ij},$$

where y_{ij} is the mean performance of the i^{th} variety in j^{th} environment, μ is the mean of i^{th} variety over all the environments, β_i the regression coefficient which measures the response of i^{th} variety to varying environments, δ_{ij} is the deviation from regression of i^{th} variety at the j^{th} environment and I_j is the environmental index.

Results

FARMERS' ASSESSMENT

Fertilizer

Farmers compared the effect of fertilizer in eight fields on the basis of field performance of the crop. They realized the need for using fertilizers since the crop vigor, stand establishment and the total vegetative growth of the crop was better on plots that received higher fertilizer rates. However, in one of the homestead fields, farmers noted that there was minimal difference between plots that received the lower and the higher fertilizer rates, which may have been due to the good fertility status of the soil. Most of the varieties in this field suffered serious lodging and farmers noted it to be among the undesirable traits and suggested no fertilizer use on such fields.

Varieties

Farmers chose seven different selection criteria for field performance evaluation of the varieties.The criteria was then used to rank the varieties (Table 1). Tall plant height and long-six-rowed spike were the two criteria that were persistently used across all the evaluated fields despite differences in the members of the evaluating farmer groups from field to field.

Table 1. Farmers' food barley selection criteria used for ranking varieties tested in 2001 and 2002 cropping seasons at Galessa watershed.

No	**Selection criteria**	**Frequency**	**Implications**
1	Tall plant height	8	Straw yield
2	Long-six-rowed spike	8	Grain yield
3	High tillering capacity & density	5	Straw & grain yield
4	Early maturity	3	Frost escape (2 from frost prone sites)
5	White grain color	3	Quality
6	Good plant vigor	1	Straw & grain yield
7	Stiff straw	1	To avoid lodging (from a homestead field)

NB. Frequency = number of times used as a selection criterion.

Farmers' ranking of the varieties is summarized by site groups as indicated on Table 3. At homestead fields and outfields, farmers' preferences tended towards the improved varieties while rest of the site groups preferred their local cultivar, 'Baleme'. The average farmer ranking of the varieties were in order of preference: 'Baleme' (local), 'Dimtu', 'Shege', 'ARDU 12-60B' and 'HB 42' although their ranking tended to change from site group to site group. Farmers' varietal preference seems to have a strong concern on total biomass production. Correlation analysis made between farmers' rating and some parameters such as stand %, biomass and grain yields indicated significant ($P< 0.01$) associations while relationships were insignificant with the other parameters. Correlation values (r) of 0.33, 0.33 and 0.38 were detected between farmers' rating and biomass, grain yields, and stand % respectively suggesting that farmers' give equal weight for both biomass and grain yields since the straw is an important feed source and roof thatching material.

RESEARCHERS' ASSESSMENT OF SITE DIFFERENCES

Site differences were highly significant ($P< 0.01$) for plant height, biomass and grain yields while differences for the major diseases were insignificant except for spot blotch incidence which was a bit higher in the low-lying outfields. Farmers' fields were heterogeneous in topography, soil fertility and other conditions as evidenced from the high coefficients of variations (20.1%). Besides these differences, weed control measures taken by the farmers were very variable than any other cultural practices to contribute for the variation. Hand weeding was the major practice for weed control in the locality and the weeding frequency ranged from no weeding to two.

Grain yields were best at homestead fields and frost-free low-lying outfields (Table 2). Plant height and biomass yield results also showed a similar trend as the grain yield. Grain yields were least in outfields in the middle of the slope and frost-prone low-lying outfields. It was from the outfields in the middle slope, the major crop field that the trial in three fields had failed. In all site groups, increment in fertilizer has brought about a significant increase in grain yields and the benefits were highest at frost-free low-lying outfields (Table 2). Generally the responses to higher fertilizer rate in plant height and biomass yield were similar as that of the grain yields and all sites responded significantly.

Table 2. Mean grain yields (kg/ha) by site groups from food barley varieties tested at Galessa with two fertilizer levels in 2001 and 2002 cropping seasons.

No.	Site groups	Fertilizer level[a]		Site group
		F1	F2	Mean[b]
1	Homestead fields	2006	2410	2208 a b
2	Outfields in the middle of the slope	1656	2090	1873 b
3	Frost-free low-lying outfields	2383	3002	2692 a
4	Frost-prone low-lying outfields	1604	1921	1762 b
	Mean[b]	1912 b	2356 a	

[a]F1=21/23,N/P_2O_5, kg/ha, F2=41/46,N/P_2O_5, kg/ha. CV % is 20.1.

[b]LSD (0.05) for site group mean is 631 kg/ha and SE ± is 160 kg/ha; LSD (0.05) for fertilizer levels mean is 215 kg/ha and SE ± is 114 kg/ha; site group by fertilizer level interaction effect was not significant.

[b]Means followed by the same letter do not differ at LSD (0.05).

Varietal responses to site groups and fertilizer

Varietal differences were significant (P< 0.05) for biomass and grain yields. The local cultivar, 'Baleme', and 'ARDU 12-60B' had the most biomass. Differences in total biomass production among the improved varieties were not significant. Grain yield results also indicated that the local cultivar, 'Baleme', 'ARDU 12-60 B', 'HB 42', and 'Shege' were best with comparable yields, 'Dimtu' yielding the least (Table 3). However, the performance of the varieties tended to change across site groups. 'Shege' yielded best at homestead and outfields in the middle of the slope while 'HB 42' and 'Baleme' were the best performers in frost-free low-lying outfields. In frost-prone low-lying outfields, the local cultivar, 'Baleme', was best.

Table 3. Mean grain yield (kg/ha) and farmers' ranking score of food barley varieties by site groups tested at Galessa in 2001 and 2002 cropping seasons

No.	Variety	Homestead fields	Mid-slope outfields	Frost-free low-lying outfields	Frost-prone low-lying outfields	Variety Mean[a]
1	Dimtu	[1] **2258**	[2] 1646	[4] 2047	[4] 1577	[2] 1882 b
2	HB 42	[5] **2186**	[5] 1769	[5] **3050**	[3] **1833**	[5] **2209** a
3	Shege	[2] **2608**	[1] **2125**	[3] 2479	[5] 1360	[3] 2143 a b
4	ARDU 12-60 B	[4] 2072	[3] **1983**	[2] **2853**	[2] **1894**	[4] **2201** a
5	Baleme (local)	[3] 1914	[4] **1843**	[1] **3033**	[1] **2148**	[1] **2235** a
	Mean[a]	2208 a b	1873 b	2692 a	1762 b	

NB. Figures in bold indicate the top three yielders; figures in superscript indicate farmers' ranking (1= highly preferred, 2= highly preferred but one, 3= intermediate, 4= less preferred but one, and 5= less preferred.); CV % is 20.1.

[a]LSD (0.05) for site group mean is 631 kg/ha and SE ± is 160 kg/ha; LSD (0.05) for variety mean is 313 kg/ha and SE ± is 109 kg/ha; site group by variety interaction effect was not significant.
[a]Means followed by the same letter do not differ at LSD (0.05).

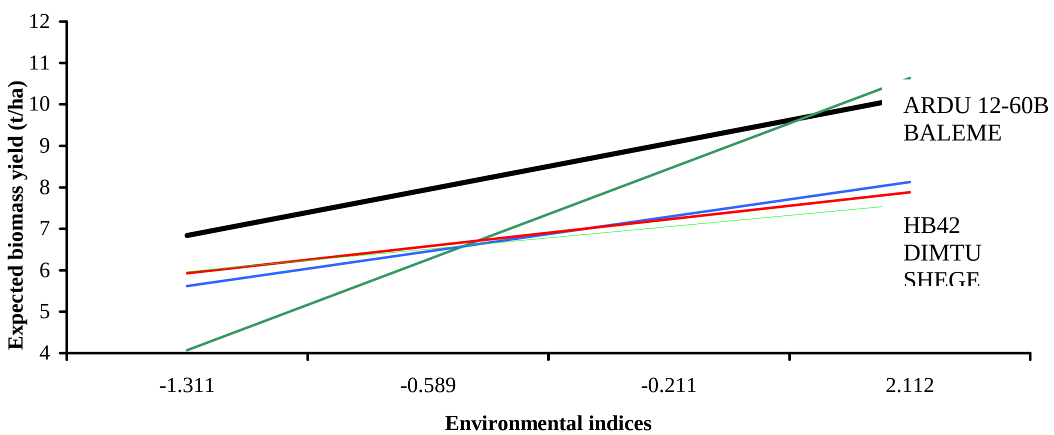
The highest fertilizer level has brought a significant increment on plant height, above ground biomass and grain yields in all varieties (Table 2). The net average grain yield increment from using the higher fertilizer rate ranged from 354 to 554 kg/ha. The most responsive variety was 'ARDU 12-60B' (554 kg/ha) and least responsivee was from 'Dimtu' (354 kg/ha). The net average grain yield increment from using the higher fertilizer rate with the local cultivar, 'Baleme', was 424 kg/ha. The use of the recommended rate of fertilizer is agronomically feasible irrespective of the variety used since all including the local cultivar were responsive.

EFFECT OF SEASONAL VARIATIONS ON VARIETY AND FERTILIZER RESPONSES

Both year main effect and year x variety interaction effects were highly significant (P< 0.01) on biomass and grain yields. Year effect on the grain yield of the whole varieties was significant (2002 being favorable) and the cause for year by variety interaction being the difference in the magnitude of the varieties response to seasonal changes. Seasonal variations on total biomass yields of 'Dimtu', 'HB 42' and 'Shege' did not bring any significant change, however, increments were significant on 'Baleme' and 'ARDU 12-60B' in 2002. Generally 2002 was a favorable year where both grain and biomass productions were significantly higher than 2001.

The stability of the varieties for biomass yields was also assessed. In the pooled analysis genotype x, environment interaction effect was found significant. The stability analysis also revealed that the variability of the varieties with respect to biomass yields across environments were entirely predictable. Regression coefficients of 'Dimtu' and 'Shege' were found to be significantly different from unity, indicating their above average stability and the where the other varieties measured average in stability. This gives a clue that 'Dimtu' and 'Shege' are adapted to unfavorable environment (based on the regression coefficients) but with very low mean yield. The local cultivar,'Baleme', exhibited almost a spill over effect over all environments except at the most favorable environment which was excelled by 'ARDU 12-60B' (figure 1).

Figure 1. Expected biomass yield in t/ha plotted against environmental indices



Effect of seasonal variations on fertilizer response was assessed and the combined analysis revealed that year main effect and year x fertilizer interaction effects were highly significant (P< 0.01) for biomass and grain yields. At both fertilizer levels between years difference for grain yield was highly significant (P< 0.01) year 2002 being the most favorable. Similar trend was also observed on biomass. Generally, the result indicated the dependence of fertilizer response to weather conditions and year 2002 being favorable. The partial budget analysis made on grain yield also confirmed that return from applying the higher fertilizer rate was highest in 2002. A MRR % of 82.2% and 437% were attained in 2001 and 2002 respectively, the average being 251.2% (Table 4).

THE RELATIVE IMPORTANCE OF FERTILIZER AND VARIETY

Net grain yield gains from using the higher fertilizer rate (41/46, N/P_2O_5, kg/ha) on the local cultivar, 'Baleme', and the net grain yield gain from using improved variety under similar management practices is as shown on table 5. The improved varieties used for comparison are the best yielding varieties in the respective site groups, namely 'Shege' in homestead fields and outfields in the middle of the slope, 'HB 42' in frost-free low-lying outfields, and "ARDU 12-60B' in frost-prone low-lying outfields.

Table 4. Partial budget analysis for using fertilizer

Item	2001		2002		Average of two years	
	F1	F2	F1	F2	F1	F2
Average yield (kg/ha)	1342	1584	2481	3127	1912	2356
Adjusted yield (20%)	1074	1267	1985	2502	1530	1885
Gross benefit (Birr/ha)	1020	1204	2084	2627	1530	1885
Variable cost						
Fertilizer	0	101	0	101	0	101
Net benefit	1020	1103	2084	2526	1530	1784
Marginal benefit	83		442		254	
Marginal cost	101		101		101	
MRR %	82.2%		437.6%		251.2%	

NB. Average annual market price of white seeded barley in 2001 and 2002 were 0.95 and 1.05 Birr/ha; prices of DAP 2.60 and 2.55 Birr/kg respectively and Urea 2.02 Birr/kg for both years.
F1= 21/23, kg/ha, N/P_2O_5, F2=41/46, kg/ha, N/P_2O_5.

Table 5. Net gains in grain yield (kg/ha) from using the higher fertilizer rate (41/46,N/P2O5, kg/ha) and improved variety by site.

No.	Site group	'Baleme'		Improved variety[b]	Increase due to	
		F1[a]	F2[a]		Fertilizer	Variety
1	Homestead fields	1595	2233	2705	638	472
2	Outfields in the middle of the slope	1794	1892	2360	98	468
3	Frost-free low-lying outfields	2789	3277	3152	488	-125
4	Frost-prone low-lying outfields	1827	2469	2047	642	-422

[a] F1=21/23,N/P_2O_5, kg/ha, F2=41/46,N/P_2O_5, kg/ha.
[b] Grain yields (kg/ha) of the selected improved varieties using the higher fertilizer level.

Discussion

Weed management practices of the farmers were among the insights encountered during the trial period. Their weeding practice ranged from no weeding to two hand-weeding even though earlier research works done at Holetta suggested that a single hand-weeding 20 days after emergence to be optimum for barley. It was in one of the homestead fields and a frost- prone low-lying outfield that the farmers weeded the fields twice, otherwise the rest five fields were not weeded at all and two were weeded once. The reason why two hand-weeding was practiced in one of the homestead fields might be because of the good fertility status of the soil coupled with ample weed seeds (transported both by animals and humans and multiplied due to the favorable condition). The twice weeding exercised on frost-prone low-lying outfields might also be associated with the good fertility status of the soil. These fields are favored due to soil deposit from up slope by erosion and few are new crop fields as a result of population pressure and decline in productivity of outfields in the middle of the slope. Past investigations made to study relationships between weeds and fertilization also suggested that percentage of weed dry-matter weight from fertilized plots to be higher than the unfertilized plots indicating the need for a recommendation of further weed control measures and fertilization as a package (EARO, 2000). In discussions made with farmers, their decision to weed or not to weed depended on a host of factors and their interaction such as the level of the weed infestation, the feasibility of weeding based on the crop performance, the crop vigor to suppress the weeds, and availability of labor or time. Generally, in red soil outfields where the fertility of the soil is very low, weed infestation and growth is very poor so that no weeding or at most one weeding was practiced in barley culture within the locality.

Of all crop fields, outfields in the middle of the slope, are the most degraded since this part of the crop fields are the major crop fields of the community that have been cultivated for a very long period without appropriate soil amelioration and conservation measures. It was from this part of the crop fields that a total crop failure at three fields occurred. Farmers were convinced and realized the need to use the optimum rate of fertilizer although few complained about the high prices of fertilizers. However, they suggested the need to synchronize the time needed for debt settlement for fertilizer with the period when they can get good prices for their produce and subsidies if possible. The economic analysis also revealed that the use of recommended rate of fertilizer is economically feasible with the two years average MRR% of 251.2%, irrespective of the variety used since all including the local cultivar were responsive. However, cautions should be made in applying fertilizer at homestead fields where it encourages lodging rather than improving grain yield productivity. ‘HB 42’ and ‘ARDU 12-60B’, which were developed to perform well under favorable environments, failed to prove their superiority at homestead fields because they have suffered serious lodging including the local cultivar, ‘Baleme’. Rather the short stature variety ‘Shege’ which was expected to do better under low fertility condition outyielded all in grain yield.

Farmers’ selection criteria was found to be site-driven as was also indicated in past studies (Mulatu et al. 2001). For instance, in this particular study early maturing types were mentioned in two frost-prone fields implying the need for varieties that escape frost. Stiff straw was used as a criterion in one of the homestead fields where most varieties suffered from lodging. Similarly, the study has revealed farmers’ site-driven varietal preference, since the varieties preferred most vary across the site groups. In such situations where there is farmers’ varietal preference, interaction with the specific site groups’ conditions or site-driven varietal preference prevailed, and diversity was the answer to exploit opportunities and minimize risk. Although interaction effect between site groups and varieties was insignificant in the analyses of grain yield data, there was a change in trend in the highest mean of the varieties across the site groups.

Generalizing the farmers’ and the researchers’ evaluations will have a confounding effect, as it is usually a case in a blanket recommendation of technologies invariably to all environments, so that varietal differences will be elusive. In such a generalized conclusion, farmers’ and researchers’ evaluations also lack matching. For instance, out of the three top yielding varieties based on the overall mean grain yield, farmers’ ranking matched only with one researchers’, indicating very minimal matching in varietal preference between researchers and farmers. However, when evaluated by the specific site groups, farmers’ and researchers’ varietal preference showed better (2:3) and exact (3:3) match. This indicates farmers’ ability to articulate their preference perfectly (Table 3) and the difficulties in formulating blueprint recommendations. In frost-free and frost-prone low-lying outfields, use of the local cultivar should deserve priority until suitable varieties are developed. Therefore, availability of improved varieties that can optionally be used in certain parts of crop fields rather than dwelling on one or few local cultivar can enable farmers to exploit opportunities and averse risk. Above all, acquaintance of farmers to the improved varieties and their production packages (capacitated and empowered to the production techniques) is one of the outcomes of this activity since some farmers have already started growing the improved varieties in selected sites. Farmers rating of varieties was also found to have a strong correlation (r = 0.33**) with biomass and grain yields indicating farmers concern to total biomass production since the straw is an important feed source and roof thatching material. Researchers usually emphasize on grain yield and disease resistances while farmers focus both on straw and grain yields with little attention to disease unless very severe to inflict crop failure and since they are secured by landraces. Therefore, future research direction in varietal development should also give emphasis to total biomass as the grain till other alternative feed sources and methodologies are developed to alleviate the feed shortage.

The other concern to farmers in varietal development is stability of the varieties for risk aversion. To avoid risks that could result from climatic fluctuations and other stresses, traditionally farmers use mixtures (landraces) of which 'Baleme' is the major landrace in the locality. The analysis made to assess the stability of the varieties on biomass yield also confirmed this fact. As indicated on figure 1, the varieties 'Dimtu' and 'Shege' were found to be above average in stability across environments but with very low mean biomass yields, owing to the fact that they were developed for low fertility conditions. The local cultivar 'Baleme', exhibited almost a spill over effect mainly due to its populational buffering capacity. Past studies made on landraces also confirmed that the stress tolerance and stability of landraces to emanate from the genetic heterogeneity of the component lines that constitute the landraces (Ceccarelli et al. 1987; Asfaw 1989; Lakew et al. 1997). Therefore, farmers are interested in getting varieties that are stable with high mean yields. Till the development of such varieties diversifying the varieties grown in the locality will enable them to exploit opportunities in favorable environments (such as homestead fields) and averse risk for not dwelling on a single local cultivar. Diversity within and between crop varieties is among the options for risk aversion even in absence of clear yield advantage in times of disaster.

In general, when gains from use of the higher fertilizer rate is compared with the gains from varieties, fertilizer is relevant except in outfields were the response of the local to the higher fertilizer rate was lower than the response from the improved variety. Therefore, fertility is the most important yield limiting factor than the improved varieties in the locality. Similar studies made in the highlands of the country to understand the relative importance of the yield limiting factors of food barley indicated fertilizer, among others, to be the most important factor where yield advantages of 47.5% - 286% were reported (Mola et al. 1992; Liben et al. 1998). Therefore, assessing efficient methods towards soil fertility improvement deserve priority.

Conclusion

In sites where soil degradation and other abiotic stresses are minimal, improved varieties can give better or comparable grain and biomass yields, so that diversity can be maintained to averse risk and opportunities exploited. To realize these improvements, capacitating farmers with the production techniques and knowledge about the requirements of the technologies are relevant and this aspect is among the gains attained from this activity to some extent, since some farmers have started growing the improved varieties in selected sites by their own initiation. In stressed sites, use of the local cultivar is indispensable until other alternative varieties are available. In varietal development, future research should focus on farmers' constraints and needs such as frost tolerant, stable high biomass and grain yielding varieties. Therefore, this modest interactive research has indicated the need for participatory technology development.

Benefits from improved technologies can be realized if farmers' are acquainted with the requirements of the technologies and the ITK (Indigenous Technical Knowledge) of a farmer is integrated in technology use and generation. For instance, if farmers are well acquainted with the requirements of the improved varieties, which variety to pick and grow where and what fertilizer rate to use largely depend on the indigenous technical knowledge of the farmers, since they know well about their field, the climate, and other conditions. Besides, if technologies are generated based on the farmers' constraints, it will be taken up immediately by the community.

Although there is no argument on the need of participatory technology generation, to what level to keep the interaction impose certain questions such as:

- is it feasible for a researcher to work in close intimacy with the communities in each and every locality?
- is it better to assign a participatory researcher so that the rest of the researchers will focus on on-station activities?
- shall we use the former research linkage, researcher – extension – farmer, by empowering the extensionists better so that accurate and timely feedback from both directions could be obtained?
- shall we keep interaction modest so that feedback from the formal chain will be strengthened from occasional on-farm researchers trials and visits?

This is the challenge that should be addressed in implementing PTD. So long as technology generation is concerned, it is the precision and timeliness of the feedback that matters so empowering extensionists and direct occasional feedback by researchers could suffice. However, INRM demands a different approach from participatory research for technology generation because its realization depends on a concerted community action and mobilization with more coherent stakeholders involvement. But how and who should mobilize the community still has to be worked out.

References

Amede, T., Jonfa, E., Dauro, D., and L. Seyoum, 2004. Understanding Participatory Research Process: The Case of Participatory Improved Agroecosystem Management (PRIAM). Pages 58-75. In: Amede, T., Assefa, H., and Stroud, A. (eds). Participatory Research in Action: Ethiopian Experiences. Proceedings of Participatory research Workshop, June 12-17, 2002. Ethiopian Agricultural Research Organization and African Highlands Initiative, Addis Ababa, Ethiopia.

Asfaw, Z. 1989. Variation in hordein polypeptide pattern within Ethiopian barley, *Hordeum vulgare* L. (Poaceae). Hereditas 110: 185-191.

Assefa, H., Gorfu, A., Jebessa, S., and T. Alemu, 2004. Evaluation of the Participatory Research Approaches of the African Highlands Initiative: Areka Benchmark Site. Pages 25-44. In: Amede, T., Assefa, H., and Stroud, A. (eds). Participatory Research in Action:Ethiopian Experiences. Proceedings of Participatory research Workshop, June 12-17, 2002. Ethiopian Agricultural Research Organization and African Highlands Initiative, Addis Ababa, Ethiopia.

Ceccarelli, S., Grando, S. and J.A.G. van Leur, 1987. Genetic diversity in barley landraces from Syria and Jordan. Euphytica 36:389-405.

Eberhart, S.A., and W.A. Russell, 1966. Stability parameters for comparing varieties. Crop Sci. 6:36-40.Ethiopian Agricultural Research Organization (EARO). 2000. EARO Annual Report, 1998/99. Addis Ababa, Ethiopia.

Farrington, J. and A.M. Martin, 1988. Farmer Participatory Research: A Review of Concepts and Recent Fieldwork. Agric. Admin. & Extension 29 (1988) 247-264.

Food and Agriculture Organization of the United Nations (FAO), 2002. Genotype x environment interaction: Challenges and opportunities for plant breeding and cultivar
recommendations, by P. Annicciarico. Plant Production and Protection Paper 174. Rome.

Forson, J.B. 1997. On-station Farmer Participatory Varietal Evaluation: A Strategy for Client-Oriented Breeding. Expl. Agric. 33(1997) 43-50.

Lakew, B., Semeane, Y., Alemayehu, F., Gebre, H., Grando, S., van Leur J.A.G., S. Ceccarelli, 1997. Exploiting the diversity of barley landraces in Ethiopia. Genetic Resources and Crop Evolution 44:109-116.

Liben, Minale and A. Alemayehu, 1998. The relative importance of variety, fertilizer, and weeding on barley production. Pages 121 – 124 *in* Crop management options to sustain food security: Proceedings, Third Conference of the Agronomy and Crop Physiology Society of Ethiopia/ACPSE (G. Kidane and D. Yohannes, eds.). ACPSE, 29 – 30 May 1997, Addis Ababa, Ethiopia.

Mola, Adamu and Abebaw, Meseret, 1992. The relative importance of yield limiting factors on barley production in the highland vertisol at Sheno. Page 54 *in* Bulletin of the Crop Science Society of Ethiopia (SEBIL) vol. 4, Fourth Annual Conference of the Crop Science Society of Ethiopia, 26 – 27 Dec 1991, Addis Ababa, Ethiopia.

Mulatu, E. and Belete, K. 2001. Participatory Varietal Selection in Lowland Sorghum in Eastern Ethiopia: Impact on Adoption and Genetic Diversity. Expl. Agric. 37(2001) 211- 229.

Rhoades, R. E. 1998. Participatory Watershed Research and Management: Where the Shadow Falls. Gatekeeper Series 81. Sustainable Agriculture and Livelihoods Programme, IIED, London.

Riley, J. and C.J. Alexander, 1997. Statistical Literature for Participatory On-Farm Research. Expl. Agric. 33(1997) 73-82.

SAS Institute Inc. SAS/STAT™ Guide for Personal Computers, Version 6 Edition. Cary, NC: SAS Institute Inc., 1987. 1028 pp.

Thijssen, R. 2003. PTD Practitioners: back to school? LEISA 19(1): 7, March 2003.

Witcombe, J. R., Petre, R., Jones, S., and A. Joshi, 1999. Farmer Participatory Crop Improvement IV. The Spread and Impact of a Rice Variety Identified by Participatory Varietal Selection. Expl. Agric. 35(1999) 471-487.

Participatory Potato Technology Development and Dissemination in Central Highlands of Ethiopia

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Abstract

A participatory potato technology development and dissemination was under taken in the central highlands of Ethiopia to encourage farmers to participate in the evaluation and selection of technologies that suit to their condition. The methodologies used to address the constraints of potato production and to disseminate the available technologies, were Farmers Field School (FFS), on farm variety adaptation trials, trainings and informal seed production through farmers participatory approach. The FFS helped farmers to understand and participate in the integrated management of potato late blight. Since 1999, 19 Farmers Field schools were formed. Four of these were selected randomly for detail evaluation study. More than 800 farmers were participated and the impact assessment showed that the farmers' traditional perception of potato management practices has changed since the introduction of FFS approach in the locality. Through on-farm variety adaptation trials, released varieties and selected verities from advanced breeding trials were tested under variable farmer management conditions to encourage farmers to participate in the evaluation and selection of varieties. A potato variety adaptation trial conducted at AHI-Ginchi benchmark site for two years (1999-2000 cropping season) in which five released varieties and a local check were tested at four farmers fields Showed that all the improved varieties out yielded the local cultivars giving a yield range of 8.5-31 t/ha under on farm condition. Four released varieties and 7 selected clones from the advanced breeding trial with two checks Tolcha and Awash were tested in two sets of experiments from 1998 to 2000 at different locations in West and North West Shewa. In the first set of trial, the yield performance and reaction to late blight of released varieties were better than the local varieties and susceptible checks.

Farmer's evaluations of the potato cultivar revealed that yield and tolerance to late blight are the main criteria. How ever, attributes such as appearance, taste and texture were also important parameters for the marketability of the variety. Different trainings for different groups (farmers, development agents, field workers, technical assistants and researchers) were given on improved potato production, integrated disease management, production of clean potato seed, post harvest handling of seed and ware potato and preparation of different food from potato. Informal seed production in the farmers field now become a major practice which helps farmers get clean and sufficient seed for the next cropping season and also benefited from the selling to other users.

Introduction

The problem of conventional research and extension has been its linear top-down approach of generating and transferring technology with little or no involvement of farmers and without proper consideration of their priorities and Capacities (Kiflu and Berhanu, 2002). This has brought shift of emphasis towards participatory approaches. Improving the exchange of ideas and information among farmers, researchers and extortionists are believed to improve the technology development process for farmers, especially those in complex, diverse and marginal environments with limited resources.

The Ethiopian potato program has been conducting researches to develop production technologies and to screen high yielder, wide adaptable and disease tolerant varieties for many years on the base of on station and researcher managed experiments which resulted in low adoption rate. This is due to lack of participation of the clients (mostly farmers) and shortage of clean and sufficient seed tuber. Therefore, to encourage farmers to participate in the evaluation and selection of technologies that suit to their condition, a participatory potato technology development and dissemination was under taken in the central highlands of Ethiopia since 1998 using different methodologies like Farmers Field School (FFS), on farm variety adaptation trials, trainings and informal seed production through farmers participatory approach.

OBJECTIVES

- To increase farmers awareness about the existing potato production constraints and possible solutions from the grass root level
- To develop high yielding and disease tolerant varieties, integrated late blight management
- To help farmers to produce relatively clean and healthy seed tubers of the improved cultivars of their own and to demonstrate the use of diffused light store (DLS).
- To increase farmers participation in all steps of research activities and technology development

Methodology

Based on the previous season diagnostic survey results & description of the farming System, the research area was defined and farmers were selected after a discussion with a group of farmers on the community priority problems and objectives of project and according to the commitment of the farmer to follow the proposed plan of action in the project. Thus only farmers who were willing to involve in the FFS and/or on-farm trials were selected. The farmers were allowed to allocate the plots wherever in their field necessary for the trial. Farmers fully participated in the management of the trials: planting, fertilization, weeding and cultivation, which were done according to the research recommendations. Both farmers and researchers followed up the trials and researchers took periodic observation.

A Total of 19 mother schools in average 8 materials were evaluated by farmers for three years (October 1999 to - June 2002). Moreover in the 20 baby schools that were organized since April 2002 after Farmers facilitators training workshop 18-28 February 2002 at Holetta Agricultural Research Organization three varieties and three advanced clones and local susceptible were planted in June 3, 2002. These FFS's were organized and facilitated by those interested relatively has better caliber farmers attended and get additional training in the workshop about potato late blight management and potato seed and ware potato production in general. These schools are gating strong technical backup of researchers and extension agents of Bureau of Agriculture. On-farm variety adaptation trials of released varieties and selected clones from advanced breeding trials were under taken under variable farmers field condition in different agro ecological zones of West and North West Shewa in such a way that the evaluation and selection process facilitates full participation of the farmers.

Five released varieties (Awash, Managesha, Wechecha, Tolcha & Genet) and a susceptible check (AL-624) were used in the on-farm variety testing trial at Meta Robi and Galessa districts. In the second set of experiment, 7 selected clones from the advanced breeding trials were tasted at seven different locations namely Wolmera, Adaberga, Dendi, Jeldu, Tikur Inchini and Grar-Jarso. Two checks Tolcha and Awash were used as a standard and susceptible check respectively. The objective of the experiment was to evaluate the performance of released varieties in the above districts for their adaptability and tolerant to late blight tolerance, and to encourage farmers to participate in the evaluation and selection of varieties.

Sprouted tubers of each variety were planted in six rows of 6m lengths and at a spacing of 75cm X 30cm between rows and plants respectively at four farmers fields in each district. Two farmers in each district sprayed their fields with ridomil MZ 63.5 at the rate of 2kg/ha to protect the crop from late blight attack, while the other two farmers did all routine cultural managements. Two field days were organized at vegetative stage (at flowering) and at harvesting time at the two districts. The farmers did evaluation during the field days in terms of disease resistance (late blight), tuber yield, tuber size etc. Data like date of emergence, no of plants emerged, plant vigour-using 1-5 scale, no of main stem, plant height and late blight scoring in percentage was recorded at different growth stage of the crop. Also yield kg/plot and number of tubers/plot were taken at the time of harvesting.

Results

IMPACT OF FFS APPROACH ON ABILITY OF FARMERS TO CONDUCT THEIR OWN RESEARCH

FFS approach which gives an opportunity for participants to discover their environment, to reconsider their way of thinking through experimentation, understand the nature of their production problems (Fig.1) and test and discover sustainable solutions. With the main objective of improving the production and productivity of potato through overcoming late blight disease and other management problems of potato it helps in tuning-up research findings to the local conditions and also strengthens research extension farmer linkage.

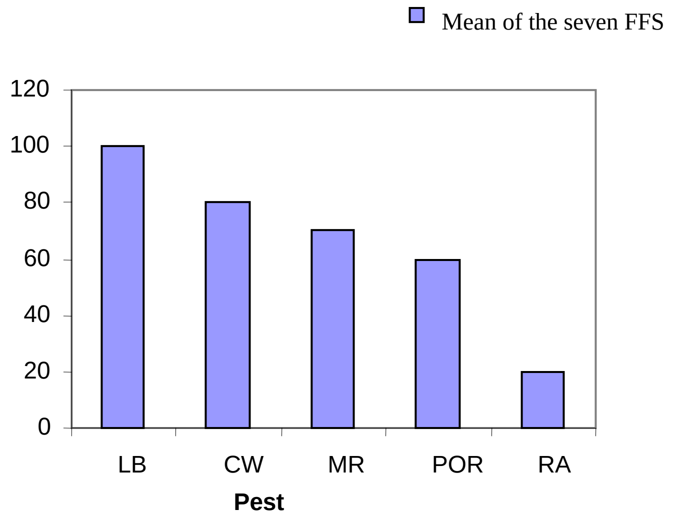


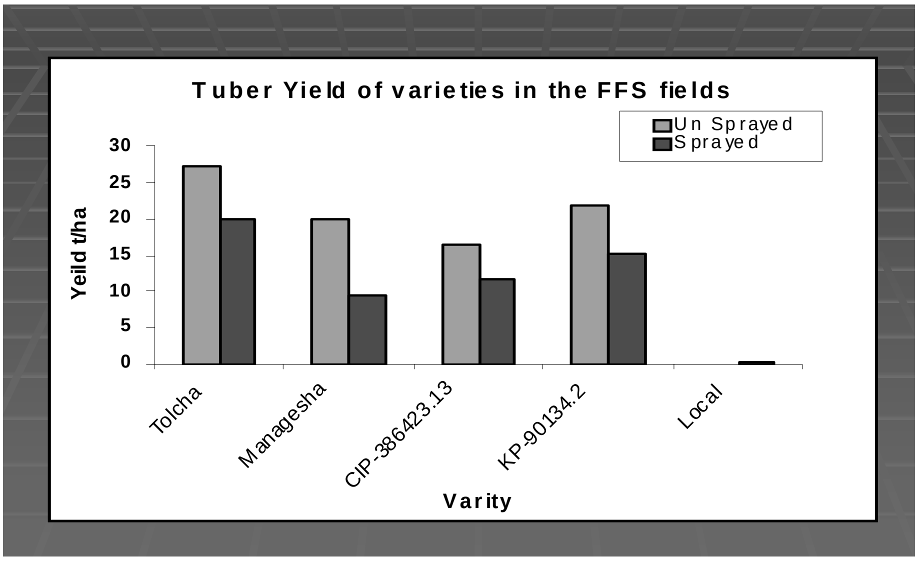
Figure 1: Potato production problems identified by FFS members in Galessa. (Source: Bekele, *etal.,2002*)
LB= Late blight, CW=cut worm, MR=Mole rat, POR= Porcupine, RA=red

FFS increases efficiency of extension systems especially during the transfer of knowledge intensive technologies like late blight management where oral communications and package approaches fails to provide detail and specific information's. In addition to this, FFS deals on hands on exercise are sustainable and effective. FFS addresses farmers' in-groups and contributes for far outreach of successful results shortly.

At the time of evaluation study, most of the farmers have expressed that they are able to continue testing and further screening of the varieties and lines by their own according to the knowledge gained from FFSs. They were able to recall the sessions covered throughout the cycle and they have also kept records on particulars of experiments and layouts. It was interesting to note that they were even able to differentiate the details of improved practices they learned from the traditional ones. The farmers' traditional perception of potato management practices has changed since the introduction of FFS approach in the locality (Bekel *etal.,* 2002). The attitude of the non-participant farmers has even changed to some extent just by simple awareness as outsiders. Almost all the potato growers in the study areas have organized themselves to become members of new Farmers' Field Schools. This implies that their traditional attitudes have started changing towards improved and scientific thinking. The participant farmers who involved in the FFSs have expressed that they are disseminating the knowledge they gained to other farmers so as to create awareness on and interest at the technologies.

In these schools about 6 to 8 clones that were previously tested in the 19 mother schools were evaluated for their tuber yield and reaction to late blight. The result from this evaluation indicated that released varieties and the selected clones out gave higher yield and tolerate late blight than the local cultivars (Figs 1&2). The objectives of these new farmers leaded schools is to sustain the efforts made so far on late blight management and assist diffusion of improved released and promising clones in the project sites.

Figure 2: Tuber Yield of the selected clones/varieties 2001



On-farm variety testing trial

On-farm testing of potato varieties encourages farmers to participate in the evaluation and selection of varieties that would satisfy their needs and expectations; assessing the performance of advanced and released varieties under farmers cropping system and understanding attributes desired by farmers so as to establish feed back flow among researchers, extension workers and farmers.

According to the farmer's evaluation, variety Genet was the best variety followed by Menagesha. Most of the farmers preferred Genet because of its tuber color, tuber size and vegetative growth habit but some prefer Menagesha because it tolerates some adverse conditions like disease, hail damage, etc. The results obtained from the two years data analysis at Meta Robi (Table1) also showed that Menagesha, Genet & Tolcha gave 28.3, 25.8 and 25.1 tons ha-1, respectively while the susceptible check (AL-624) gave 14.5 t/ha. It is also observed that even the tuber yield of the susceptible check (AL-624) can be improved to a reasonable yield with a single Ridomil MZ spray at a rate of 2kg/ha. This result indicates that the improved varieties can give higher tuber yields during the main season while most farmers can't grow potato during the main season using their own local varieties due to the devastating effect of late blight. Performance of the clones in the second trial across the seven locations revealed a considerable variability ($p<0.5$) among clones within the same or across locations for tuber yield (Table.2). In almost all the locations, most of the clones out yielded the standard and susceptible checks. Mean tuber yield across locations indicated that (Table.2) CIP-380479.6 followed by CIP- 387412.2 and CIP-384321.3 gave higher tuber yields 30.8, 25.9 &22.9 t/ha, respectively.

Farmers evaluation of the cultivars for quality revealed that attributes such as appearance, taste and texture were the most important parameters (Gebremedhin *et.al 2002)* used to compare varieties/clones. Based on the criteria, cultivars Tolcha, Menagesha, Wechecha and Genet ranked on the order of acceptance. Over all acceptance for boiled potatoes by farmers over four districts showed that clone/cultivar CIP-383032.15 was the best while CIP-387315.2 was the least preferred (Table3 and Figure 3.).

Table 1. Mean tuber yield (ton/ha), ATW (gm) and ATN/m2 of potato varieties tested on-farm at Meta Robi (two years)

Variety	Yield (ton/ha)	ATW (gm)	ATN/hill
1. Genet	25.77	50.99	49.54
2. Tolcha	25.10	74.73	34.54
3. Awash	17.78	43.77	37.76
4. Al-624	14.50	45.05	30.20
5. Wechecha	27.27	77.78	35.25
6. Menagesha	28.33	73.87	36.77
C.V (%)	22.39	22.92	19.19
LSD (0.05)	5.289	14.28	7.316

Table 2. Mean yields t ha-1 of potato clones in the multilocational on farm trial in 2000**.**

Variety/clone	Location							
	Wolmera	Ada-berga	Jeldu	Tikur Inchini	Grar Jarso	Degem	Galessa	Mean
387315.2	1.4	9.0	28.5	12.0	29.6	63.0	13.2	22.4
382173.12	3.6	14.5	35.9	14.9	23.2	52.2	6.1	21.4
382121.5	2.6	9.4	31.0	10.7	23.9	42.2	12.7	18.9
383032.15	18.2	24.8	26.1	16.2	11.7	41.2	18.1	22.3
380479.6	21.0	32.4	41.6	24.6	21.9	47.4	26.7	30.8
384321.3	18.6	27.7	13.6	25.6	24.4	27.5	23.4	23.0
387412.2	23.0	27.1	33.6	19.0	18.9	47.6	12.1	25.9
Awash	1.7	5.6	8.4	7.5	9.6	31.6	10.7	10.7
Tolcha	16.2	19.0	9.5	14.0	11.0	32.7	22.6	17.9
Mean	10.7	17.0	22.8	14.4	17.4	38.6	14.6	
LSD 0.05	5.0	9.2	9.2	5.7	9.3	1.2	6.7	
CV (%)	29.29	33.59	24.93	24.42	27.86	20.04	26.83	

Source: Gebremedhin *et.al 2002*

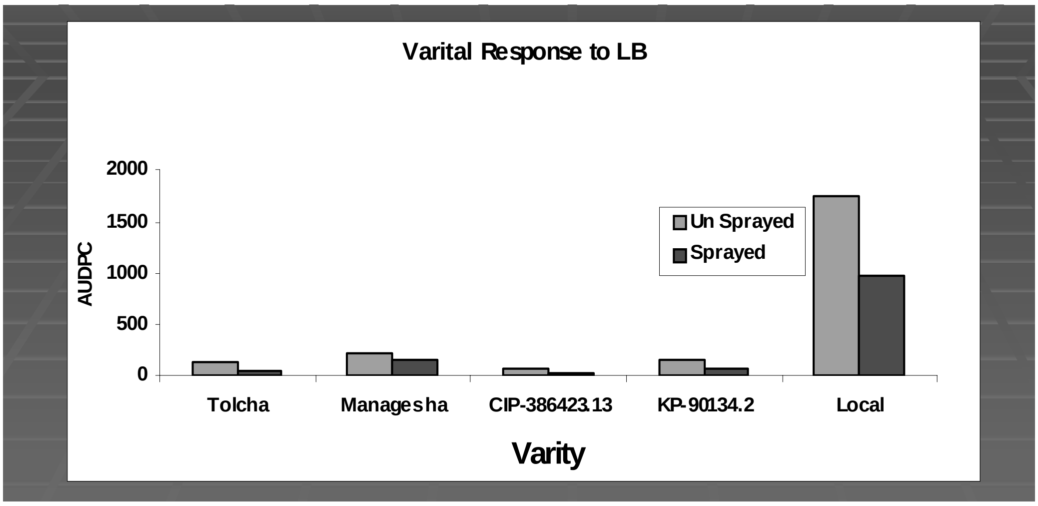
Table 3. Farmers evaluation for boiled potato in four districts West and North-west Shewa.

Variety/clone	Location					
	Wolmera	Degem	Galessa	Grar Jarso	All over	Rank
383032.15	6.58	5.72	7.24	6.42	6.49	1
382173.12	6.00	5.32	6.38	6.83	6.13	2
380479.6	5.64	3.58	5.90	5.75	5.22	3
Tolcha	5.88	4.88	6.87	2.83	5.12	4
382121.5	4.85	6.35	4.31	4.17	4.92	6
387412.2	4.53	6.02	3.72	5.42	4.92	6
Awash	6.8	4.24	-	3.50	4.85	8
384321.3	5.00	6.08	3.65	5.42	5.04	5
387315.2	3.78	4.05	2.58	4.58	3.75	9

1= Most preferred, 9= Least Preferred

Source: Gebremedhin etal., 2002.

Figure 3: Responses of clone/varieties to LB in the FFS fields, 2001.



Informal seed production

In most areas of Ethiopia, among local farmers, it is a common practice to save the small and inferior tubers as seed that they cannot normally sell for consumption. Shortage of sufficient quantity of good quality seed potatoes is one of the most important constraints that limit both potato productivity and production. It is believed that this practice has contributed to the built-up of high level of virus diseases in the locally grown potato cultivars in Ethiopia. Informal seed production in the farmer's field contributes in producing healthy and sufficient seed tuber. Thus, in addition to seed tuber production going on in the research stations, informal seed production in the farmers field now become a major practice which helps farmers get relatively clean and sufficient seed for the next cropping season and also benefited from the selling to other users.

The system enables farmers get improved varieties, relatively healthier and sound seed potatoes than the local varieties and seed at an appropriate physiological age of planting. Trainings were also given to farmers on each location on selection techniques at field level for disease free seed, optimum tuber size and construction and use of DLS to ensure improved and quality seed tuber production at farmers' level.
From the year 1999 to 2003, 2515qt potato seed tuber produced in different farmer's field which shows progress from 165 qt in the year 1999 to 800 qt in 2003 (table 4). Since the farmers who are growing seed potato are also advised to construct the diffused light store, 152 DlSs (table 5) constructed in different districts.

Table 4. Seed potato produced on research station and on-farm (qt).1998- 2003

Year	On station (Holetta)	On-farm (West and North Shewa)	Total
1998	350	-	350
1999	400	165	565
2000	500	350	835
2001	600	500	1100
2002	700	700	1400
2003	1200	800	2000
Total	3750	2515	6265

Table 5. Potato Storages constructed by farmers in West and North

District	Number of DLS Built by Farmers	Number of ware potato Constructed by farmers	Number of Farmers participated in On-farm Potato research*
Wolmera	45	1	173
Adaberga	5	-	20
Jeldu	40	6	818
Dendi/Galessa	36	4	438
Grar jarso	5	-	25
Degem	5	-	25
Tikur Inchini	16	2	70
Total	152	13	1569

Training

A total of 2165 individuals were trained from 2002-2004 of which 535 women on potato food preparation, 61 development agents on potato production and management and 1569 farmers on potato production and late blight management (Table6).

Table 6. Trainings given to Women Farmers, Home Agents and Development Agents 2002-2004

Districts/Zone	Women Farmers Trained on Different Potato Food Preparation	Development Agents Trained On Potato Production Managements	Farmers Trained on Potato Production Managements
South showa	515	42	1474
North-west showa	-	11	95
North showa	20	8	-
North and South Welo	-	20	-
Bahirdar/Adet	56	11	-
South Ethiopia	-	6	12
Total	591	98	1581

References

Bekele Kassa, G/Medhin W/Giorgis, Fasika and Awel Mela, 2002. Integrated Potato Late blight Management: Experience of farmer field school (FFS) in Dendi District. Gemechu Keneni, Yohannes Gojam, Kiflu Bedane, Chilot Yirga and Asgelil Dibabe (eds.). Towards farmers participatory research: Attempts and achievements in the central highlands of Ethiopia. Proceedings of client-oriented research evaluation work shop, 16-18 October, 2001, Holetta Agricultural Research Center, Holetta Ethiopia. Pp 56-67.

G/Medhin W/Giorgis, Endale Gebre, Bekele Kassa and Atsede Solomon, 2002. On-farm Evaluation of Potato Varieties in West and Northwest Shewa Zones. Gemechu Keneni, Yohannes Gojam, Kiflu Bedane, Chilot Yirga and Asgelil Dibabe (eds.). Towards farmers participatory research: Attempts and achievements in the central highlands of Ethiopia. Proceedings of client-oriented research evaluation work shop, 16-18 October, 2001, Holetta Agricultural Research Center, Holetta Ethiopia. Pp 230-239.

G/Medhin W/Giorgis, Ramzy EL-Bedewy, Bekele Kassa, Modesto olnya, Endale Gebre, Atsede Solomon and Berga Lemaga, 2003. Yield Performance and Late Blight Reaction of Different Potato Genotypes in the Highlands of Ethiopia. Akoroda, MO (ed). 2003. Root Crops: The Small Processor and Development of Local food Industries for Market Economy. Proceedings of the Eighth Triennial Symposium of the International Society for tropical Root Crops- Africa Branch (ISTRC-AB). Jointly- Organized by the ISTRC-AB and the IITA, International Institute for Tropical Agriculture (IITA), Oyo Road, Ibadan, Nigeria. 12-16 November 2001.pp-551-554.

Kiflu Bedane and Berhanu Kuma, 2002. Farmer Participatory Research: An Overview. . Gemechu Keneni, Yohannes Gojam, Kiflu Bedane, Chilot Yirga and Asgelil Dibabe (eds.). Towards farmers participatory research: Attempts and achievements in the central highlands of Ethiopia. Proceedings of client-oriented research evaluation work shop, 16-18 October, 2001, Holetta Agricultural Research Center, Holetta Ethiopia. Pp 2-11.

Kindu Mekonen, Hailu Beyene and Alemu Tadesse, 1997. Natural resources Management at Galessa, Garagisher and Gare areru peaant also contains Dendi Wereda, Western of Shewa, Ethiopia TPRA report (unpublished).

Agroforestry Practices, Opportunities and Research Needs in the Highlands of Dendi Wereda, Ethiopia

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Abstract

Understanding of local practices and knowledge are vital as starting points for agroforestry research and development endeavors. Cognizant of that informal and formal surveys were conducted at Galessa and Garie Arera KAs (kebele administrations) of Dendi wereda in the years 2000 and 2001. The objectives of the surveys were to understand and describe indigenous agroforestry practices, identify and characterize major tree species, identify reasons for tree planting in the context of the farming system, and identify and prioritize major constraints related to tree planting. For the informal survey, individual and group discussions, transect walk and informal observations were employed. For the formal survey structured questionnaires were developed, trained enumerators recruited, 250 households from the two KAs randomly selected and information collected and documented. The common agroforestry practices at both study sites are scattered trees on farmlands, gullies and rivers, in home gardens, on grazing lands and around fences. Hagenia abyssinica, Dombeya torrida and Buddleja polystachya are most abundant at Galessa where as Acacia abyssinica, Adhatoda schimperana and Croton macrostachys are most common at Garie Arera. Free livestock movement is the major bottleneck that hinders the expansion of tree planting activities outside homesteads. Soil erosion, feed and wood shortages, and soil fertility depletion are identified by many farmers as critical problems. Investigation of the feed value and soil improving characteristics of some of the potential indigenous trees and shrubs need to receive priority research attention. Moreover, on-farm introduction and evaluation of fast growing, cash generating, and fodder and fuel wood producing exotic trees and shrubs should be strengthened.

Introduction

Agroforestry is the traditional practice of growing trees on a farm for the benefit of the family. It has been in use for at least 1300 years (Brookfield and Padock, 1994 in Sanchez 1995). It has a great technical and economic potential to address the production and sustainability problems of small-scale farmers and others land users in developing countries.

Many authors also elaborated the potential benefits of trees in agroforestry practices. As Rochelau (1988) reported, trees used in Agroforestry systems can provide a variety of services such as improvement of soil fertility for crop production, improvement of microclimate for crop growth and control of crop pests. Another important role of agroforestry systems is keeping Carbon in the terrestrial ecosystem and out of the atmosphere. This would be accomplished by preventing further deforestation and by accumulating biomass and soil carbon.

Dicko and Sikena (1991) attested that in extensive animal production systems in the dry areas of Africa, it is generally estimated that trees and shrubs contribute up to 90% of rangeland production and account for 40 – 50% of the total available feed. Such figures illustrate the existing and urgent need for better use of such potential, particularly in the present context of environmental degradation, which is affecting most parts of tropical Africa. Wickens (1980) also illustrated that in the self-contained, low-economy peasant communities, the chief role of multipurpose trees apart from their values as fodder is for the provision of food, medicine, fuel, timber, fiber, pollen, nectar, dyes, gums, waxes, resins and also play a very important role as wind-breaks, in providing shade and protection against heat and cold and in reducing erosion.

The presence of trees as part of contemporary farming systems has its origin in two attributes of trees (Michael and Peter, 1999) .On one hand, it is the role in sustaining crop production, the impact on the physical environment, most notably through the restoration of soil nutrients and energy, and protection against damage from wind and water. On the other hand the role of various tree products in the household economy includes products used directly by the rural households for food, fuel and construction materials, inputs to agriculture such as fodder, mulch and raw materials for making agricultural implements and storage structures, and products or activities that provide household members with employment and income.

Patterns of tree growing varies in the different agro ecological zones and in different farming systems. Careful and efficient collection of information on agroforestry practices at different agroecological zones, therefore, has a great contribution either to promote or to improve important practices. Furthermore the indigenous knowledge on these practices needs to be effectively analyzed, synthesized, stored, accessed and later be applied in similar areas or be available for future use. Thus, informal and formal survey were conducted with the objective of describing and understanding indigenous Agroforestry practices, identifying and characterizing major tree species, identifying reasons for tree planting, and also identifying and prioritizing major constraints related to tree planting.

Methodology

Study site

Both study sites Galessa and Garie Arera are located in Dendi wereda, West Shewa zone of the Oromia Regional State. Galessa is located on altitude ranging from 2700-3000masl and Garie Arera situated at an altitude ranging from 2300-2500 masl. Rainfall is Bimodal. In Galessa the dominant and widely grown crop is barley and followed by potato. Where as in Garie Arera different types of annual crops are grown including Wheat, Teff, Barley, Noug, Sorghum, Chickpea and lentil.

Survey procedure

A multidisciplinary team of researchers composed of a forester, agricultural economist and forage agronomist conducted the informal survey in 2000. The discussions were made with a group of farmers from different 'gots' in the 'kabeles' of the two study sites independently. In addition other discussions were made also with individual farmers and development agents. Transect walk and observation were employed to collect qualitative information.

Following the informal survey, a formal survey was conducted in 2001. A total of 150-farmer heads of household at Galessa and 100 farm households in Garie area were randomly selected from lists of farm households available in the '*Kebele'*. Using a pre-tested questionnaire, trained enumerators interviewed the selected farm households. The formal survey was targeted at verifying the informal survey results.

Results

Scattered trees on croplands

The practice of raising trees dispersed on cropland is based on protection and management of selected mature trees already on the site It may also involve planting of new trees or it may depend up on careful management of selected seedlings established on site through natural regeneration (Rocheleau et al., 1988). In the study area at Garie arera planting of trees on cropland is not practiced because range livestock grazing is a major bottleneck for the survival and growth of young seedlings. However, deliberate leaving of naturally grown trees and shrubs is common.

Farmers classified naturally existing trees on cropland in three categories. The first category included the species that have a beneficial effect on soil fertility. The second category included species that have adverse effect on adjacent crops and the third category species that contribute to wood production without any clear adverse effect on adjacent crops.

Among the sample farmers at Galessa, about 13.3% categorized *Hagenia abyssinica* as soil improvement species although some 2% of the respondent farmers had the feeling that the species has significant effect on adjacent crops. From researcher personal observation, the soil under *Hagenia abyssinica* seem very fertile and even on some farmers' fields, the barley crop showed lodging under this tree, which is a good indicator of rich in organic matter and nitrogen. Therefore, to conclude about the importance of the tree species for soil fertility, further study on soil fertility status under the tree and its effect on barley crop are necessary. In Gare Arera *Croton macrostachys* is common on farmland and commonly found on wheat and teff fields. According to farmers' explanation, the tree does not have negative impact either on wheat and *teff* yield.

Trees on home gardens

Trees occur in home gardens in almost every agro ecological zone and farming systems in Ethiopia. In different parts of the country, farmers exercise different practices of home garden. The practices vary from one agroecology to the other, but based on farmer's preferences, many experiences and practices are adapted from their parents and the community. We can find in home gardens some species of trees and shrubs remnants of pre-existing forest when it was converted to residential area. Farmers in both study sites grow tree and shrub species in home gardens provided that they are a good source of income and serve as food source for their family. The most commonly grown and preferred species by the farmers are *Enset vetricosom* and *Arundinaria alpina* at Galessa and *Eucalyptus spp*. in Garie Arera. Farmers intercrop enset with potato and cabbage. The enset plant does not have any negative impact on potato and cabbage. However, *Arundinaria alpina* has been found to be highly competitive with crops.

Living fences

Living fences are familiar and a common feature throughout much of rural Ethiopia. The living fences are undoubtedly one of the most useful agroforestry techniques, as the need to control the movement of wild and domestic animals is a key element in most African land- use systems (Rocheleau et al 1988). The most widely grown tree and shrub species that are used as living fences at Gare area are *Adhatoda schimperiana, Millettia ferruginea, Vernonia amygdalina, Euphorbia spp and Ricinus communis.* Where as at Galessa the most widely grown species are *Buddleja polystachya, Vernonia auriculifera, Senecio gigas, Dombeya torrida and Ricinus communis.*

According to a farmer's explanation, wheat crop could grow under *Vernonia amygdalina*, as the shrub will not affect the crop provided excessive braches. The shrub also contributes to soil fertility improvement. *Adhatoda schimperiana* shrub can grow with wheat and teff and contributes to soil fertility improvement with little negative effect on adjacent crops. *Vernonia auriculifera, Dombeya torrida and Senecio gigas* have been reported to improve soil fertility without negative effect on adjacent crops.

Although different tree and shrub species have variability in advantages and disadvantages, farmers in the study sites have their own criteria in selecting the species as living fences. The most important criteria include the following: the species should coppice easily, be fast growing, the flower should serve as a good source of bee forage, the leaves should serve as livestock feed, should have dense crown and some times it should be thorny so as to avoid extravagancies. About 73.3% of the sample farmers at Galessa prefer those species that coppice easily, whereas 58.5%, 56.5%, and 54% of the sample farmers prefer species that are thorny, that have more leaves and have dense crown.

Trees and shrubs along waterways

In our study area there exists many waterways due to the topography of the study area, although clearance of vegetation along the waterways has caused gully formation, which requires temporary or permanent conservation structures. Currently, farmers do not plant trees and shrubs along waterways except the presence of naturally grown mature trees/shrubs. Based on the information obtained from farmers, the most widely found tree/shrub species at Galessa include *Hagenia abyssinica, Budelja polystachya, Juniperus procera, and Dombeya torrida* and at Garie Arera include *Podocarpus gracilor, Rosa abyssinica, Carissa edulis, Olea africana, Ficus spp., Juniperus procera and Acacia abyssinica*. These naturally grown trees and shrubs have different benefits to the farmers. They help to control soil erosion, serve as food, fuel wood, shade, farm implements, bee forage and protect rivers and springs from drying. The presence of potential indigenous trees and shrubs along waterways is a good opportunity for future gully stabilization program that encompasses a combination of conservation structures and vegetation.

Trees and shrubs on borderlines and boundaries

Planting of trees around the farm boundary is not a common practice in the area. This is because farmers conflict due to the effects of some tree species on neighboring crop fields. However, some farmers plant Eucalyptus globules to produce wood for household consumption and to generate income by selling it. This is done provided two neighboring farmers agree to plant *Eucalyptus;* otherwise farmers should plant the Eucalyptus tree at least 6 meter from neighboring fields. In addition to *Eucalyptus* spp. the most commonly found tree/shrub species in boundaries in Galessa include *Hagenia abyssinica, Dombeya torrida, Buddelja polystachya, Juniperus procera and senecio gigas* where as in Garie arera *Mytenus spp., Acacia spp. Carisa edulis and Ekbergia capensis.*

Trees and animal feed

With the launching of the AHI project in collaboration with EARO in these areas, it has been made possible to have an in-depth understanding of problems of the prevailing farming systems of the areas in which natural resource degradation and animal feed shortage have been identified to be prior problems. This calls for a coordinated effort by policy makers, development experts and researchers in the maintenance and expansion of multipurpose tree populations and the evaluation of the role and potential of the various species from the point of view of animal feed and environmental protection.

In the highlands of Ethiopia, feed shortage is the major factor that impeded livestock productivity in the study area. In these areas, livestock feeding is mainly based on grazing on some fragmented lands including the seasonally waterlogged land at the margin of people’s holding, land not suitable for arable farming and the poorly fertile land fragment in and around the vicinity of owned holdings. Besides, crop residues from teff, barley and wheat at Gare-Arera and fallow lands as well as barley straw at Galessa serve as another source of feed with great priority being given to oxen in feeding the crop residues. The general perception of farmers in both peasant associations was that the available feed resources from the mentioned sources are critically inadequate to sustain their animals and there are situations where they encounter considerable loss of animals due to feed shortage.

Multipurpose trees and shrubs are increasingly recognized as important components of animal feeding, particularly as suppliers of protein and especially in harsh environmental conditions where the available grazing is not generally sufficient to meet the requirements of animals, at least for part of the year. This mainly occurs in some mountainous areas like Galessa and in the dry areas where grazing is degraded. Consequently, it is a common practice among farmers to feed their animals with tree leaves by cutting the local tree species available in their holdings and in the nearby Chilimo forest. Tree species locally called ``*Kombolchaa*`` and ``*Dannisaa*`` were reported to be among the tree species often used for animal feed.

In Galessa and Gare-arera areas of the Ethiopian highlands, the more valuable natural multipurpose tree species are removed and more land is brought under cultivation. The increased pressure on the land has often led to a reduction or even omission of the period under bush fallow and during periods of heavy rainfall, loss of topsoil due to gully erosion becomes a problem on sloping lands. Despite the versatile importance of multipurpose trees, research and development efforts with regard to trees and shrubs have been minimal until the occurrence, in recent years, of prolonged droughts, which affected the fragile ecosystems of the Galessa and Gare-arera areas.

Some of the desirable characteristics of multipurpose trees have been summarized by several authors (Wilden, 1986; Atta-Krah *et al*., 1986; Ivory, 1989; Baumer, 1991). These include easy establishment and rapid early growth to compete effectively against weeds, thornlessness and perenniality, high productivity under repeated cutting, grazing or browsing, resistance to local pests and diseases, high seed production ability or reliable vegetative propagation, little or no fertilizer requirement, high production of good quality forage in terms of protein and mineral contents, adaptability, palatability, digestibility and non-toxicity. It is therefore necessary to consider these factors while aiming to maintain and expand a given tree species in farming systems of a given area. The prevailing environmental degradation and acute animal feed shortage at Galessa and Gare-arera areas of the Ethiopian highlands needs an immediate intervention using multi-purpose trees as an entry point in reaction to the multi-faceted problems of the farming systems of the areas. In the present scenario of increasing demand for forage and the relatively extensive availability of low quality basal feed materials which require protein supplementation, high protein fodders from leguminous trees could have a significant role in animal feeding systems throughout the Ethiopian highlands in general and in Galessa and Gare-arera areas in particular. Undoubtedly, multipurpose trees, whether or not they provide fodder for animals, do offer an adequate response to environmental degradation and to changes in climate, problems that have begun to be observed with some anxiety in the last few years at Galessa and Gare-arera areas. In this respect, there is a need for more integrated research to develop technically viable, economically and socially acceptable approaches for the sustainable development of multipurpose trees in reaction to the perceived environmental degradation and acute feed shortage

TREE PLANTING AND THEIR MAJOR CONSTRAINTS, OPPORTUNITIES

Currently farmers' plant trees to produce fuel wood, construction wood, wood for fence and to generate income in a very short period of time. The expansion of Eucalyptus can be a good indicator. The survey results at both study sites showed that farmers preferred Eucalyptus and Cupressus (Table 1) as a major and important species because the species were used for different purposes like fuel wood, construction wood and for fences. Moreover due to the species' fast growing quality, farmers get benefits and high market demand in a very short period. Farmers' priority preferences of trees and shrubs for different uses are also indicated in Table 2.

Table 1. Farmers preference ranking of trees/shrubs at Galessa and Garie Arera

	Tree/shrub species	Garie Arera % -age of farmers	Galessa % -age of farmers
1	Eucalyptus globulus	96	88
2	*Cuppresus lusitanica*	82	85.3
3	*Rahmnus prinoides*	72	42.7
4	*Arundinaria alpina*	15	-
5	*Fruit trees*	15	-
6	*Casuarina equstifolia*	9	-
7	*Hagenia abyssinica*	8	64
8	*Enset ventricosum*	7	-
9	*Dombeya torrida*	-	28.7
10	*Chamacytisus palmensis*	-	21.3

Table 2. Farmers priority reasons for planting of trees/shrubs at Galessa and Garie Areara

	Purpose of planting:	Garie Arera %-age of farmers	Galessa %-ageof farmers
1	Fuel wood	99	96
2	Construction wood	98	86
3	Wood for fence	68	76.7
4	Income generation	59	60
5	For shade	17	26.7
6	Soil fertility improvement	12	24.7
7	Animal feed	4	24.7

Although trees and shrubs have different benefits in the farming system there exists different factors that hinders the expansion of tree plantings. Among these factors as indicated in table 3, the most common ones in Galessa and Garie Arera are land shortage, lack of preferred seedlings, shortage of water, damage by domestic and wild animals and shortage of family labour. As prioritized by the farmers, land shortage is a major critical problem in the study areas and in the highland areas of the country. Due to the indicated constraints most farmers' plant trees in areas they own and also in areas that are easy to control and manage so as to minimize damage by livestock. Farmers' priority niches for future tree plantings are indicated in Table 4.

Table 3. Prioritized major constraints for tree planting at Galessa and Garie Arera**.**

No	Constraints	Garie Arera %-age of farmers	Galessa %-ag e of farmers
1	Land shortage	61.3	63.3
2	Lack of seedlings	36.7	54
3	Lack of preferred seedlings	32.7	13
4	Shortage of water	19.3	34
5	Damage by wild animals	14.7	5
6	Damage by livestock	10.7	3
7	House hold labor shortage	13.3	2

Table 4. Future need/opportunity where Galessa and Garie arera farmers plant trees

		Garie Arera % -age of sample farmers	Galessa %-age of sample farmers
1	Homegarden	56	62
2	Living fences	51	38.7
3	Gullies and waste land	44	45
4	Boundary planting	21	14
5	Communal grazing land	6	11.3
6	Scattered trees on farms	1	8

Conclusion

Most of the indigenous species are under threat and also their effect on crops yields are not properly documented. For most dominant as well as preferred species it is important to study their effects on crop yield. Future study is suggested on the nutrient concentration of the most preferred and dominant indigenous tree species growing in the area and their decomposability. Research should also focus on fast growing, system compatible and marketable tree /shrub species for future ease of adoption by farmers. It is important to consider those potential indigenous trees and shrubs species for gully stabilization, particularly those that perform well along waterways and also combine these with conservation structure. Promotion of the most preferred species according to niche compatibility and area availability will improve system resilience.

References

Arnold Michael J.E.,and Peter A. Dewees, 1999.Trees in managed landscapes : Factors in farmer decision making: In Sgroforestry in sustained Agricultyral Systems Pp 277-294.

Atta-Krah, A.N., Sumberg, J.E. and L. Reynolds, 1986. Leguminous fodder trees in farming systems – an overview of research at the humid zone programme of ILCA in southern Nigeria. In: Potentials of forage legumes in farming systems of sub-Saharan Africa. Haque, I., Jutzi, S. and Weate, P.J. (eds.), ILCA, Addis Ababa, pp. 307-329.

Baumer, M. 1991. Tree as browse and to support animal production. In: Legume Trees and Other Fodder Trees as Protein Sources for Livestock. FAO Expert Consultation held at the Malaysian Agricultural Research and Development Institute (MARDI) in Kuala Lumpur, Malaysia, 14 to 18 October 1991. Food and Agriculture Organization of the United Nations, Rome, Italy.

Brookfield, H and C. Padock, 1994. Appreciating agrodiversity: A look at the dynamism and diversity of indigenous farming practices. Environment 36:5, 6-11.

Dicko, M.S. and L.K Sikena, 1991. Fodder trees and shrubs in range and farming systems in dry tropical Africa. In the FAO Expert Consultation on Legume Trees and Other Fodder Trees as Protein Sources for Livestock held at the Malaysian Agricultural Research and Development Institute (MARDI) in Kuala Lumpur, Malaysia,14 to 18 October 1991. Food and Agriculture Organization of the United Nations.

Ivory, D.A. 1989. Major characteristics, agronomic features and nutritional value of shrubs and tree fodders. In: Shrubs and tree fodders for farm animals. Devendra, C. (ed.), IDRC-276e, Ottawa, Canada, pp. 22-38.

Rochelau, D.,F. Weber and A. Fieldjuman, 1988. Agroforestry in drylandsAfrica. Kenya: International council for research in Agroforestry.311 P.

Sanchez. P.A. 1995. "Science in Agroforestry," Agroforestry systems,30,5

Wickens, G.E. 1980. Alternative uses of browse species. In Houèrow, H.N. (ed.). Browse in Africa. The current state of knowledge, International Livestock Center for Africa (ILCA), Addis Ababa, Ethiopia.

Wilden, J.H. 1986. Trees in forage systems. In: Alley farming in the humid and sub-humid tropics. Kang, B.T. and Reynolds, L. (eds.), IDRC – 271e, Ottawa, Canada, pp. 71-81.

Integrating Various Biological Measures for Erosion Control and Soil Fertility Management: The Case of Gununo, Ethiopia

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Abstract

The increasing soil degradation of highlands over time as a result of soil erosion and continuous cropping of lands without rest due to land shortage is a well known phenomenon. This problem was identified as one of the major problems of Gununo area, one of the highlands of Ethiopia. Physical and biological soil conservation measures and soil fertility improvement activities have been implemented together with the farmers with the objective of incorporating farmers' decisions or evaluations on the technologies. Various types of multipurpose plant species were evaluated for their performance as bund stabilizers, and also planted at different niches. The type of activities and niches for each activity were chosen by the farmers. Level soil bunds were constructed on three farmers' fields at a distance of 10 to 15 meters apart based on the farmers' advice that it would be difficult for cultivation with oxen and cropping land would be reduced if it was below 15 meters. Elephant grass, banana and legume shrubs were planted on the bunds for stabilization. The farmers compared the soil loss due to run-off before and after the implementation of the soil conservation measure. The farmers observed that with the soil conservation measures in place, the soil remained on their farms, which would otherwise have been washed away. The elephant grass is fast growing, drought resistant, used as feed throughout the year and anchors the soil bunds, and farmers praised AHI for it. Sweet potato yield increased from biomass transfer of Sesbania sesban and from the FYM and inorganic fertilizers. Most soil conservation and fertility improvement technologies benefits take longer to be realized and so have no immediate acceptance by farmers who prefer technologies that offer quicker benefits like fodder. Thus, an integration of technologies that offer both quick and longer term benefits would be a desirable situation for the farmers to really adopt them..

Introduction

Degradation of arable lands due to soil erosion is one of the most critical challenges in the Ethiopian highlands, and is most apparent in southern Ethiopia. The degradation and loss of soil resulting from soil erosion and depletion of organic matter and nutrients are very much aggravated by poor farming practices. It is partly due to the poor farming practices characterized by general lack of conservation measures and over population leading to intensive cultivation of fragmented lands, deforestation, and overgrazing.

The study area Gununo AHI watershed is a typical representative of such highlands with an elevation of 2100masl, average annual rainfall of 1300mm, and with estimated population of density of 523/km. As a result of high population density, livestock pressure, undulating slopes and soil types, land degradation through soil erosion is a serious problem in the area. In some fields, the entire topsoil layer has already been lost to erosion and cultivation is now practiced on the subsoil. The annual soil loss rate in the area is estimated at 75t/ha/year, which is more than the average rate of 42t/ha/year for the whole highlands area of the country (Belay, 1992).

Background

Past research and development efforts have focused on natural resource management where generating new technologies on research stations and disseminating the obtained results has been through a top down approach. Despite the scientific accuracy and theoretical feasibility of these technologies, various practical problems made the acceptance and adoption of these technologies difficult. Among these problems were: prevalence of diverse socio-economic and biophysical conditions, poor integration of some of these technologies to the existing farming systems, and inadequate know how of the farmers about the application and management of the technologies. Therefore, a change in the approach is required to enable the development of flexible conservation (mechanical, agronomic and biological) options which can be modified and adapted to the specific environments and be optimized by farmers. Farmers' knowledge must be acknowledged and technologies be synthesized to incorporate old ideas into the new ones instead of transferring predefined solutions (Hagmann, et al. 1995). The objective of this paper was to look for sustainable intervention measures against the problem of land degradation through multidisciplinary team and stakeholder participation, systems oriented, and on-farm participatory research on land and soils management options in the study area.

Methodology

As an initial step for utilization of indigenous knowledge, identification and documentation of existing traditional practices in soil and water conservation was done in two phases. In the first phase, identification of appropriate villages and farmers was done through review of secondary data, discussions with extension agents, elderly farmers, and preliminary surveys and field tours in the erosion prone study area.

The second phase involved detailed field observations, taking measurements on pertinent parameters, survey techniques such as administering open-ended questioners and formal and informal discussions with group and individual farmers. Even though the study covered all the selected study sites, more time and concentration was given to farms and farmers where unique practices and / or knowledge were encountered.

After participatory planning and prioritization of activities with all stakeholders, several potential options were identified as solutions for soil degradation in the area. However, as an entry point, only the simpler ones that required use of less resources and know how were started with farmers. These included trials like soil conservation bunds designed by farmers, live hedges for fodder, strip planting of banana, boundary planting of high value trees and integrated organic and inorganic fertilizers management. These experiments were undertaken with seven volunteer farmers. Based on individual farmer's interest and objective, the type of experiments and number of treatments were introduced to each farmer. All the management activities were left to the farmers themselves. All the farmers and researchers participated in recording their own initial observations. The following sub-trials were undertaken during the first trial:

- evaluation of contour hedgerows of fodder shrubs for soil erosion control and other associated benefits. Under this trial three types of fodder shrubs (*Sesbania sesban, calliandra callothyrusus and leaucena diversiflora*) integrated with an elephant grass were evaluated on the bund for their multipurpose benefits.
- Strip planting of perennial crops, banana (Musa spp) local and introduced (cavandish giant) and Enset (*Enset ventricosum*). These were evaluated for their performance in integration with soil bunds.
- Boundary planting of Gravillea *robusta* and avocado (*persia americana*). These multipurpose plant species were evaluated for their performance as bund stabilizers shade tree, livestock feed as fodder, cash income generation and soil fertility improvement.
- In addition to these various soil fertility improvement options were made available to the farmers such as green manuring and integrated organic and inorganic fertilizers management. Farmers evaluated the performance of the plant species based on their own criteria and pointed out their own opinions about the plant species.

Results

Indigenous land management practices

Several indigenous techniques and knowledge were identified in the area but only those practices which seems to be effective and could be used in wider scale and circumstances either in present form or modified and integrated with other practices will be addressed in this paper. The following six indigenous knowledge and techniques such as traditional soil bunds, banana strips along the contour lines, deep tillage along contour, strips of sugarcane, local grasses and taro, field boundary drainage ditches, leaving strips of unplowed and unweeded lands were experimented on.

Traditional soil bunds

The traditional soil bund was the most overriding measure of soil and water conservation and its distribution was more than 44% of the farms surveyed. This is because it is easy to manage and has other benefits associated with the farming system. Farmers use simple hand (local) tools and oxen plow for construction and the design of the structures are made following the contour line. Depth of the bund was in the range of 20-30cm, and spacing between successive furrows depends on slope and crop type and hence varies between 8-30m. It requires little technical input and also minimal time and labor for construction especially when using oxen plow. Farmers prefer the structure because of its high integration and flexibility with the farming systems and land holdings. The structure can well integrate with small and fragmented land holdings of the area. It can easily be removed with little labor and time input when not required. However, the structure requires frequent maintenance and has low stability especially during heavy rainy seasons. Heavy rainstorms easily demolish the structure because of its shallow depth and consequently heavy overflow can further aggravate soil erosion.

Strip planting of perennial crops

Strip planting of perennials such as banana, taro, sugarcane, and local grasses was found to be an important soil conservation measure prevailing in the area followed by traditional soil bunding. The method was observed in 21% of the farms surveyed. These locally available perennials are planted in strips along the contour lines. Farmers also pointed out that this measure is effective in moderate to low slope conditions. The grass strip is mostly located in the upper part of the field to control run on from up slope fields and spacing between the strips varies from 6m to 40m. For banana, spacing within the strips is 2.5-3m between the strips 10-30m depending on slope and land size. Sugarcane strips are changed every two to four years because of its root competition problems. The method requires low technical and labor input for establishing the strips and there are no special tools and technical knowledge required for its maintenance. The strip planting method is mostly applicable in moderate to low slope conditions and small land holding systems. It can easily be removed when not needed. Despite all these technical feasibility and simplicity there are also some risks and problems associated with the measure. Vigorous sucker development invades the farmland rapidly if management of the suckers is poor. Sugarcane is a heavy feeder and hence competition with annual crops. Some of the local grasses may become persistent weeds.

Field boundary drainage ditches

This is the second most important soil and water conservation measure prevailing in the area with distribution of about 26% of the farms surveyed. As to design of the structure, it is done by cutting ditches down the slope on both sides and some times also along the upper boundary. Both the width and depth of such ditches are greater than the shallow traditional contour ditches and they are constructed in such away that they join natural drainage line or other similar ditches down slope. For its construction and maintenance simple local tools such as hoes and spade are used and also it requires little or no technical input.

The structure is highly compatible to the farming system of the community in such away that it is well integrated with small and fragmented land holdings of the area and also applicable for all crops in gentle to medium slope areas. The drawbacks with this structure is that it is not flexible because it is constructed as a permanent structures. It also requires frequent and close supervision and maintenance otherwise it can lead to farther accelerated erosion down the slope.

Deep tillage and leaving strips of unplowed and non-weeded lands

These techniques of soil and water conservation were observed in more than 19% of the farms surveyed. Plowing the land deeper along the contour and then leaving the course aggregates at the surface increases the infiltration rate and also the course aggregates resist run off. The other method of creating courser surface aggregates and barriers was by leaving strips of unweeded lands of about 1m width along the approximate contour direction and then the weeds and shrubs on the strip develop into a live barrier. One or two of such strips are used in the farm, and their location is mostly at an abrupt slope point. The former one requires deeper and sharper tools, and stronger oxen for more drought power but the latter one does not need any additional tools, labor, and time for its construction and maintenance. The abandoned weeds can also be used as feed for their cattle. Both methods are well integrated with the farming system of the area for medium slope areas and for all annual crops except tef. Regarding the risks associated with deep tillage, it can decrease the germination rates. In the case of the live strips of unplowed land, there was no observed problem nor was any problem associated with it reported by the farmers.

PARTICIPATORY EVALUATIONS OF AGROFORESTRY INTERVENTIONS AS LAND MANAGEMENT OPTION

Evaluation of high value trees for boundary planting

In this sub-trial two high value tree species, Avocado (*persia americana*) and *gravillea robusta* were evaluated for their performance to be integrated as boundary plants. Initially due to prolonged dry spell in the area the survival and growth rate of both seedlings were affected. Avocado was affected more than Gravillea *which* established comparatively better at the same conditions (see fig.1). Through all growth stages of the two plant species, both the research farmers put their interest on Gravillea than avocado, because its seedlings established very easily, grew vigorously and straight up and became a full tree which could be used as feed for cattle during dry seasons (Table. 4). They also pointed that there was no observed negative effect on soil productivity. According to ICRAF (1992), *Gravillea robusta* is a very successful Australian tree planted and widely used in Africa, 0-3000masl. It has a variety of uses such as fuel wood, timber, poles, furniture, veneer/play wood, charcoal, fodder (leaves), bee forage, shade, mulch, green manure, wind breaker, ornamental, terrace stabilization, intercropping, and soil conservation. The tree grows well with food crops if there is good management especially in reducing the shade effect on underneath crops. The timber is hard, straight and has an attractive grain. On the other hand, farmers complained that Gravillea have got long horizontal roots which can widely expand to the farm and create problems for oxen plow cultivation. It also has shade effect on the beneath growing small crops. However, in good management conditions the tree can well integrate with food crops especially in reducing the shade effect and ditching some of the extremely extended horizontal roots to the farm.

Avocado has got high fruit value, and is highly productive, because of its large number of branches which can bear fruit. Moreover, farmers preferred the tree for shade purpose especially in front of the house. But farmers' evaluation on the performance of the tree for boundary planting revealed the following limitations:

- It takes longer time to set fruits
- Most plants are fruitless (genetic factors)
- Difficult to harvest because of its height. Shorter varieties could be promoted
- Have got large canopy so that the shade affects the crops beneath. However, shade tolerant crops such as sweet potato can better integrate with the tree.

Therefore there is a need for management options especially in identifying appropriate niches such as planting in front of the houses, out field border areas, and also they can be integrated in the farm if there are good management conditions.

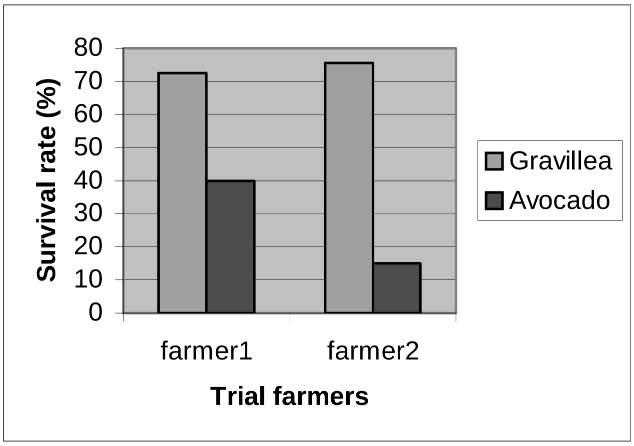

Figure 1. Survival of high value tree species as boundary planting in Gununo area.

Evaluation of fodder shrubs for contour hedgerows planting

In this sub-trial three types of legume fodder shrubs (*Sesbania sesban, Calliandra callotyruses and Leaucena diversiflora*) were evaluated for their performance in integration with the soil conservation bunds under three farmers fields (as replicate). It was observed that *calliandra callotyruses and leaucena diversiflora* were severely damaged by the dry spell during early stages. However, *Sesbania sesban* tolerated better (Fig.2). This might be due to its wide agro ecological domains for adaptation. According to Kahsay Berhe et al., 2001. , *S. sesban* is suited to about 17% of the total landmass, mainly to western and southern regions of the country. Ethiopia is one of the home origins for *s. sesban* and hence this species is abundantly found around rift valley lakes. Studies undertaken on broad beds on seasonally water logged vertisols at Debre Zeit indicated that *S. sesban* can yield up to 4t/ha leaf dry matter (ELCA, 1986). Seedlings grow rapidly and vigorously; early biomass production is high (Table. 1). Sesbania species are a potential source of high quality forage with leaves and tender stems that are readily eaten by large and small ruminants (Gohl, 1981). The species have crude protein levels as high as 30% (Kahsay Berhe et al., 1999).

Farmers also understood that these legumes provide inputs to the soil through addition of organic components. One of the trial farmers chopped the leaves of the legumes and incorporated to his farm as green manure. He was also interested to compare the crop stand of sweet potato on the soil where *Sesbania sesban* leaves were incorporated and where they were not. He observed that the crops grown in the treated plots were vigorous, dark green and finally harvested much better yield than the untreated plots. Therefore this experiment made him understood the advantages of the legume species as green manure for soil fertility improvement. In addition he was planning to cover the whole farm with the legume leaving spaces in such a way that the crop cannot compete with other crops. Farmers again suggested that the legumes are preferred for their cattle as alternative feed during dry seasons when feeds are not available than for soil fertility improvement.

Even though Sesbania is more adapted to the area, *Calliandra calothyrusus* is also highly preferred by one of the trial farmer (Birhanu) for its abundant seed production. Farmers also selected Calliandra for its fast regeneration after pollarding. The species was also recommended to all Nitosols in southern, western and southwestern regions of Ethiopia (Kahsay Berhe and Mohamed Saleem, 1996). Leaucena was also observed to have good root net works and surface coverage which can reduce runoff and stabilize bunds well. The three legumes were evaluated on the bases of their performance for biomass production, biomass incorporation fodder value, its establishment, bund stabilization.

Table 1. Evaluation of the performance of legume fodder shrubs under farmers selection criteria.

Legume shrubs	Farmers selection criteria				
	Biomass production	Decomposition rate	Fodder value	Easily establishment	Bund stabilization
Sesbania sesban	3	1	1	1	1
Calliandra callothyruses	1	2	2	2	3
Leaucena diversiflora	2	3	3	3	2

Note: 3 is highest score and 1 is lowest score.

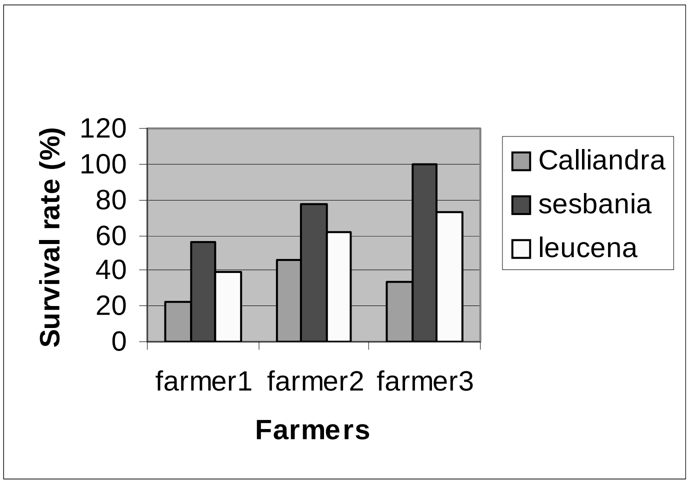

Figure 2. Survival of legume fodder shrubs for contour hedgerow planting at three farmers' field.

EVALUATION AND IMPROVEMENT OF SOIL BUND UNDER FARMERS' DESIGN AND MANAGEMENT

In Gununo it is not uncommon to see farmers destroying their soil conservation structures constructed by the Soil Conservation Research Project (SCRP) which is near to the AHI watershed. Some farmers even try to modify the structures by their own design while others integrate some local stabilizers. The major reasons pointed out by farmers are the apparent wastage of productive land, which could be used for crops, facilitation of soil bunds for the invasion of noxious weeds, high labor requirements to maintain it frequently, difficulty for plowing with oxen when constructed in such a way that the distance between two structures is not enough to turn oxen while plowing and also as a dwelling of mole rats. In addition, farmers also suggested that high productivity of crops were obtained from the areas where soil bunds were demolished. This is also true because of the deposition of surface fertile soils by the soil structures.

Based on the suggested drawbacks of physical soil conservation measures various improvement options were tested through farmers' participation. Among the improvement techniques were: compromising the design character with systems compatible to the area and integration of various multipurpose bund stabilizers. Initial studies conducted by AHI research team in natural resources management to modify the technologies and adapt to the local needs showed different options. The vertical distance between successive contour bunds was determined by the amount of land involved, the degree of slope and the farmers' usual method of preparing lands (Tilahun et al., 2001). The trial farmers also agreed to set the bund within 10 to 20 meter intervals. They also observed yield improvements due to soil conservation measures. For the improvement and productivity of the structure, various combinations of multipurpose plant species were used for bund stabilization, such as strips of enset, banana, Gravillea and Elephant grass. According to Bertu (1991) the objectives of bund stabilization are two fold. The first objective is to save labor and time required to maintain the broken bunds so that this labor can be used to construct new bunds. Second objective is to maximize output per unit of land.

Since the average size of land holding is small, farmers do not like to lose any portion of their land for production.

Assessment made by the farmers for the evaluation of various multipurpose bund stabilizers showed that Elephant grass has got better performance. Farmers also pointed the following advantages for the selection of Elephant grass:

- Its fast growth
- Roots strongly anchor the soil so that it stabilizes soil bunds
- Highly preferred by their cattle
- Drought resistant and as a result it is an important alternate feed source during dry seasons. On average farmers harvest this grass with in fifteen days interval (Table.2).

It was also observed that biomass production of the grass varies depending on soil fertility and management conditions. Poorer farmers having lower numbers of cattle harvest the grass within twenty days interval but richer farmers with large numbers of animals harvest the grass with in fifteen days interval (Table.2). According to Tilahun et al., (2001), enset and banana grew very slowly in the first two seasons, they could not prevent the bund from being washed away, and farmers were also worried about their roots spreading to the rest of the farmland, while Gravillae proved drought prone and grew poorly in the infertile soils. Some of the research farmers also tried to integrate the plant species on the bund with the elephant grass. It was observed that, banana species better integrated with elephant grass on the bunds. However, it requires good management such as frequent desuckering so as to reduce competition with the grass and also nearby crop plants. Gravillea also showed good performance when combined with the grass, but its low establishment on the bunds limited its performance.

EVALUATION OF THE PERFORMANCE OF BANANA (MUSA SPP) UNDER STRIP PLANTING ON SLOPPY LANDS

Varieties of banana (cavandish Gient and the local variety) were planted for the evaluation of their performance on the bund and in strips. The introduced variety cavandish Giant was planted on the bund for bund stabilization in the middle part of the farm and also as strips. The plant produced a number of suckers and stabilized the bund well. Farmers witnessed that the crop has got wider root networks so that it can stabilize the bunds well. However it takes about three years to bear fruit. Farmers tried to compare the number of fruits set by the introduced banana variety (cavandish giant) with the local variety and revealed that the new variety produced higher number of fruits (av.100) than the local one. They also appreciated the new banana variety for its shortness as it withstands lodging and easy to harvest. Farmers also wished to evaluate the new variety further at different points of the farm especially at homestead areas. However they have the following complaints on the new introduced variety.

- It takes longer to bear fruit
- The fruit test too sweet, which reduced its market preference although the children like it
- The fruits (finger) are thin in size
- It highly competes for nutrients with crop plants around

The local variety on the other hand performed better on strip planting near the homestead areas than in the outfield soil conservation bunds. It is fast growing, has bigger finger size fruits and also vigorous sucker development under good sucker management conditions.. However its severe lodging and wider sucker invasion reduced its performance for bund stabilization. Farmers also suggested that the new variety performed better for bund stabilization while the local varieties performed well in strip planting nearer to the homesteads.

IMPROVING SOIL FERTILITY THROUGH MULTIPLE APPROACHES

Gununo is one of the representative areas with serious soil degradation problems. In some farms even little response of crops to chemical fertilizers was observed. This is mainly due to low level of soil organic matter content, which has vital role in the availability of nutrients to the growing plants. Farmers use various organic sources for soil fertility improvement. These include household refuse, crop residue, manure, and leaf litter. However, the availability of these materials is mainly determined by socioeconomic status of the farmers and their application is also limited only to homestead farms. Poorer farmers have no access to farm yard manure because of the low number of cattle they have. Even in the case of richer farmers they do not abandon crop residues in the farm. They continuously remove this material as source of feed for their cattle.

In order to address the apparent problem, the team of AHI researchers in natural resources management developed strategies to alleviate the alarming soil degradation rate and to improve productivity of the land. A wide range of techniques for soil fertility improvement were undertaken through participatory research.

EVALUATION OF INTEGRATED ORGANIC AND INORGANIC FERTILIZER MANAGEMENT

Participatory on farm trial was conducted with two farmers (*Kuruto* and *Bade*) on integration of farmyard manure with NP fertilizers for sweet potato. The result showed that treatment with FYM and DAP gave highest tuber and green top yield in both the farmers' field in comparison to treatments with NP fertilizers alone (Table 2). It was also observed that the crop stand and harvested yield varies in different locations of the farm. Homestead areas are much suited to root crops because these crops highly require organic materials. Since organic materials create suitable conditions for plant growth through improving physical properties of the soil, the underground roots can freely expand to the wider areas within the soil. Yield variation with the two farmers might be due to high access of organic manures by the richer farmer and also good management of the field. Therefore the above observations indicate that high yield potential of the root crops can also be achieved by application of organic materials in the outfield farms.

Table 2. Average yield of sweet potato (Green top yield and Total yield) in tons/ha at different organic and inorganic fertilizer rates.

Treatments	Kurutos farm		Bedes Farm	
	Total yield t/ha	Green top weight t/ha	Total yield t/ha	Green top weight t/ha
FYM 5t/ha	4.4	2.2	15.3	5.6
50kg/ha DAP + 25kg/ha Urea	9.5	3.7	19.5	7.6
2.5t/ha FYM + 25kg/ha DAP	9.5	3.1	21.0	5.1
Control (no fertilizer)	5.9	2.3	16.6	5.2

EVALUATION OF LEGUME COVER CROPS FOR GREEN MANURING

Green manuring is an important technique of creating suitable conditions for plant growth by optimizing nutrient availability in the soil. Greenland (1986) as cited by Reijntje, et. al (1992) pointed out that green manure crops can contribute 30-60 kg N per ha annually. The cumulative effects of continued use of green manure are important not only in terms of nitrogen supply but also with regard to concentrating organic matter and other elements such as phosphate and micro-elements which are mobilized in the top soil, making it available for plant growth (Reijntje, et, al 1992). Deep rooted and nitrogen fixing green manure crops in a rotation can help recover nutrients leached to the subsoil and make available nitrate in the soil. Given shortage of land in the study area, such forms of green manuring like alley cropping, relay fallowing, live mulching, shaded green manure could be used to improve soil fertility.

Table 3. Biomass productions of elephant grasses integrated with soil bund

Farmers	Number of bunds constructed	Bundle of grass harvested per year	Frequency of harvesting per year
A	4	288	24
B	3	108	18
C	3	216	18
D	3	216	18

Whereby: 1bundle = 15kg

Initial studies made for the evaluation of seven legume cover crops (*Trifolium*, *Sstylosanthus*, *Croletaria, Mucuna, Tephrosia, Vetch and Canavalia*) on the basis of farmers' selection criteria and this showed that there was a distinct variation between farmers for the adoption of these legumes (Tilahun et al., 2001). According to this study the best-endowed farmer, who owned livestock and had relatively fertile soil, preferred *Stylosanthus* and *Vetch*, because they favored for fast growing legumes that can be used as fodder, while the other farmers, who had fewer resources, put their interest on *Crotalaria* and *Canavalia* which produce biomass quickly and can be used as green manures (Table 4).

The same study also revealed that farmers' criteria for the evaluation on the performance of the legumes was on the basis of seven indicators: the root system, establishment of the crop, biomass production, resistance to drought, decomposition rate of green manures, effect on soil moisture, and fodder value (Table 4).

Table 4. Farmers criteria for selecting legume cover crops

Species	Firm roots	Early soil cover	Biomass	Rate of decomposition	Moisture conservation	Drought resistance	Fodder value
Croletaria	2	6	6	6	2	2	1
Vetch	1	5	5	4	1	1	6
Mucuna	6	4	3	3	6	6	4
Canavalia	5	3	4	1	4	5	2
Tefrosia	3	2	2	2	5	3	3
Stylosanthus	4	1	1	5	3	4	5

Key: 6 is the highest score and 1 the lowest

Source: Tilahun et al., 2001

Table 5. Performance of various multipurpose plant species observed after one year under farmers' management condition in Gununo area.

Plant species	Average plant height (cm)				Biomass yield (kg)		
	Demeke	Mengesha	Birhanu	Belay	Demeke	Mengesha	Birhanu
Sesbania sesban	71.4	109.9	29	*	2.2	2.65	2.0
Calliandra calothyruses	19.3	15.3	10	*	-	-	-
Leaucena diversifolia	14.3	11.68	13.4	*	-	-	-
Gravillae robusta	*	*	44.7	28.3	*	*	*
Avocado	*	*	23.3	28.4	*	*	*

Note:*indicates where not planted.

Conclusion

Participatory planning and prioritization are very helpful stepwise approaches to identify real problems at grassroot level enable identification of practical solutions from different perspectives. As a result of the integration of activities and participatory team approach, the technological solutions forwarded are technically feasible, economically applicable and environmentally sound. Further more, the participation of all stakeholders helps in avoiding conflict of ideas and interests between them. Farmers are very well aware of the causes and consequences of natural resources degradation nevertheless, various socio-economic problems, which need immediate actions, limit their efforts against it. They are rational and conservative in investing their resources like land and labor to new technological interventions. Thus, they are always interested in technological solutions with minimum risk and multipurpose benefits.

It was also learned that prior to introduction of any new soil and water conservation technologies, communities' biophysical and socio economic aspects should be undestood. Since farmers have a range of problems, which should be addressed in the short term, multiple technological options should be provided for selection. In the past, most of the experimental results obtained at plot level would not be an exact representation of the large area. As a result, there was always low distribution of the obtained results to the neighboring farmers and hence low effectiveness of the technologies especially soil and water conservation measures. Therefore scaling up of these experiments to the watershed level is a much better strategy and presents high chances for better technology adoption. With regard to the performance of the multipurpose plant species, most of the species performed well even though, they are damaged by dry spell at initial stage. *Sesbanis sesban* performed better of all the legume shrubs in the area and also it is highly preferred by farmers for its faster growth and drought resistant characteristics. Farmers also preferred Gravillea to avocado for boundary planting because it integrates better with under growing agricultural crops because of its lower shade effect. The latter one is broad leaved with wider canopy hence affect the crops by shading. Therefore as a management option, the appropriate niche for this plant could be planting as live fence, as shade, and on grazing lands. Local banana species was preferred by most farmers than that of the introduced one (Cavendish giant). However, it was also recommended that the new variety should be tested farther at different locations of the farm from homestead to outfield.

Soil bunds with relatively wider spacing, shallow depth and with bund stabilizing elephant grasses was observed to be the most sound soil conservation technique to the area. This is because of the fragmented nature of the land holdings, and no part of the land is allocated for production of supplementary feed for their cattle except some richer farmers who are endowed with larger land holdings bordering catchments and communal grazing areas. Moreover, the above technique has showed yield improvement as compared with previous seasons and non-conserved farms with similar management and slope conditions near by. Both the experimenting and non-experimenting farmers realize this fact, and consequently, they are constructing more bunds out of their own initiative.

References

Belay Tegen, 1992. Erosion: its effect in Gununo area, southern Ethiopia and some techniques of its control. PhD thesis, Bern, Switzerland.

Bertu Nedessa, 1991. Bund stabilization. In: Berhe W and Peter V.D., (Editors). Ethiopian soil conservation news. No. 10, Addis Ababa, Ethiopia.

Eyasu, E. 2002. Farmers' perception of soil fertility change and management. EDM, Addis Ababa.

Gohl, B. 1981. Tropical feeds. FAO animal production and health series no, 12, FAO, Rome, Italy, 189-199.

Hagman, J., Murwira, K. and E. Chuma, 1996. Learning Together: Development and extension of soil conservation in Zimbabwe. ILEIA Newsletter.

ICRAF. 1988. Agroforestry in Dry land Kenya.

ICRAF. 1992. Selection of useful Trees and Shrubs for Kenya.

ILCA (International livestock Centre for Africa). 1989. Annual report for 1985. Addis Ababa, Ethiopia, 50p.

Johan N, 1992. Understanding organic farming. In: spore No. 40, August 1992.

Kahsay Berhe and M.A. Mohamed Saleem, 1996. The potential of Calliandra calothyrsus as fodder tree on the acidic Nitosols of the southern, western, and southwestern highlands of Ethiopia. PP. 234-244. In: D.O. Evans (ed.) International workshop on Genus Calliandra, Forest, Farm, and community tree research reports (special issue). Winrock International, Morrilton, Arkansas, USA.

Tothill J.c., Read, J. and Asres Tsehay, 1990.

Tilahun Amade, Takele Belachew, and Endrias Geta, 2001. Reversing degradation of arable land in the Ethiopian High lands. Managing Africa's soils No. 23: 10-15.

Reijntjes, C,. Haverkort, B. and A. Waters Bayer, 1992. Farming for the future. An introduction to low-External-Input and sustainable agriculture. London: Macmillan press.

Differentiated Criteria for Participatory Selection of Improved Technologies: Experience from AHI Areka Site

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Abstract

Participatory evaluation of improved technologies was undertaken with farmers in Gununu at Areka benchmark site. There were various categories of technology evaluation schemes, which included crop varieties and farm implements. In these experiments, different varieties of wheat, haricot bean, tef, maize, irish potato, sweet potato and three improved oxen and donkey driven farm implements were tested and evaluated. The experiments were conducted with 19 farmers between 2000 and 2001 based on their interests of the technology. A number of neighboring farmers were also involved in the evaluation process. Evaluation of varieties was made at different growth stages of the crops, time of cultivation and use of the farm implements. Farmers had different criteria of selecting the technologies. Using their criteria, they selected best varieties of Tef (Dz-01- 196, Dz-01-358 and Dz- Cr- 37), maize (CG4141 and BH 660), bread wheat (Tusie, Abola and Kubsa), bean (EMP-252 and ARA - 8) and Irish potato (Tolcha and Wechecha). No sweet potato variety outshined the local 'Gadisa' variety. The selection criteria of the farmers were market quality, associated with color (beans and tef) stover, and yield (wheat), disease resistance (potato) and yield (all). The effect of varieties on the subsequent crop early maturity and demand for inorganic fertilizers were also important criteria of selection. Similarly, none of the farm implements fitted the local farming practices because of the different weight of the implements to be pulled by the oxen.

Introduction

During the PRA of 1997, which was conducted in the Gununo village, Areka, Southern Ethiopia, farmers identified different problems (most of the problems were not specific to certain social groups) out of which lack of improved crop varieties and suitable improved farm implements were among the major system constraints. With this background information, research questions were developed with farmers to test and evaluate the available technologies of improved crop varieties and improved farm implements.

The village is situated at an altitude of 2100 meters above sea level and is characterized by very high population (>400 persons per km^2) that resulted in very small land holdings. Main crops grown include enset (*Enset ventricosum),* coffee, tef, wheat, maize, sweat potato, Irish potato, haricot bean, barley, vegetables (like cabbage, cucumber) and fruit trees like avocado and mango. Enset, coffee and vegetables are grown around homesteads while the rest are grown on the main farm fields. Those homestead grown crops face relatively favourable soil environment with relatively better fertility status and hence their productivity is reasonably high, even without the use of chemical fertilizers. The soil is nitosol type on which local plow called '*maresha*' is used to plow with a pair of oxen.

Lack of appropriate technologies for poor farmers is among the constraints identified to be responsible for the low production and productivity. In response of these challenges, research institutions developed various numbers of varieties and agronomic recommendations year after year but unfortunately with poor rates of diffusion beyond the pilot sites. This may be because of the existing knowledge gap between the research findings and / or recommendations and the actual socio-economic situation of the rural poor. Hence, the poor farmers remained with cultural practices and landraces that have existed for millennia. It is not surprising when low-income poor farmers adopted technologies with low inputs but with minimum risk while there are technologies that are with high input and high return under favorable conditions, which could cause high risk during stress conditions. In general, the technologies usually claimed to be available and shelved are usually lame and often appear to have marginal advantages at best over farmers' own practices (Woldeyesus and Chilot, 2002). Technologies that have been developed in researcher-managed conditions based on the interest of researcher have to be evaluated whether they fit to the farming system or not as these technologies may or may not suffice the complex interest of the farming system. Participatory testing of already developed technologies can give lessons for the future to develop system compatible technologies.

Therefore, the objectives of this project were:

- To test and evaluate crop varieties and farm implements with farmers
- To document important criteria to be considered for further research work when individual technologies are developed

Methodology

All on-farm trials were conducted between 2000 and 2002 main growing seasons. Improved varieties of five tef and maize, four wheat and haricot bean, three sweet potato and two Irish potato were tested with the available local land races. Three farm implements were tested with local plow. Maize, haricot bean and sweet potato were grown during '*belg (February to June)*'; tef and wheat during '*meher (June to September)'* and Irish potato during both *belg* and *Meher* seasons. Seed rate / plant population density and fertilizer rate were used based on the research recommendation for each crop type and planting date was adjusted to farmers' practice. The plot of 5m x5m to 10m x 10m was used for each variety depending upon the household's land holding and decision making. Except tef, which was sown by broadcasting, all the rest crop types were sown / planted on rows either through drilling or recommended spacing for the crop type. Farm implements were tested by comparing their efficiency, effective width and depth on plot size of 5m x 20m and their effect on the test crop (tef).

Farmers were involved through out the whole process of experimentation and at the end of the season they evaluated each technology in group and/ or individually. Farmers' preference criteria for each technology were recorded besides the economic yield data. Evaluation of farm implements was also conducted with farmers and selection criteria were recorded and evaluated accordingly. To confirm the farmers' criteria, time used to plow the plot, depth and width of plow at different plowing operations were recorded. The yield of test crop was measured from the mentioned plot size. Finally the data were organized and analysed using descriptive statistics while farmers' preference was put in rankings / ratings with the preference criteria to compare with the collected yield data.

Results and Discussion

In all the trials carried out, yield was not the determinant factor for crop variety selection. Besides yield, farmers considered other parameters like color and field performance (tef), grain color and uniformity (wheat), seed filling on seed line, stalk length, stalk strength and earliness (maize), seed color and size (haricot bean), root flesh color, easiness for cooking, insect pest resistance (sweet potato) and color of tuber flesh, easiness for cooking and disease resistance (Irish potato) were considered by farmers as selection criteria.

Accordingly, farmers selected three varieties of tef (Dz-01-358, Dz-01-196 and Dz-Cr-37) focusing mainly on the grain color. For tef, being white in color is very important criteria to get a return that pays off better in the local market. The selected varieties gave lower yield than Dz-01-974 but because of the above mentioned criterion farmers ranked it the least rank (Table 1). Moreover, farmers complained that none of the varieties were resistant to lodging, which causes maximum tef yield loss.

The grain yield variation became high when the plot-based yield was extrapolated to a hectare. The result of farmers' selection would have been different if the crop had been grown in wider experimental plots that could show the variable soil quality and productivity of the respective farms. The tested bread wheat varieties were more or less with similar grain color and size, except 'megal', which is not as attractive as others in color. As a result the farmers' preference relied mostly on grain yield (Table 2).

Table 1. Average grain yield (qt/ha) and farmers' rank of tef varieties grown in the year 2000 and 2001 growing season at different farmers' field. (1 is the best and 5 is the least preferred by farmers)

Variety	Year 2000	Year 2001	Average yield	Rank*
Dz-01-196	5.85	7.2	6.8	1
Dz-01-358	6.95	8.0	7.7	1
Dz-01-354	4.25	7.3	6.3	4
Dz-Cr-37	3.65	6.9	5.8	2
Dz-01-974	3.00	10.53	8.0	3
Local	-	5.63	6.1	5
Average	4.47	7.6	6.0	

* Farmers ranked varieties by considering seed color, field performance and grain yield.

Table 2. Average grain yield (qt/ha) and farmers' rank for wheat varieties grown in the year 2000 and 2001 growing season at different farmers' field. (1 is the best and 5 is the least preferred by farmers)

Variety	Year 2000	Year 2001	Av. yield	Rank*
Abola	14.3	14.8	14.6	1
Tusie	9.8	15.0	12.7	4
Wabe	13.4	13.5	13.1	3
Kubsa	14.7	13.5	14.0	2
Megal	13.2	13.02	13.1	5
Av.	13.08	13.6	13.34	

The crop's local market price variation is not only governed by variety difference as tef, and the major selection criterion was grain yield. All tested wheat varieties fulfilled farmers selection criteria including the baking quality and taste when roasted. In the case of maize, the criteria mentioned (Table 3) were more important than grain yield. The variety 'Katumani' was selected least because of its early maturity characteristic and hence highly exposed to attacks of different rodent pests. On the other hand, selection of haricot bean varieties was based on the grain yield (Table 4). The result from haricot bean trial targeting on yield because haricot bean is consumed by roasting solely (hence any colored bean can be used) or it can be roasted mixing with maize. For the latter, the red colored and better yielding varieties were important than '*red welaita'* as it changes the color of the component maize to red. Thus, varietal development objectives need especial attention in choosing red coloured ones for local consumption.

Table 3. Average grain yield (qt/ha) and farmers' rank to select maize varieties grown in the year 2001 growing season at different farmers field. (1 is the best and 5 is the least preferred by farmers)

Variety	Average yield	Rank*
A511	17.0	5
CG4141	20.6	1
BH660	13.6	2
BH140	20.8	3
Katumani	13.2	6
Local	15.3	4
Average	16.75	

In all the parameters mentioned for Irish potato, farmers preferred those improved varieties than the local land race. The problem associated with the local crop varieties is the potato late blight that can totally devastate the potato crop. Farmers were satisfied with those *tolcha* and *wechecha* varieties from the reaserch centres for their resistance ability to this disease. Similar experiments conducted at west and north *Shewa* parts of Ethiopia confirmed this. From the four tested varieties in this area these two varieties showed lowest disease score than the other varieties (Gebremedihin et al. 1999).

Table 4. Average grain yield (qt/ha) and farmers' rank to select haricot bean varieties grown in the year 2000 growing season at different farmers field.

Variety	Average yield	Rank*
Roba -1	5	4
ARA-8	5.6	2
A-788	4.8	3
EMP 252	6.5	1
Red wollaita	1.0	5

Table 5. Total tuber yield (tones/ha) of different varieties of Irish potato grown at different farmers field in 2000.

Variety	Growing season		Average
	Belg*	Meher*	
Tolcha	13.14	11.27	12.20
Wechecha	12.76	11.57	12.17
Local	4.19	7.25	5.72
Average	10.03	10.03	10.03

In the case of sweat potato, tuber size and yield were important parameters for the selection of varieties. All farmers rejected early maturing maize and sweet potato varieties (Table 7). Since the area is characterized by double season rainfall patterns, selecting for early maturing varieties was considered as underutilization of the land resources and rainfall for their low crop yield. For example, farmers plant and harvest the local better yielding sweet potatao variety 'G*adisa'* for two main growing seasons in a year (from Oct-December and Feb-May). Any new variety which comes to this system is expected to beat the local variety in terms of yield and test. The other drawbacks mentioned for the early maturing sweat potato types were erect leaf structure (do not shade soil), low above ground biomass (serves as feed source for livestock and source as planting material) and poor vine establishment when planted. The importance of sweet potato in the farming system of Wollaita is very important as a security crop. Besides its food value, farmers use it for fattening oxen and cows and regularly feed the above ground part to their livestock during dry seasons. Sweat potato vine is also an important and highly valued resource as a planting material, particularly its availability to plant sweet potato at the first shower following dry season.

When yield is considered as a major criterion, yield variation among farms is far greater than differences among varieties thanks to the variability in soil fertility status among farms and systems. Commonly, farmers with relatively small land holdings have got poorer yields than those with relatively wider land holdings (personal observation). Resource poor farmers plow the land repeatedly with out addition of external inputs (like chemical fertilizers).

Farmers were not attracted by the tested farm implements due to its heavy weight to be pulled buy local oxen. Furrow depth and width of this plow increased from first plow to third plow operations. Since the soil type is nitosol and the feed shortage is critical, it is difficult to use this plow that demands more energy. The donkey driven plow needs more time than the local plow but also the tradition of using donkeys for plowing is uncommon. Besides these, donkeys didn't pull straight and in the desired direction, which may lead to facilitation of soil erosion. The most efficient of all the tested plow types is the small moldboard plow. It turned down weeds and grasses and it also contributed to soil moisture retention and soil conservation. The only draw back for this plow was the initial design to be drawn by single ox. Maximum grain yield was obtained from the plots plowed by the large moldboard plow (with greatest depth) while the least was from the donkey driven plow (with the least depth) (Table 7). This could be due to moisture retained by plowing deep into the soil.

Table 6. Farmers rating under different criteria and tuber yield (tones/ha) of sweet potato varieties grown during 2001 growing season. (1 is the best and 4 is the least preferred).

Preference criteria	Varieties			
	Kudade	Dubo	Feleha	Local
Market demand	1	4	3	1
Tuber size	1	4	3	2
Powder ness when cooked	1	2	2	2
Easiness for cooking	1	1	4	3
Color attraction	4	3	1	2
Ground cover	1	1	1	1
Early maturity	3	3	2	1
Insect pest tolerance	4	2	1	2
Total score	16	19	17	13
Rank	2	4	3	1
Yield average	11.1	9.1	9.6	

Table 7. Time efficiency (min/plot), t, depth (cm), d, and width (cm), w, of different plows under three plowing operations carried out during 2000 and 2001 growing season.

Plowing operation	Farm implements											
	SMBP			LMBP			DDP			Local		
	t	d	w	t	d	w	t	d	w	t	d	w
First	15.00	16.23	24.53	18.00	14.86	27.60	21.0	13.17	23.90	13.33	14.86	25.10
Second	17.00	15.70	24.20	17.67	17.73	28.73	19.67	13.50	24.17	19.33	18.00	18.00
Third	17.33	16.43	23.60	19.67	20.73	30.13	22.56	16.67	22.56	22.56	16.63	26.10
Average yield	10.42			10.70			9.12			10.25		

References

Bulcha Woyesa, Adugna Wakijira and Agajie Tesfaye, 2001. On farm variety evaluation of linseed noug at Meta Robi wereda, west shewa zone.In: Gemechu K., Yohannes G. Kiflu B. Holleta Research Centre. Ethiopia.

Chiliot Y. and D. Asgelil, 2001. Towards Participatory Research: Attempts and achievements In The Central Highlands of Ethiopia. Addis Ababa, Ethiopia.

Gebremedhin W., Endale G., Bekele K. and S. Atsede, 2001. On farm evaluation of potato varieties in west and north west Shewa zone. In: Gemechu K., Yohannes G. Kiflu B., Chiliot Y. and Asgelil D. 2001. Towards Participatory Research: Attempts and achievements In: The Central Highlands of Ethiopia. Addis Ababa, Ethiopia.

Gemechu K. Mussa J., Belay A. and K. Maaza, 2002. On farm evaluation of faba bean and field pea varieties around Holleta. In: Gemechu K., Yohannes G. Kiflu B., Chiliot Y. and Asgelil D. 2001. Towards Participatory Research: Attempts and achievements In The Central Highlands of Ethiopia. Addis Ababa, Ethiopia.

Getachew A., Berhanu L. and G. Kassu, 2001. On farm evaluation of bread wheat varieties at Ginchi watershed site. Gemechu K., Yohannes G. Kiflu B., Chiliot Y. and Asgelil D. 2001. Towards Participatory Research: Attempts and achievements In The Central Highlands of Ethiopia. Addis Ababa, Ethiopia.

Woldeyesus S. and Y. Chilot, 2002. Participatory client orientation of research in low input cropping systems of Ethiopia.

Approaches and Findings of AHI Phase 1 and 2 on Participatory Research at Galessa Benchmark Site

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Abstract

The African Highlands Initiative (AHI) launched an agricultural research based development program in the densely populated and degraded highlands of Eastern and central African countries. The program passed through two consecutive phases and is now in its planned third phase. The program operates in Ethiopia at two watershed sites, namely Ginchi / Galessa and Areka. In its first phase, the program dealt with the diagnosis of key issues and characterization of the site including soil and water conservation issues, and integrated pest management activities. The early evaluations of the program in the first phase indicated that the top down approach was used to implement the planned activities and consequently did not result in the expected results and long term integration of introduced technologies. Learning from its past experiences AHI initiated participatory integrated watershed management (PIWM), broadening its approach to include the political and social aspects of the site's environmental concerns. It is hoped that this approach will continue to promote the improvement of livelihoods of the community in the watershed sites and lead to scaling up of INRM to a broader audience. This paper therefore, attempts to review the past experiences of AHI in terms of the contributions of different approaches used in the implementation process; limitations in the Galessa watershed and try to anticipate possibilities in the planned phase III.

Introduction

The Ginchi benchmark site was selected as a watershed site due to the high human population density, high numbers of livestock, poor and declining soil productivity, the presence of different stakeholders and its representative ness of other highland areas. The AHI program has operated in the site since 1995 in three consecutive phases.

Phase One

In phase I a research approach that focussed on identify problems in the site was used where the focus was on the diagnosis and characterization of the site. Researchers and extension agents were trained on Participatory Rural Appraisal (PRA) techniques. The technique focussed on methods and approaches that enable local people to examine, expand, analyze and share their own knowledge of their own lives, conditions, needs and problems. A Survey was conducted at Galessa Kota Gishir and Galessa Koftu which is the adjacent farmers association over a period of 10 days by a team of researchers and extension agents (Kindu et-al 1997). Interviews, focused group discussions; transectoral walk, observation, pie chart and matrix ranking PRA tools were used for the survey work to identify problems. Constraints were prioritised using matrix-ranking techniques. An analysis of soil samples were to determine their physical and chemical characteristics was conducted at Holetta Research Centre soil laboratory. The researchers, extension agents, and representatives of the *wereda* health canter; Ministry of Education and local policy makers discussed the results of the survey, with the facilitation of trained moderators.

Identified and Prioritized Problems and Suggested Solutions in Various Sectors were as follows:

- Shortage of water for both livestock and human use
- Grazing land / feed shortage

- Population growth
- Food shortage

Suggested possible solution included:

- Call to the attention of concerned stakeholders to deal with water resource development and food shortage
- Family planning and education to address the human population growth
- Intensive farming systems to solve the problems of food shortage, feed shortage and problems related to grazing.

Methodology

OBSERVATIONS ON THE APPROACHES OF THE FIRST PHASE

AHI research domain organized around three sets of thematic technical agendas in the first phase: (i) integrated pest management (IPM), (ii) improvement of soil productivity, and (iii) characterization and diagnosis of the benchmark site. The most pressing problem of the community, was the shortage of water for both livestock and humans was not effieciently addressed by researchers. The reason for this was lack of involvement of the communities in the discussions held by the group of researchers, extension agents and the *woreda* administration during problem identification prioritization and plan for the future. Hence, early evaluation of the program indicated that the approach was top-down and fell short of achieving the expected integration, systems approach, or partnerships. Consequently, the regional task force recommended the appointment of National and site coordinators and the adoption of a benchmark "integrated research team" approach in the plan for phase two.

APPROACHES/METHODOLOGY IN PHASE TWO

Phase 2 followed participatory approaches to test and demonstrate improved integration of inputs required that addressed NRM issues. AHI teams comprising principally of National Agricultural Research Institute (NARI) scientists were designated to work in the site. Unlike phase I, the approach entailed bottom-up problem identification, priority setting, planning and resource allocation, and use of several participatory methods. Introduction and testing of useful "on-the-shelf" technology options easily adopted by farmers were used as entry points.

DEVELOPMENTS IN RESEARCH PROPOSALS

The site team researchers developed a series of research protocols to undertake integrated research at Ginchi / Galessa following the phase one recommendations. The research protocols were developed to address site level constraints in the area of Agro forestry, Food crops, Soil fertility and conservation, improving the fallow system through forage crops development and assessment of the status of livestock production.

Agro forestry

Phase II studied indigenous agroforestry practices and performance evaluations of trees and shrubs for agroforestry purposes under farmer's management practices. Discussions in this area included the following topics: indigenous agroforestry practices, adaptation potential, characterization of major tree species, prioritization of major constraints related to tree planting and suggestions for possible research interventions. (AHI ginchi site summary report, 2001/2002).

Food crops

Evaluation of released & elite food barley varieties and informal potato seed production took place in order to verify the performance of these varieties through participation of farmers and to identify high quality varieties. The evaluation aimed to improve production and provision of relatively clean and healthy potato seed tubers and demonstrate the use of diffused light store (AHI ginchi site summary report 2001/2002).

Soil fertility and conservation

Other area of studies that address soil fertility and conservation were: assessing the value of compost as alternative fertilizer, and the impact of biomass transfer in live-fence leguminous shrubs on soil fertility. This included the impact of the contribution of native rhizobia for their N-fixation and yields of introduced legume crops. Various soil conservation activities were conducted to evaluate the effectiveness of temporary structures and MPTs for gully stabilization (Worku Atlabatchew and Asgelil Dibabe, 2002) and ground water yield.

Forage crops

A proposed study on fallow improvement practices in Gallessa area in conjunction with forage development aimed to identify productive forage legumes that could be integrated into fallowing stages. An assessment of the effect of forage crops on the productivity of the subsequent barley crop was also included. (AHI Ginchi site summary report 2001/2002).

Results

MAJOR FINDINGS IN PHASE II

Resource assessment surveys were conducted for the site and the information generated was compiled.
More than 10 multipurpose tree and shrub species were introduced and evaluated for their adaptation and growth around homesteads and open fields. As a result, two exotic and one local tree species were found to be promising for wider utilization. The need for further experimentation and dissemination of indigenous trees and shrubs in the area was also considered. Among 5 improved barley varieties introduced to the site and evaluated on different farmers' fields for two years, DIMTU, ARDU 12-60B and HB42 are found to be promising for further dissemination. Five released varieties of potatoes were introduced and evaluated on four farmers' fields. (AHI Ginchi site summary report 2001/2002, Kindu Mekonnen) Varieties Menagesh, Wechecha and Genet performed better and provided an average yield of 27, 18 and 16 t ha^{-1}, respectively, over two seasons. Informal potato seed production scheme was exercised on two farmers' fields. As a result it was possible to produce good quality potato seed with a mean yield of 20.1 t ha^{-1} (Getnet Assefa *etal*., 2002) and 40.8 t ha^{-1} (Menagesha). (Bekele Kassa, 2002).

The fallow land improvement practices showed low herbage dry matter productivity of grazing areas: normally waterlogged, communal grazing land, forest margin and short arable fallow lands. Fifty forage accessions and species (Oats, Medics, Clovers, Hairy vetch, Common vetch, Narbon vetch) were introduced and evaluated for their adaptation and forage production for three seasons. From the forage trial it was possible to identify better performance with high biomass production potential of Oats (1693, D-27 and A-20) and Hairy vetch (2438, 2437, and 2465) accessions. Oats and Hairy vetch produced 17.3 and 7.1 t ha^{-1} on dry matter bases, respectively (Getnet Assefa *etal*., 2002). Late blight was found to be the main disease in potato, which contributed to form about 25 % to 100% yield loss. Combined use of compost and inorganic fertilizer was found to be advisable for potato production from the experiment conducted on five farmer's fields (Bekele Kassa *etal*., 2002).

The results of the designed experiments and findings were demonstrated to the farmers (households) through field days, trainings and visits in which more than 530 farmers and experts participated to evaluate on-farm research activities. Similarly, more than 50 experts and researchers participated in trainings, workshops and visits both inside and outside the country that have been organized by the project. (AHI Ginchi site summary report 2001/2002)

Phase III

Phase 3 focuses on developing, testing and institutionalizing participatory integrated natural resource management (INRM) approaches and methods relevant to solving production, land degradation and associated natural resource management issues. Intensification of the INRM work in watershed sites, scaling up of INRM approaches to wider levels of application; pursuing institutional change in favour of INRM and enhancing networking among INRM practitioners are some of the focal areas in this phase (AHI phase III document).

POSSIBLE EXPECTATIONS IN IMPLEMENTATIONS OF PHASE III

Taking into account its past experiences during the first two phases, AHI is trying to build upon what has been learned and accomplished in the past. The problem identification involved participation of all categories of the community (wealth age gender and social capitals) and also has taken into account the influence of markets on technology adoption. The major focus of the third phase is to bring more integration and collective action leading to local action, innovation and sustainability in the INRM by employing an integrated, systems approach.

Problems were identified and prioritised with full participation of the community. Feed back meetings were made to the community. Entry point was identified based on the needs expressed by the community: Spring water development for humans and livestock was one of the most important needs. The community members have committed themselves to implementing the proposed water issue in all aspects (money contribution, labour supply, and material inputs). This is the indication of expected future integrations to come as a result of proper problem identification, prioritisation and implementation processes.

In phase III the following outcomes will be expected:

- More integration in favour of INRM
- Research and development support for improved watershed management
- Enhanced capacity of researcher and research institution to promote and use INRM approaches
- Integration of technical, economic, policy, and institutional and social dimensions

OVERALL OBSERVATIONS OF THE APPROACHES IN PHASE ONE AND TWO IN THE AHI PROGRAM AT GINCHI / GALESSA BENCHMARK SITE:

Farmers' participation

Even though the phase II approach has made substantial progress in dealing with some production and conservation constraints, the participation of farmers or community in planning discussion did not make the impact expected. However, representative groups of farmers, both male and female household heads and key informants were interviewed to collect the required information on the livestock status in the area. Farmers also participated in compost application on potato field and biomass transfer. However, the system did not initiate other farmers to participate and benefit at large from the improved technology.

The role of social capitals and their participations

Social organizations (*idr, senbete, iqub*) may have a considerable influence to change the social relationships of any community, since they have local regulations and bylaws that may influence the community. Theses categories of social institutions could be used to mobilize the community to development actions. Participations in field days and trainings conducted to transfer knowledge and findings obtained from phase II exercise however were limited to the head of the households, regardless of their entity to influence the social capitals.

Participation of wealth group/category

Respondents identified and categorized farmers into rich, middle and poor. Size of cultivable land and livestock number were used as indicators of wealth group (AHI Ginchi site summary report 2001/2002). Farmers' participation in the implementation of different development activities was influenced by their wealth status which influenced the common goals. Basically, to bring integration for a common development action, from which the community will be benefited at large, there has to be a common understandings and commitment to implementation. The initial planning of the PRA and discussion of the results did not take in to account the role that the wealth category could play in the integration of development activities.

Gender sensitivity

Male and Female members of any community have an important role in a community development activities. From the general report on Galessa and *Garee arera*, it can be deduced that the role of males and females were divided according to agricultural and non-agricultural activities in the community. Men were responsible for major agricultural operations such as land preparation, planting, weeding, harvesting, threshing and looking for animal feed. Men had also authority over most of decision making such as income disposal, marketing of major agricultural products and resource management. (AHI report). The poorest female members of the rural community had limited options for income generation other than gathering firewood for sales.

Market situation

Local markets are a driving force for technology adoption. At Galessa despite the introduction of many barley variables, farmers showed more interest in potato growing than barley after the introduction of the new verities. This might be due to the fact that potato is a widely grown food crop in Galessa area and introduction of new potato varieties in the near by villages have already marked the area as a potential potato seed source and created market opportunity for the potato seeds in the area. information regarding market situation in integrated Natural resource management became an important component.

Conclusions

The identified issues in the first phase and research activities planned to be implemented in Ginchi / Galessa watershed area can definitely have substantial contributions for possible solutions to some of the problems identified in the area and could ultimately reduce food shortage and increase soil conservation. However, it seems that there were some limitations that have contributed to the failure to bring the expected integration. Supply of drinking water for human and livestock was the highest prioritised problem in the area even during the first phase of the project implementation. Unless such felt need of the community is resolved, they may not be motivated to deal with other complex knowledge intensive issues that can have a long-term impact. To alleviate such problems that are beyond the mandate of research, policy makers should take the lead to suggest the solutions, since the team comprised of researchers, extension agents, and representatives of the *Wereda* Health Center, Ministry of Education and policy makers. The phase III problem identification, prioritization and planning were adequately participatory and involved different categories of the community. They have committed themselves in cost sharing for watering point development activity; which as the initial entry point of the future activities in watershed management. Hence, the out come of the phase III is expected to bring optimum integration in Galessa watershed management in favor of INRM.

References

AHI, 2001. Ginchi benchmark site activity summery for year 2001 and Ginchi, Galessa benchmark site 2001/2002 Report .

Kindu Mekonnen, 2003. African Highlands Initiative Ginchi/Galessa benchmark site phase 3 (2003) annual report, AHI, Kampala.

Agajie Tesfaye, Chilot Yirga, Kiflu Bedane, Worku Atlabachew,Rezene Fessehaie and Alemayehu Refera ,2002.Farming practices and constraint analysis of Vertisol areas:The case of Ginchi Watershed site In Gemechu Keneni, Yohannes Gojjam, Kiflu Bedane, Chilot Yirga and Asgelil Dibabe (eds.).Towards Farmers' Participatory Research: Attempts and achievements in the Central Highlands of Ethiopia. Proceedings of Client-Oriented Research Evaluation Workshop, 16-18 October 2001, Holetta Agricultural Research Center, Holetta, Ethiopia. Pp 124 –146

Bekele Kassa, Gebiremedhin W/Giorgis, Fasika Kelemework, Awel Mela, O.M Olanya, P.T, Ewell, R.El-Bedewy and O.Orteza, 2002**.** Integrated potato late blight management: Experience of farmer field school (FFS) in Dendi District.

Keneni, Yohannes Gojjam, Kiflu Bedane, Chilot Yirga and Asgelil Dibabe (eds.), 2001. Towards Farmers' Participatory Research: Attempts and achievements in the Central Highlands of Ethiopia. Proceedings of Client-Oriented Research Evaluation Workshop**,** 16-18 October 2001, Holetta Agricultural Research Center, Holetta, Ethiopia. Pp 68-77

Getnet Assefa, Abreham Gebeyehu, Fekede Feyissa and Tadesse Tekletsadik, 2002. On-farm performance of forage crops and assessment of natural pasture Productivity in West Shewa Zone. In Gemechu Keneni, Yohannes Gojjam, Kiflu Bedane, Chilot Yirga and Asgelil Dibabe (eds.). 2002. Towards Farmers' Participatory Research: Attempts and achievements in the Central Highlands of Ethiopia. Proceedings of Client-Oriented Research Evaluation Workshop, 16-18 October 2001, Holetta Agricultural Research Center, Holetta, Ethiopia. Pp 246 – 265

Kindu Mekonnen, Bekele Kassa and Hailu Beyene, 2002. Experiences of participatory research on natural resources management at Galessa. In Gemechu Keneni, Yohannes Gojjam, Kiflu Bedane, Chilot Yirga and Asgelil Dibabe (eds.). Towards Farmers' Participatory Research: Attempts and achievements in the Central Highlands of Ethiopia. Proceedings of Client-Oriented Research Evaluation Workshop, 16-18 October 2001, Holetta Agricultural Research Center, Holetta, Ethiopia. Pp 44 – 54

Kindu Mekonnen, Hailu Beyene, Alemu Tadesse (eds.), 1997. AHI report 1997. Natural resources management at Galessa Kota Gisher and Garie Arera peasant associations, Dendi Wereda, Western Shewa, Ethiopia. Institute of Agricultural Research P.O. Box 2003 Addis Abeba Ethiopia

Worku Atlabatchew and Asgelil Dibabe, 2002. Participatory gully stabilization with temporary structures and grasses at Ginchi Watershed site. In: Gemechu Keneni, Yohannes Gojjam, Kiflu Bedane, Chilot Yirga and Asgelil Dibabe (eds.). 2002. Towards Farmers' Participatory Research: Attempts and achievements in the Central Highlands of Ethiopia. Proceedings of Client-Oriented Research Evaluation Workshop, 16-18 October 2001, Holetta Agricultural Research Center, Holetta, Ethiopia. Pp 316 –324.

Evaluation of a Farm-Level Decision Support Tool for Trade Off and Scenario Analysis for Addressing Food Security , Income Generation and NRM

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Abstract

Resource-poor farmers face difficult decisions over the use of scarce nutrient sources in crop-livestock production systems. A better understanding of the comparative values and trade-offs in the use of land, labour, manures and other locally available resources is required in order to increase the production and efficiency of mixed crop-livestock systems. While efforts are required to expand our knowledge of the biophysical aspects of alternative uses of organic nutrient sources, similar efforts are also required on the socio-economic driving forces behind farmers' decision making. The approach uses trade-off analysis, partial budgeting and multiple goal linear programming to identify management options to address farmers production criteria and overcome their constraints. This evaluation includes both the short and longer-term economic and environmental benefits. From the social and economic viewpoint, organic resources can be identified that could substitute for mineral fertilizers in areas where fertilizers are not affordable. From an environmental aspect, management practices could be identified that results in fewer nutrient losses and could rebuild or maintain the soil resource base. A multi-stakeholder coalition has been working in Ethiopia, Tanzania, Zimbabwe and Uganda and has successfully developed a decision support tool (DST) to explore these different trade-offs and scenarios based on smallholder farmers existing practices and opportunities. This project used case studies from AHI benchmark sites in Lushoto, Tanzania and Areka, Ethiopia to discuss the potential of the DST for improving farmers and development partners decision making to achieve food security, increase farm income, increase returns to land and labour and maintaining sustainable production.

INRM As a Way Forward to Food Security and Poverty Alleviation: The Case of Kwaliei Village, Lushoto, Tanzania

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Abstract

Research was conducted with farmers to devise strategies to reverse degradation of natural resources in order to improve livelihood by integrating a menu of technological options.in the at Kwalei village in Lushoto district located in the West Usambara Mountains, Tanzania. The village is mountainous with high altitude (1200 to 1600 m.a.s.l), having steep slopes (33% to 62%) with accelerated soil erosion, high rainfall (from 800 to 1200 mm per annum), and low soil productivity, Integrated options provided to farmers for adaptive testing included: erosion control measures such Fanya juu, bench terraces and trash lines; multipurpose trees (MPTs) for fuel-wood, fodder and stabilisation of the conservation structures and high yielding and diseases tolerant varieties of tomatoes, cabbage, beans and bananas. A participatory approach was used for all stages of the work. Options chosen by farmers were addressing problems identified by farmers, farmer research groups were facilitated by researchers on a thematic interest basis; groups were trained on the principles and application of the technologies and experimentation methods .For example, soil conservation training was through paraprofessionals involving 24-village technician known as the "Soil Conservation Farmers Group". Small farmer interest groups working together included "MOTO MOTO" (fire, roughly meaning ultra active), "NGUVU KAZI" (manpower), and "UMOJA NI NGUVU" (unity is strength). Local trainings were enriched by study tours, exchange, farmers' days and traditional dances. Results paid off and after four seasons: paraprofessional fields' increased from 24 to 98 farmers; 6958m of infiltration ditches (Fanya juu) and 9515m bench terraces were constructed; about 280m diversion channel was excavated; approximately 5800 multipurpose trees were planted. Farmers applied farmyard manure at different rates to bench terraces and some farmers started to use compost. Farmers who conserved their land had a 3-5 fold yield mostly attributed to improved water management and some farmers had crops from poor fertility areas that were normally uncultivated. Milk yields increased from 1 to 2.5 liters per day because of increased fodder. An informal survey revealed improved livelihoods: 150 farmers were able to purchase new bicycles, 11 bought mobile phones, 80 bought diary cows, 100 built houses with corrugated iron-sheet roofs, and the food secure period increased from 3 to 9 months per year. There were three major conclusions. (i) Participatory INRM approach addresses farmers priority needs related to poverty and food security, hence there is a better chance for adoption. (ii) Empowered and capacitated farmers were able to choose among the technical options of their making, for example, many took up Tengeru 1997 maize variety but realized after conservation that yields paid off substantially. (iii) Farmers tend to take the most financially beneficial option before considering investments in NRM. These lessons are useful in scaling up the INRM approach and technical options.

Impact of Policy and Technology Interventions on Nutrient Depletion, Poverty, and Food Security in the Machakos Agricultural System: An Application of Nutrient Monitoring and Tradeoff Analysis Tools

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Abstract

Developed as a decision support tool for natural resource managers, TOA offers exciting prospects for studying agricultural ecosystems within the fledgling paradigm of integrated natural resource management (INRM). TOA systematically incorporates biophysical data – hence spatial variability – in economic analysis. The point of departure is the characterization of an agricultural system in terms of key activities, indicators and scenarios. A hallmark of the methodology is its quantification of tradeoff relationships between key economic (short-term) and environmental (long-term, sustainability) indicators of the agricultural system, simulated under different scenarios of the economic environment. The statistical nature of the methodology enables scaling-up of farm level results to policy-relevant scales such as the watershed or farming region, accentuated by its incorporation of spatial heterogeneity into economic analysis, while the simulation modeling affords a needed robustness granted the dynamic economic environment typically characterizing agricultural systems. Having been successfully applied to smallholder farming systems in South America (Peru, Ecuador), the present application to Machakos is meant to parameterize the model to smallholder farming systems in East Africa. Machakos is arguably an integral part of the African Highlands Initiative (AHI), by virtue of its hilly nature and the proneness of the environment to soil erosion. The problem for the Machakos application is soil degradation and long-run nutrient depletion emanating from short-term agricultural livelihood activities, a problem that has been highlighted for many parts of Africa. The ultimate objective is to demonstrate the general utility of TOA in studying natural resource management in smallholder farming systems in East Africa – through a workshop – thus exciting a demand for technical backstopping from various stakeholders. For completeness, TOA is applicable to other problem areas related to agricultural systems, including watershed management, agricultural pesticides and human health, and urban agriculture problems.

Prospects for Intensifying Dairy Systems on Smallholder Farms in Western Kenya: A Case Study of Emuhaya Division, Vihiga District

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Abstract

Availability of land has remained the major obstacle limiting dairy production at smallholder farm level in Western Kenya. Smallholder dairy farmers, therefore generally intensify their farming systems by integrating dairy with crop production and shifting from free grazing to semi-zero- or zero grazing. The intensification of smallholder dairying has underpinned changes in the farming systems to sustain more intensive land use and support more people per unit area of land in smallholder households. However, the concern is whether the smallholders will continue to benefit from dairying through continued intensification when facing the pressures of continuously shrinking land holdings, worsening soil fertility and reduced access to formerly public delivered livestock input and output services, while imported nutrients remain relatively low and non agricultural job opportunities remain lacking. The objectives of the study reported were therefore 1) to improve the feed availability to the dairy sub-enterprise on smallholder farms through the development of integrated and sustainable feeding systems based on Napier grass and forage legumes, 2) to evaluate cattle disease control and management strategies using indigenous technical knowledge (ITK) and 3) to produce high quality manure for improving soil fertility and hence crop and fodder production. Results indicated higher output/input ratio (or benefit/cost ratio), higher total farm milk production, higher milk yield per cow per day, improved soil fertility, leading to improved crop production, total dry matter yield and quality fodder among the test farmers compared to the control farmers. It is concluded that feeding, animal health and soil fertility improvement interventions to support continued intensification of smallholder dairying must be within the context of the household's economy. Prospects for intensifying dairy systems on smallholder farms must therefore concurrently involve both technical and institutional innovations that may encourage greater complementarities and stratification in the dairy sub-sector.

Multiple Models to Enhance Farmer Innovation in Sustainable Nutrient Recycling: AHI's Experience

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Abstract

Continual food insecurity and deteriorating livelihoods of millions in East Africa is highly related to long standing decline in soil and human nutrient budget and poor distribution among system components and sub-units. Even within the crop sector there are mixed enterprises variably attached to specific farm units, namely the house, homestead, mid field, outfield and pasture land and wood lots. Various participatory tools and models were used to increase nutrient enrichment, to minimize trade-offs in nutrient budget between various farm enterprises, to reduce mining of nutrients of specific farm units, to reduce excessive accumulation of nutrients of certain farm units at the expense of other farm units, and also optimize the nutrient budget of the people without mining the land based resources, which could be extrapolated to other communities and higher scales. Although a U-form relation between population pressure and nutrient management is needed to feed the ever growing population it became elusive to achieve it due to multiple causes. This paper will present potential tools and models to intensify the existing systems, namely:

1. *DSS to identify spatial and temporal niches to increase organic biomass production of the system as increased use of chemical fertilizers may not compensate for the organic matter-related processes, particularly in the far out fields.*
2. *Designing strategies that could encourage farmer innovations to minimize nutrient mining of some farm units to enrich other enterprises*
3. *Fitting technologies with win-win benefits to attract collective interest of farming groups and communities to manage nutrients better*
4. *Models to design nutrient management in systems perspective with various scenarios considering socio-economic differences so as to minimize resource degradation while maximizing benefits that comes out of the system as food, feed and cash*
5. *Develop policy suggestion for system shift and nutrient input enrichment through bottom-up negotiations at individual farmer, community and district levels. Increasing awareness of the communities on nutrient cycles and disorders and its implication on human and system health.*

Implementation of these innovations demanded a mix of technological & institutional interventions. The immediate impact will be improving the nutrient recycling of the system through manipulation of the existing household resources, which will have a considerable implication on soil and human health. Local institutions could be benefited by getting knowledge and methodology on how to quantify and optimize nutrient recycling of the current production systems to possibly minimize nutrient mining but reversing the current trends using the existing local resources. Strategies are suggested to enhance local innovation in improving sustainable nutrient recycling. This paper would present case studies where the above mentioned strategies have been tested in a participatory research frame work at plot, farm and higher levels in Ethiopia and Kenya.

Why Do Farmers Invest in NRM? Experiences with Farmers Growing Forages in SE Asia and E Africa

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Abstract

The purpose of the Forages for Smallholders Project (FSP) in S.E. Asia was to increase the available feed sources to improve livestock production and strategic use of forages to improve soil conservation and nutrient management. The technologies that were developed through participatory approaches were immensely diverse, suiting household and livelihood priorities, individual practices and capabilities, farming systems, climates, pests and disease incidence, soils, and topography. Through regular field visits, farmer group meetings and surveys in the Philippines and Vietnam, a better understanding was obtained about perceived benefits of forage technologies, and factors that influenced the use of these technologies for animal production, land-, water- or nutrient management. Research methods and monitoring and evaluation (ME) systems are described, lessons learned are presented, and the potential for similar ME systems for East Africa is discussed. A general trend observed in Southeast Asia was that most farmers used forage technologies for the purpose of increasing feed supply, but those farmers with more assets also used them for improved NRM. The realistic potential for investment in natural resources by farmers in East Africa compares favourable to Southeast Asia.

Chapter 4:

Enhancing Gender Inclusion, Equity and Social Awareness

Local Institutions and Their Role in NRM: A Regional Synthesis

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Abstract

There is a common tendency in community-level development and conservation initiatives to ignore local resources in favor of externally-initiated practices, human resources and organizational arrangements. To understand the potential role of existing forms of social capital in addressing natural resource management problems, local institutions at watershed level were studied in the highlands of Ethiopia and Tanzania. Group discussions as well as individual and focus group interviews were conducted with leaders and key informants from different villages in pilot watersheds to identify the local institutions existing in these areas. Selection of respondents ensured broad coverage of the different farmer categories, including gender, resource endowments and location in the landscape. Historical trend analyses were done to find out how the local institutions have changed over the years with respect to their importance. Several local institutions with diverse objectives and varying levels of importance in the lives of different actors were found to exist, and to play key roles in the daily lives of community members. The objectives of these institutions range from income generation, collective farming and fund-raising to social and recreational purposes including ritual and sports. Some are active in natural resource management or can be used to enhance uptake of technologies in natural resource management. Suggestions are given on how these existing forms of social capital can be built on to contribute more to uptake of natural resource management technologies for social and economic development of highland communities.

Introduction

North (1986) defines institutions as the rules that guide how people within societies live, work and interact with each other. According to Singh (1994) they are formal or informal rules about who makes decisions, according to which procedures, what actions are permitted what information must be provided and what payoffs will be assigned to individuals. Grace et al. (2000) emphasize this by saying that institutions may either include or exclude an actor group (e.g. individual, households, ethnic groups) from access to resources. Formal institutions constitute the written or codified rules such as the constitution, judiciary laws, organized markets and property rights. Meanwhile, informal institutions are the rules governed by behavioral norms in society, family, and / or community, and include sanctions, taboos, traditions and code of conduct (North, 1990). Local institutions fit into this category. They may take the shape of a formal organizational structure, but commonly consist of informal norms and practices within a community or ethnic group (Friis-Hansen, 1999).

Rural communities live in well-organized structures that structure their activities and interactions with the environment in their quest to derive a living out of the available resources. The household, kin groups, hamlets and villages are the main actors through which local communities are organized (Singh, 1994). Such structures are the local institutions through which the communities' diverse aspirations are fulfilled. They are highly path dependent (Olate, 2003), dynamic and develop with the society according to needs. They may last for a long time, accomplish their objectives and fade out, or transform to capitalize on emerging opportunities.

Local institutions differ according to their functions and objectives. According to Donnely-Roark et al. (2001), they encompass many different types of indigenous organizations and functions such as village level governance, acceptable methods of community resource mobilizations, security arrangements, conflict resolution, asset management and lineage organization. In Mozambique (Carrilho, 1994; Blom, 2000; Virtanen, 2000; Serra, 2001), traditional leaders including spiritual leaders were found to be important traditional institutions with responsibilities such as land allocation, conflict resolution and mediation with spirits, the latter being important where norms have been violated. Other local institutions include councils of elders, traditional midwives, rainmakers, and sacred forests and trees. Sacredness bestowed on some trees or forests has been found to reflect important ecological functions and to protect public goods and environmental services (Gerden and Mtallo, 1990; Meliyo et al. 2004; Mbuya et al. 1994; Ramakrishnan, 2004). Such trees or forests are therefore traditionally protected through norms and regulations. Breaking the rules might attract severe punishment from the spirits (Laurrel and Nyberg, 2000).

Apart from being the warehouse for indigenous knowledge and beliefs, local institutions have the potential to effectively link service providers and the local communities. Working in Burkina Faso, Donnely-Roark, et al. (2001) observed that local institutions surround and connect communities and interact with other institutional systems such as the local government, to articulate communities' needs. Local institutions could be effective in engaging the energies and social relations of ordinary citizens and in increasing the willingness of the citizenry to invest in public goods. However, successful engagement with rural communities should start with recognizing that have institutions through which they can practice or organize collective action (Heltberg, 2001). In the past local institutions were seldom considered as an important factor in sustainability. Rather, land management practices were emphasized. Gupta (1992) argues that the two, institutions and management practices, are organically related. Whereas technologies and land management practices enable the transformation of resources and determine the pace, cost and effectiveness of change, institutions determine whether and how the relationship between technologies, environment and people would be viewed now and in future. To effectively exploit the potential of local institutions in NRM, an in-depth understanding of their evolution, goals, operations, objectives, strengths and weaknesses is essential.

This paper summarizes findings of a study on local institutions in target watersheds in three of the AHI benchmark sites in Ethiopia and Tanzania. The objectives were to identify the local institutions existing in the target watersheds, as well as opportunities to build upon them to achieve environmentally sustainable, economically viable and a socially acceptable system of natural resource management (NRM). The working hypothesis is that local institutions are important in the mobilization of rural communities towards improved natural resource management. The paper concludes with insights on how findings can guide research and development efforts towards efficient utilization of relevant local institutions in developing appropriate strategies for uptake of NRM technologies.

Methodology

The target watersheds studied were Areka and Ginchi in Ethiopia and Lushoto in Northeastern Tanzania (Fig. 1). Areka is highly populated (more than 400 people/km^2) with small farm sizes averaging 0.25 hectares and is intensively cultivated. Poverty levels are high and cash opportunities few (AHI, 2001). Ginchi in Ethiopia has a population density ranging from 100 to 200 people/km^2, long dry spells and a high livestock population compared to the carrying capacity of the area. Erosion and forest encroachment are major problems on the hillsides. Lushoto is one of the most populated areas in Tanzania with a population density of more than 100 people/km^2 (URT, 2003). Land degradation, excessive deforestation and land fragmentation are among the major problems in the district. Farm sizes are small ranging from 0.2 to 0.9 hectares for an average household of 8 members (Lyamchai et al. 1998).

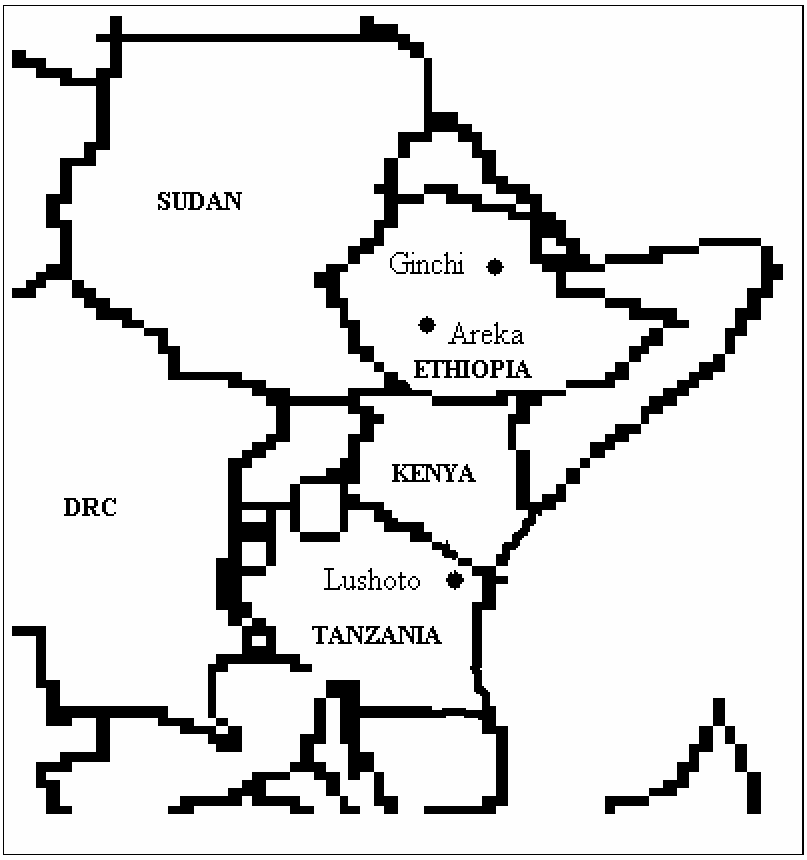

Figure 1. Map of Eastern Africa showing sites of this study

Individual interviews with leaders and key informants covering different categories (gender, resource endowment and location in the landscape), group discussions and focus group interviews with elders, youth and women groups were used to identify all local institutions available and their roles, strengths and weaknesses. Respondents were also asked to elucidate the potential of these institutions in NRM. The use of key informants was necessary in order to get information from an informed audience familiar with organizations of their communities. Focus group discussions provided the opportunity to probe further into inner details of the institutions. The use of leaders was based on the premise that they are among the more informed members of the community since they are relatively better trained. Further, leaders make use of most of the local institutions in their leadership roles. Historical trend analysis was done to establish how the local institutions have changed in importance over the years. For all sites three time periods were considered. In Lushoto these were before 1930s (during the colonial period), 1960s (after independence) and after 1990 (liberalization period) while in Areka and Ginchi local institutions were assessed during the feudal period (before 1974), during the Derg regime (1974 – 1991) and after 1991. The three time periods were characterized by major changes that affect the performance of most of the local institutions. This information is important given the dynamic nature of institutions, to understand reasons for change in importance, and positively use the information in our engagement with the communities. Information generated was synthesized and cross-checked with available secondary data.

Results

A typology of local institutions

The diversity of local institutions in the pilot watersheds was found to be similar across sites when contrasted on the basis of their function, with slightly greater divergence in the institutions found in Areka and Lushoto sites (Table 1). Nine types of local institutions were identified with some having more than one function.

Land based institutions

These types of institutions came out more prominently in Areka and Ginchi, where the government owns the land and farmers have the right to use and bequeath to their sons once they get married. In Areka three institutions (Table 1) are responsible for access to land, namely sharecropping, contracting and renting. Under share cropping, one farmer provides land and the other oxen while both provide all other inputs including labor, seed and fertilizers. Contracting involves a person transferring land use rights to another person on cash basis for a period ranging from 5 to 10 years. Few households adopt renting land through paying annual fees. Similar institutions exist in Ginchi where *Yekul* is the name used for sharecropping institution. In some contract arrangements, the contractor is allowed to reduce the cost of the seed and the fertilizer before sharing the rest of the produce equally. In both watersheds renting is time bound and is not transferable. Similar arrangements did not come out strongly in Lushoto although it is known that farmers do rent land.

Table 1. Typology of local institutions in the target watersheds

Function based local institution	Areka (Ethiopia)	Ginchi (Ethiopia)	Lushoto (Tanzania)
Land institutions	Sharecropping, contracting and renting	*Yekul*	-
Livestock institutions	*Kota, Missa–kotta, Ulo – kottaa, Hara* and *Gatuwa*	As in Areka	Rotational livestock groups (*kopa ng'ombe, lipa ng'ombe*)
Labor institution	*Debo* and *Zaye*	*Debo*	*Kiwili, Ngemo*
Mutual assistance institutions	*Iddir,* (sub – institutions: *Amba Iddir, Hera Iddir, Dabua Iddir* and Church *Iddi*r), I*qube,* and *Meskel* Banking	*Iddir kube, Senbete*	*Kibati*
Health institutions	Traditional midwives	Traditional midwives	Traditional healers Traditional midwives *Hunguza,* Devil cleansing (*Mbungwa*)
Traditional beliefs	-	*Mahiber* *Qaalluu* (Holy man), *Qaallitti* (Holy woman)	Sacred trees / sacred forests, *Wakilindi*
Traditional leaders	-	*Jabir, Gadu,* *Qaalluu, Qaallitti*	*Zumbe* Council of elders
Recreation	*Mahiber*	*Mahber*	Traditional dances, *Kidembwa* (kitchen Parties (women only)), sports
Conflict resolution	Council of elders	*Jabir, Gadu, Qaalluu, council of elders*	*Zumbe,* council of elders

Livestock based institutions

In Areka, livestock is an important enterprise in the farming system. There are 5 different institutions related to livestock ownership and management (Table 1). These are *Kota, Missa- Kota, Ulo – kottaa, Hara* and *Gatuwa*. They all involve sharing of livestock under different arrangements related to the distribution of benefits. For example, under *Kota* the arrangement is half sharing of ownership of livestock between two individuals or households. The aim is to pull limited resources and own the animals in share. The offspring, milk, manure and use for traction are shared on equal basis between the parties. During lactation period cows are moved from one house to another to share the milk. *Missa–kota* is similar to *Kota*, the difference being one of the partner shares only one-fourth of the benefits. *Hara* is share rearing arrangement and is practiced by those with no livestock. The offspring remain the property of the livestock owner while the one managing the animal benefits from milk, draft power and manure. *Gatuwa* is the pairing of oxen owned by different individuals when each individual owns only one ox. In Ginchi similar livestock institutions exist except that what they share is mainly the offspring. In Lushoto there are rotational livestock groups introduced by the Department of Livestock Development in a project called *kopa ng'ombe lipa ng'ombe* where a farmer is given a pregnant cow on condition that (s)he should pass over the offspring if it is a heifer, to the next farmer in the group. The process goes on until all farmers in the group have cows. To belong to a group the farmer has to fulfil some conditions including having a good livestock shelter and established pasture.

Labor sharing institutions

Labor sharing institutions are more prominent in Areka and Lushoto. In Areka, two labor institutions; Debo and Zaye were identified. Debo is collective action consisting of a group of 70 – 80 people who work together in return for a large feast of food and drink. It is also practiced in Ginchi, especially during periods of heavy workloads. Debo is mainly used in agricultural activities and house construction. This is similar to the collective action in Lushoto under the name Ngemo where community members contribute their labor during land preparation, manure transport, harvesting and house construction and feast after the task. An additional labor sharing institution, Kiwili, which has diverse roles, was identified in Lushoto. Under Kiwili members share their labor in farming and assist each other financially at times of difficulties. Debo and Zaye in Areka and Ngemo and Kiwili in Lushoto are what Olate (2003) refer to as linking social capital, which draws members from the family, close friends and neighbors.

Mutual assistance institutions (Financial, social))

Kibati in Lushoto and *Sentebe* in Ginchi are the mutual assistance institutions in the target watersheds. Several institutions concerned with fund raising to provide social insurance, assist members in time of crisis (e.g. funerals) and meet different expenses such as religious and other ceremonies, were identified in the three sites. In Areka two institutions; *Iqub* or *Shufuwa,* and *Meskel* banking were identified. The former is essentially a rotating fund scheme where members contribute some money per specified period of time (usually a week). Under *Meskel* banking, members contribute specified amount of money (about 0.5 birr per week) to be used during *Meskel* celebrations. The *Iddir* in Areka and Ginchi,is a social unit formed through voluntary membership of 20 – 100 individuals to provide social insurance. In Areka four types of *Iddir* were identified depending on function. These are *Amba Iddir, Hera Iddir, Dabua Iddir* and Church *Iddir*. *Amba Iddir* is concerned with assistance related to death such as meeting funeral expenses. *Hera Iddir* is similar to *Amba Iddir* but confined to the youth and apart from assisting each other to meet funeral expenses they also do house construction on reciprocal basis. *Dabua Iddir* is based on family relationship and has as its function to help relatives in crisis and in ceremonies. Church *Iddir* is church mediated (the Orthodox Church) for the purpose of members supporting each other through contributing labor or money. It could also fit under labor sharing institutions. Similar to the *Iddir, Senbete* in Ginchi assists members in times of funerals. However, it is a men's only group. It is also a means of strengthening ties. In Lushoto a mutual assistance institution called *Kibati* assists members in meeting expenses related to funeral and other crises.

Health Institutions

Health institutions relying on traditional medicine, cleansing from evil spirits and pleading to super-natural powers by traditional spiritual leaders are present in Lushoto, Areka and Ginchi. In Lushoto, cleansing from evil spirits (*Mbungwa*) is done in a small hut constructed at the base of a sacred tree such as *Ficus thonningii* (Fig. 2) by men. Most members of the community fear going near such places. Traditional midwives are an important health institution in all the three sites especially for the poor and those far from health services. Their role is recognized by the governments in Tanzania they are provided with modern skills in the trade. Fortunetellers and calamity prevention such as against terrible diseases are health related institutions reported from Lushoto and based on belief. One such belief is Hunguza mainly practiced against human diseases such as measles.

Traditional beliefs (Including rituals, spiritual leaders and sacred areas)

Institutions in this sector came out strongly in Ginchi and Lushoto. In Ginchi, the *Mehiber* is mainly an elders' club of mixed gender, strong in expressing traditional religious beliefs. Members prepare food and drink during their sessions and membership is voluntary. The *Qaalluu* (holy man) and *Qaallitti* (holy woman) among the Oromos in Ethiopia were believed to be the media through which their god (*Waaqaa*) makes contact with his people (Hassan, 1990). Individuals would these institutions to fulfill religious obligations, meet friends and kinsmen, witness a spectacle, sing, dance, and be fed. The *Qaalluu* also double as councilors. In Ginchi and Lushoto, traditional rituals are performed in sacred areas at the base of sacred trees such as *Ficus thonningii* (Fig. 2) or in sacred forests (Fig 3). Trees considered sacred in the Baga Watershed in Lushoto are predominant in the agricultural landscape as giant trees. Unauthorized people are not allowed to approach or cut such trees.

As part of crop protection against crop pests in Lushoto, *Hande* is practiced. This is a belief based on the application of some botanical pesticide derived from *Tephrosia spp.* According to this practice, no one is allowed to go to the field after application for the next 7 days believing that doing so will render the treatment ineffective. Based on this belief farmers are required to apply the pesticide at the same time and severe punishment befalls those who break the rules. In Lushoto, there are also rain-makers (*Wakilindi*), believed to have powers to plead for and predict the rainfall pattern.

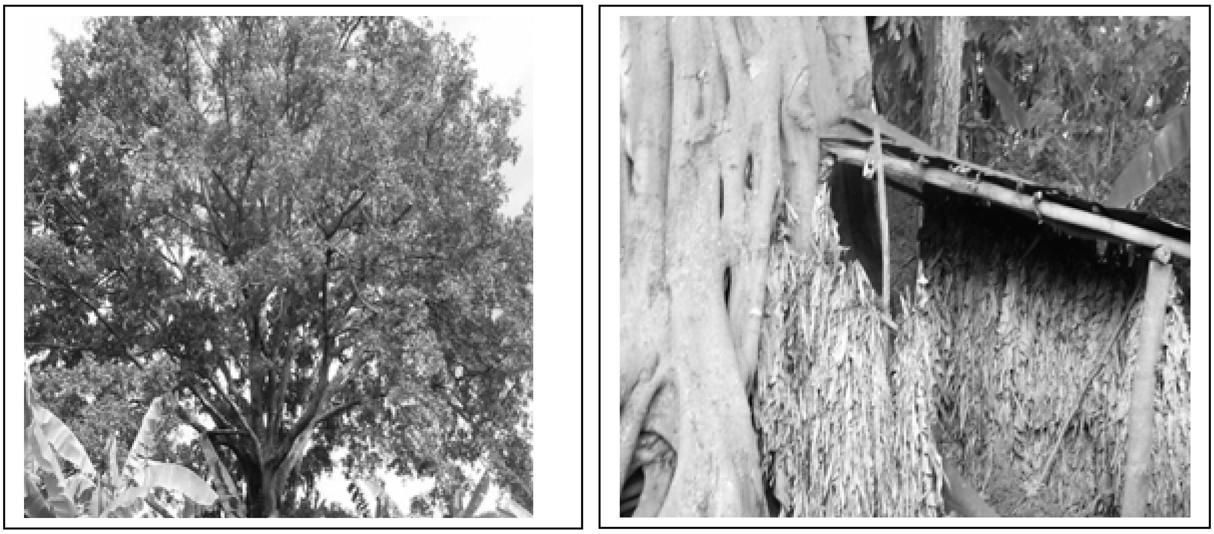

Figure 2. *Ficus thonningii* (left) one of the sacred tress in Lushoto at the base of which

For this practice, no one is allowed to go to the field after application for the next 7 days believing that doing so will render the treatment ineffective. Based on this belief farmers are required to apply the pesticide at the same time and severe punishment befalls those who break the rules. In Lushoto, there are also rain-makers (*Wakilindi*), believed to have powers to plead for and predict the rainfall pattern.

Figure 3. Sacred forest in *Ghinchi* Site: The *'Adbar'*

Traditional Leaders

This institution was recorded in Ginchi where there are the *Jabir, Gadu, Qaalluu (Men)* and in Lushoto (*Zumbe*). The *Jabirs* are persons with high status in the traditional belief system and serve as ultimate authority in traditional beliefs. Among the Oromos, *Gadu* and *Qaalluu* were the primary means through which economic, political and legal systems were controlled and governed. Individuals as well as groups would therefore go to these institutions to settle disputes (Legesse, 1973).

Recreational Institutions

In Lushoto several recreational groups were identified including traditional dance and sports groups mainly football. *Kidemwa* is a special traditional dance group for women only and is used to enlighten young perspectives brides on what they should expect, should do and should not do in marriage. This has spread to urban areas to form what they now call 'kitchen parties'. Share drinking is a prominent recreation institution in Areka where it is more apparent during the harvest. The local institution *Mahber* involves households sharing the same religion organizing parties every month in rotation, particularly in memory of the Christian Saints.

Conflict resolution

Several local institutions responsible for conflict resolution existed in the studied areas but their importance is fading away (see below). Conflicts over management and use of resources and household disputes were generally resolved by traditional leaders and the council of elders. In Lushoto the *Zumbe* and in Ginchi the *Jabir, Gada, Qaalluu, Qaallitti* were frequently contacted to provide direction and settle disputes. Some of these institutions of leadership are no longer in place, for example, the *Zumbe* in Lushoto ceased to exist when all the chiefdoms were abolished after independence. Others have been weakened by different factors including civil unrest in Ethiopia and colonialism in Tanzania.

Historical Trends

Changes in importance with time for some local institutions were assessed over three time periods. These were before 1930s, 1960s and after 1990s for Lushoto and the feudal period (before 1974), during the Derg regime (1974 – 1991) and after 1991. In Lushoto most institutions have been there for a long time except for the mutual assistance institutions (especially for fund raising), which came into existence in the 1970s. Sports institutions started in the 1960s. Most of the local institutions dealing with traditional beliefs and rituals are fading away in importance (Figure 4), with reasons advanced by community members including the coming of modern educational, religious and administrative systems that deter their use. In-migration of other tribal groups into the community and commercialization of services by outside institutions have also made their importance fade. For example, *Hande*, rain-makers, devil cleansing, fortune tellers, sacred areas for rituals are all decreasing in importance due to modern religions, influx of outside cultures and policies. Indeed, some of the spiritual undertakings like cleansing from evil spirits are at best seen as devil worshipping; both practitioners and those seeking their assistance do so in hiding (Mama Asha Kassim and Zainab Zuberi; pers. comm.).

Traditional healers are increasing in importance although some have over-commercialized their services. In most of these institutions their importance to communities started to fade in the early 1960s. Institutions for labor sharing (*Kiwili, Ngemo*), mutual assistance (financial) (*Kibati*) and traditional dances are increasing in importance while sacred forests, cleansing from evil spirits are decreasing in importance with time.

The importance and power balance of local institutions in Ethiopia have been evolving together with the political evolution of the country. During the feudal times (before the 1974 revolution), most of the rural people were dependant on local institutions for conflicts resolution, social coherence and local education using religious institutions. However, the importance of these institutions declined during the Derg regime (1974-91) and from 1991 onwards for example, tenure arrangements in relation to land and other natural resources. Changes in the political landscape saw the coming of different institutions like the *Baito* system which has a significant role in relation to natural resource issues. Civil unrest in Ethiopia has also contributed in eroding the role of some of the local institutions in NRM (Chisholm, N. 1998).

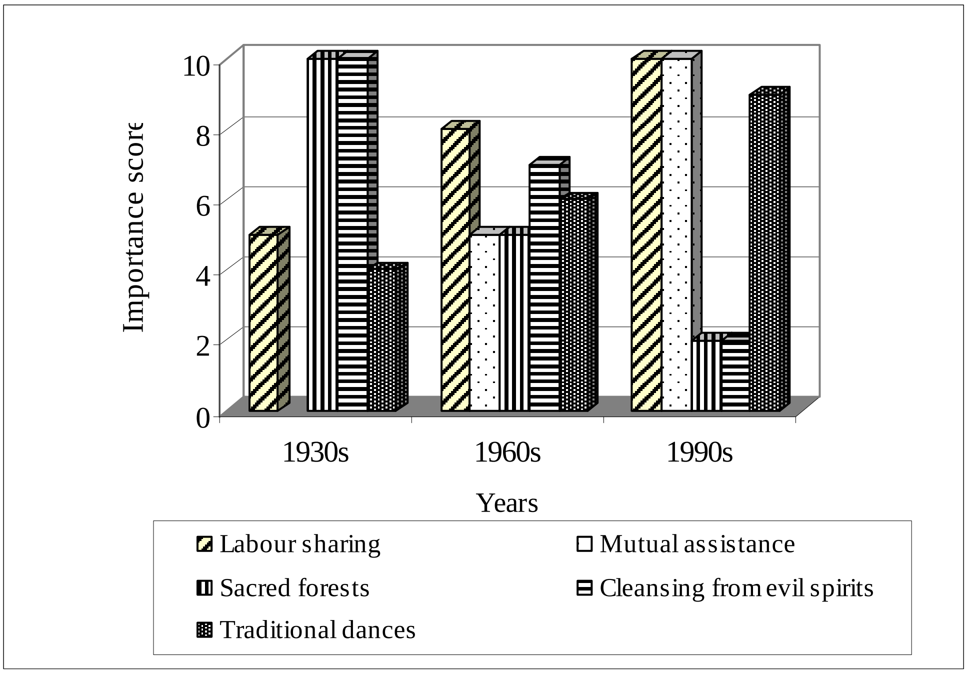

Figure 4: Trends in importance of some of the local institutions in Lushoto

Changes in importance of the local institutions do not differ appreciably between the different sites. Some institutions have disappeared from the scene. Traditional leadership structure has been replaced by a formal system under the local government structures where leaders are democratically elected. Under the current leadership system the enforcement of by-laws is weak, as leaders tend to protect their relationship with the rest of the community members. In Lushoto, respondents observed that village leaders were weak, corrupt and often favor offenders who are their close relatives.

Discussion

Sustainable management of the resources in highland areas of eastern Africa is a major concern of the local, national and international community due to the population density and the diversity of products emanating from these areas. To balance livelihood and conservation objectives, it is essential to engage local communities in the management of their natural resources. For successful engagement of the local communities, partners need to recognize and work with their local institutions. This is because of their role as custodian of local knowledge (Donely-Roarck, 2001), and in mobilizing collective action (Gupta, 1992; Olate, 2001) and connecting members of different communities (Donely-Roarck, 2001) all of which are fundamental to effective NRM. From the study, different local institutions directly involved in NRM exist in the target watersheds. Other institutions, though not directly related to NRM, can be sensitized in engaging members in NRM issues. Local institutions whose major function is NRM include land, livestock, and labor sharing institutions Traditional leaders, traditional beliefs and rituals, and mutual assistance institutions play an indirect but essential role in NRM through conflict resolution, natural resource governance and risk reduction. Health and recreational institutions can be sensitized to include NRM in their activities given the reliance of traditional healers on local biodiversity and the reliance of recreational institutions on the natural resource base for fund-raising.

Land institutions prominent in Ethiopia, to a great extent, influence how land is managed. Where long lease is practiced, the renter is motivated to make long-term investments in NRM such as soil conservation and agroforestry. On the contrary, short-term leases discourage farmers from taking long-term land improvements (Doolette and Magrath, 1990; Meindertsma and Kessler, 1997) greatly contributes to land degradation.. Farmers and government policy-makers should therefore be encouraged to consider the terms of leasing in relation to the long-term productivity of their land. The many livestock based institutions in Ethiopia represent an important social capital with respect to NRM. These institutions enable farmers with no livestock to access manure, an important ingredient in soil fertility improvement in the highlands where soil nutrient levels are very low (Stroud, 2000). Meanwhile, the labor sharing institutions common in all target sites, are a form of social capital that enable members to accomplish difficult tasks that would otherwise be impossible by one individual. Mutual assistance institutions strong in Areka, Ginchi and Lushoto are an effective way of raising financial capital within the communities, and enabling members to acquire goods and services that are highly priced. Given the tough official bank lending regulations, institutions like *Iddir* and *Kube* in Areka and Ginchi can contribute to NRM. With the increased capital made possible through these institutions, farmers can hire labor for land preparation and soil conservation, buy food and drinks to support traditional collective action activities, or make investments in new enterprises.

Traditional beliefs and rituals as well as traditional leaders have been strong NRM institutions in most local communities. Comparing current NRM practices in the presence of state-backed by-laws with those of the past when traditional beliefs played an important role in preserving common pool resources, noticeable differences may be seen. Because NRM practices were reinforced through spirituality, sacred forests and trees were highly respected (Eaurrel and Nuberg 2000). The association of sacred tree species with important water conservation functions (German et al, in press) suggests that scientific explanations may be found for some of these traditional practices. Delineation of sacred forests in critical parts of the landscape (hilltops, catchments) was likely to have had a positive influence on water conservation and watershed function (Gerden and Mtallo, 1990). Using 'indigenous knowledge' encoded in traditional beliefs, and through experience, local communities were aware of which forests contributed what to their wellbeing. So they would impose restrictions and ensure that they are adhered to by invoking spiritual powers.

Traditional leaders in most cases were also spiritual leaders, integrating spirituality with natural resource governance. Because they had legitimate powers bestowed on them by the community social harmony and the spirit of unity was ensured and this could be exploited to include aspects of NRM in their activities. In both countries the imposition of a new system of administration saw the emergence of new titles (*Fetawavari* in Ethiopia and *Mwenyekiti wa Kijiji* or Village Chairperson in Tanzania). Although legitimate according to the formal system, their performance leaves much to be desired. In the first place the new leaders are not necessarily coming from the original ruling clans who were traditionally believed to be god appointees to look after the spiritual and material welfare of their people. One of the major setbacks resulting from the weakening of the institutions of traditional beliefs and traditional leaders is the enforcement of bylaws on NRM. In Lushoto taking an offender to the official courts might attract a wrath and completely sever relations among local community members, who might be blood relations or friends. However, in the traditional system the legal system would work without members harboring grudges. One might argue that it is primitiveness to adhere to traditional beliefs. However, better aspects of any culture should be upheld.

Recreational institutions offer an opportunity to bring individuals with similar interests together. As a means of raising funds to meet costs related to their groups, members of these institutions are involved in various production activities including cultivation of high value crops. NRM issues such as soil conservation and managing irrigation water can be done through such groups if sensitized and backed up by appropriate technological, policy and institutional innovations.

The decrease in importance of the institutions on traditional beliefs, rituals, sacred forests and trees is a disadvantage to the management of natural resources. Failure by guardians of these institutions to provide scientific explanations related to the beliefs has led to people relating them to primitiveness. Systematic studies directed towards decoding the ‘indigenous knowledge’ imbedded in some useful traditional beliefs are therefore necessary to provide guardians of local institutions with the necessary information by which they could defend some of these beliefs in a scientific way. Finally, the study revealed that some of the local institutions are gender sensitive (e.g. for men only or for youth only) and effective use of such institutions in NRM should take this into consideration.

Conclusion

Multiple local institutions exist in the study area most of which have diverse functions. There is close similarity in their functions across the sites and several of them could be used in NRM. Historical trend analysis shows that institutions indicate a decline in importance of institutions based on traditional beliefs and sacredness and an increase in importance of labor sharing, mutual assistance and traditional dances institutions. Some institutions are gender sensitive admitting only certain types of members. It is concluded that local institutions are important structures that guided the lives of local communities and some did commendable work in the protection of natural resources. It is suggested that efforts to re-visit the local institutions already started by some countries be supported to include correlation studies that will relate beliefs that focused on NRM to scientifically proven realities. The *‘spirits’* should then be the scientific data that show the importance of such areas like sacred forests to the community. There is also need to understand why the informal legal system worked relatively well compared to the formal system, and foster strategies which seek to integrate aspects of the traditional system of governance into the formal system., It would be interesting to understand the current popularity and personal reliance on different types of institutions by different social groups to establish what groups should be used in which institutions in arriving at effective use of these institutions for NRM. Finally, Judicious management of natural resources in the mountains of eastern Africa will depend on recognizing and working with the local institutions and apply the relevant local knowledge and experiences of communities in these areas.

References

AHI, 2001. The African Highland Initiative (AHI); 1998 Annual Report. 2001. Kampala, Uganda

Blom, A. 2000. Ambiguous political space: Chiefs, land and the poor in rural Mozambique. Researcher School at International Development Studies. Roskilde University, Copenhagen.

Carrilho, 1994. Administatiçao local e administatiçao tradicional de terras, Poder e autoridade tradicional. Vol. I. Ministerio da Administatiçao Estatal. Nucleo de desenvolvimento administrativo. Maputo, Moçambique. 109 – 121

Chisholm, N. 1998. Community-Based Natural Resource Management in Tigray, Northern Ethiopia. The World Bank/WBI's CBNRM Initiative.

Donnely-Roark, P., Ouedraogo, K. and X. Ye, 2001. Can local institutions reduce poverty? Rural decentralization in Burkina Faso. Environmental and Social Development Unit. Africa region.

Doolette, J.B. and W.B. Magrath, 1990. Watershed Development in Asia: Strategies and Technologies, Wordl Bank Technical Paper Number 127, Washington.

Friis-Hansen, E. 1999. The social economic dynamics of farmers' management of local plant genetic resources. CDR Working Paper 99.3. Danish Center for International Studies. Department for Development Research.

Gerdén, C. Å. and S. Mtallo, 1990. Traditional TPF reserves in Babati district, Tanzania: Case study in human ecology. FTP: Ministry of Land, Natural Resources and Tourism and Swedish University of Agricultural Sciences, Int. Dev. Center. Working Paper 128, Uppsala, 51p

Grace, C., de Heana, A., Den, D., Konde, A., Seba, H., Shhankland, A. and Sinclair, 2000. Sustainable livelihoods in Ethiopia. Institute of Development Studies, England. Research Report 44.

Gupta, A.K. 1992. Saga of a starfish. Participative design of sustainable institutions for NRM. Center for Management in Agriculture. Indian Institute of Management, Ahmedabad 380015.

Hassan, M. 1990. The Oromo of Ethiopia. A history 1570 –1860. Pont Chester Sudney, New York. Cambridge University Press.

Heltberg, R. 2001. Property rights and natural resource management in the developing countries. Institute of Economics, University of Copenhagen. Denmark.

Laurrell, Å. and Å, Nyberg,. 2000. Plant species composition and plant uses in traditionally protected forests in Tanzania. A minor field study No. 119. Department of Systematic Botany, University of Uppsala, Sweden.

Legesse, A. 1973. Gada: Three approaches to the study of the African Society. New York: The Free Press.

Lyamchai, C. J., Lyimo, S.D., Ndondi, R.V., Owenya, M.Z., Ndakidemi, P.A. and N.F. Massawe, 1998. Participatory Rural Appraisal for Kwalei Catchment, Lushoto District. The African Highlands Ecoregional Programme (AHI), Selian A.R.I Arusha, Tanzania.

Mbuya, L.P., Msanga, H.P., Ruffo, C.K., Birnie, A. and B. Tengnäs, 1994. Useful trees and shrubs in Tanzania. Identification, propagation and management for agricultural and pastoral communities. Technical Handbook No. 6. Regional Soil Conservaytion Unit/ SIDA, Embassy of Sweden. Nairobi, Kenya.

Meindertsma, D. and J.J. Kessler, 1997. Towards better use of environmental resources. A planning document of Mbulu and Karatu District'. Netherlands Economic Institute/AGRIS (T) Ltd.

Meliyo, J.L., Mansoor, H.A., Masuki, K.F.G., Mowo, J.G. and S.S. Riziki, 2004. Social and Biophysical profile of the Baga Watershed, Lushoto. (in Prep.)

North, D. C. 1986. The new institutional economics. Journal of institutional and theoretical economics. 142: 230 – 237.

North, D.C. 1990. Institutions, Institutional change and economic performance. Cambridge. Cambridge University Press.

Olate, R. 2003. Local institutions, social capital and capabilities. Challenges for development and social intervention in Latin America. Washington University in St. Louis. Oct. 2003.

Ramakrishnana, R.S. 2004. Sustainable cultures to sustainable development. Paper presented at the IRMMA Conference (Interdisciplinary Research and Management in Mountain Areas) Banff, Canada. 23 – 26 September 2004).

Serra, A. 2001. Legitimacy of local institutions for natural resource management: The case of M'punga, Mozambique. School of African and Asian Studies, University of Sussex and Centro de Experimentação Florestal, Sussundenga, Mozambique.
Singh, K. 1994. Managing common pool resources. Principles and case studies. Oxford University Press, Delhi.
Stroud, A. 2000. African Highlands Initiative Progress reports 2000. Kampala Uganda.
URT, 2003. The United Republic of Tanzania. 2002 population and housing census Volume II. Age and Sex distribution. Central census office, National Bureau of Statistics, Dar es Salaam.
Virtanen, P. 2000. Community Based Natural Resources Management: Defining the community in Mozambique. In: Forests, Chiefs and Peasants in Africa: Land management of natural resources in Tanzania, Zimbabwe and Mozambique. Eds. P. Virtanen and Malti Nummelia Silva Carelica, 34, 116 – 137, 2000. University of Joensuu, Faculty of Forestry, Finland.
Williams, A. 1995. Communities and sustainable forestry in developing countries. Institute for contemporary studies. San Francisco, California. USA.

Understanding Conservation and Livelihoods – Realities or Rhetoric: A Case of AGILE in Uganda

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Abstract

The fundamental support to life and economic processes offered by natural resources is often understated. Increasingly, degradation of the natural resource base is having a substantial impact on the economies of developing countries where a majority of the poor directly depend on natural resources for their livelihoods. Further, the poor are most vulnerable to the consequences of natural resource degradation, amongst which is land degradation, considered to be one of the major threats to food security in sub-Sahara Africa. Improving natural resource management (NRM) will undoubtedly make substantial contribution towards the welfare of the poor. Various theses attest to different initiatives and methodologies for better management of natural resources. Nevertheless it is imperative to acknowledge the numerous tradeoffs necessary both at the household level and at the community level in the implementation of a landscape approach to conservation. Recent studies detail the importance of social capital at multiple institutional levels, the role of environmental entitlements, including land and resource tenure, the values of social and cultural preferences, income strategies that take into consideration cyclical events or political risks like insecurity. The African Grassroots Innovation for Livelihoods and Environment (AGILE) process is aimed at empowering local groups to take charge of their own development, livelihood and environmental management. It seeks to develop partnerships with the local government and NGOs who provide relevant support and services to the grassroots, seeing to it that land management practices are better linked to livelihood and enterprise options. It aims at initiatives that are sustainable and that the grassroots are less dependent. In implementing the AGILE concept to Landcare, a bottom up approach is advocated. This paper describes the process of community engagement in livelihoods and natural resource activities under AGILE, including the use of appreciative inquiry in community action planning, stakeholder engagement, and partnership development processes in three districts of Uganda.

Introduction

In Sub Saharan Africa, the nexus of population pressure, low and declining agricultural productivity, and unsustainable use of natural resources threatens a downward spiral of increasing poverty and land degradation unless effective strategies to reverse the spiral are identified and implemented. Food insecurity, uncertain livelihoods coupled with environmental priority concerns which include land degradation and desertification, the protection and sustainable use of forests, effective management and protection of biodiversity, water resources issues, pollution problems, climatic uncertainties including drought and climatic change, demographic change and population pressure on natural resources are factors to contend with in alleviating poverty.

Land degradation, which includes degradation of vegetation cover and soil, is a major ecological concern in Africa. It is estimated that about a half-billion hectares in Africa are moderately to severely degraded, corresponding to one-third of all cropland and permanent pasture on the continent (UNEP/ISRC, 1990). The implication of this scenario given that more than 80 % of the populations are rural based is daunting. Various studies give different views on the issue of soil degradation (Leach and Mearns, 1996; Scoones and Toulmin, 1999a, 1999 and Lomborg, 2001). The conventional understanding of natural resource management institutions and associated uncertainties coupled with the empirical limitations in data collection on land degradation calls attention to the need for a robust view of the sciences as a yardstick in the generation of answers for the various challenges facing rural communities. The need for a holistic approach, a systems interpretation of concepts would be more accommodative of the dynamic and interactive processes at play.

The evident decline in agricultural productivity in the region is both a cause and a consequence of the deterioration of the natural resource base. Sub Saharan Africa faces a formidable challenge; most rural communities remain poor and food-insecure in the aftermath of widespread macroeconomic, political and sectoral reforms that have largely failed to stimulate significant agricultural productivity improvement. Currently a wide range of traditional and modern techniques for effective NRM and documented best practices exist. Nonetheless environmental degradation proceeds at high rates in much of the region, reflecting in large measure disturbingly low rates of sustainable NRM strategies especially among the poorer subpopulation of smallholder producers. A typical manifestation of a smallholder is one who is subject to a host of forces – population pressures, pervasive poverty, and maldistribution of traditional farmlands, inequitable land tenure systems, and inadequate attention to subsistence agriculture, adverse trade and aid patterns and the burden of international debt.

In this paper, we examine efforts at positioning integrated natural resource management as an effective means in alleviating rural poverty while protecting the integrity of the environment. Following a brief review of prior environmental conservation efforts, the Landcare approach is introduced, and key aspects differentiating this approach from prior conservation efforts highlighted. Experiences and lessons learned so far in the implementation of a unique form of Landcare in eastern Africa, the African Grassroots Innovation for Livelihoods and the Environment (AGILE), form the main substance of the paper. Challenges of integrating science and policy in natural resource management through the capitalization of collective action are highlighted. The paper concludes by examining the possibilities and implication for lesson learning and upscaling.

ENVIRONMENTAL CONSERVATION IN RETROSPECT

A historical exploration of environmental and development discourse provides a setting for better understanding of the circumstances prevailing in Sub Saharan Africa. The early developments of the agrarian economies of most African states were shaped by the brutal colonial interventions which undermined indigenous systems of land ownership and land management. The colonialists' intent was turning previously self-sufficient economies into sites of agricultural production for export. In East Africa, beginning in the latter part of the nineteenth century, the British initiated a string of events which led to the replacement of the African ideology of mutual obligation and social responsibility with a European ideology of exclusive rights (Davison, 1986). The colonial era and consequent modernization shattered traditional institutions and customs, forcing rural peoples to formulate (or adopt) new visions, the major one being the clamor for independence and self determination.

Post-independence elites did little to reverse unjust patterns of land use and tenure, nor did they stave off their dependence on overseas markets. Markets mediated through local rulers based on colonial structures were pervasive. These have reached deep into third world farming systems creating greater instability, poverty and environmental degradation while perpetuating the power of the wealthy and land-owning elites. The scepter of landlessness, hitherto unknown, has become an established norm; political agitation and calls for agrarian reforms abound.

Agrarian reforms have often been oriented toward modernizing agriculture through capital-intensive farming and freer land markets (Powelson and Stock, 1990). The reforms have so far failed to respond to the needs of the rural poor, and landlessness is on the raise. Reforms have failed to effect adequate redistribution of land or alleviate poverty. Further, the perpetuation of the poverty-environment nexus has raised global concerns on the state of the environment.

Participatory initiatives stand to gain if proper mechanisms are adopted to move the process from the rhetoric of development and conservation to actual implementation. Initiatives to promote greater control over common property resources, for example, often define the policy problem strictly in terms of devolution of control over resources from the centralized state to local communities. Unfortunately, little consideration is given to whether local institutions possess the political authority, social legitimacy and the level of technical competence to regulate resource use. Further, there is need for appreciation of local and indigenous conservation practices to environmental management. The understanding of the heterogeneity of the rural population and the consequent ambiguity of singular concepts such as community (who they are, leaders, women, youth, or the landless, the elites) or the household (are they the single women households, or the children led households resulting from the AIDS scourge or wars or the polygamous households). There is also need to acknowledge the role of existing actors (individuals, households, communities and institutions) in flexible resource use and management practices in variable environments. It is this scenario that has informed AGILE. It recognizes sustainable livelihoods as a pathway to environmental conservation and the need for local people to be capacitated to take charge of their local development and environmental conservation.

THE CASE FOR AFRICAN GRASSROOTS INNOVATION FOR LIVELIHOOD AND THE ENVIRONMENT (AGILE) IN EASTERN AFRICA

AGILE is an approach that integrates the Landcare experience from elsewhere into the East African setting, drawing on knowledge of African institutions and technologies and fostering enabling policies. The aim is to "scale up" African grassroots innovations in technology, natural resource management, policy reform and livelihood while not losing their relevance to local needs. Landcare, as inferred to in the Philippines experience[1], is a method that rapidly and inexpensively diffuses agroforestry and other technical practices related to NRM and livelihoods among thousands of farmers. Landcare is also viewed[2] as a movement led by the grassroots to foster improved livelihoods and environment, spreading through the social energy of individuals, communities and supporters. It is considered still by others as a basis or platform for autonomous farmer-led organizations concerned with the long-term health of the land to share knowledge and innovations, influence policy, and broker services. The AGILE concept is evolving, fueled by insights gathered through the work carried out at community, district and national levels. This is being done through the involvement of stakeholders, development of partnerships and identification of champions of the approach. There have been insights into community assets and gaps, livelihood and environmental conservation issues; institutional dynamics, relationships and methods being used to work with communities and local groups; the dynamics of community interest groups in relation to projects, government initiatives and other opportunities; and also insights related to the influence of the policy and development environment on progress at local levels. These insights have essentially broadened our understanding of the possibilities for an African 'Landcare approach'. Increasingly, emerging information suggests that AGILE should indeed provide a platform, forum, and market in which various technologies, practices, innovations, policies and conditions are discussed, analyzed, adapted to pertinent conditions, adopted and disseminated, with the community at the grassroots taking a commanding role.

Farmer institutional development: Farmer led organizations and the case for collective action

Farmer-driven approaches are central to the AGILE concept. The need for an empowered farmer level of interactions is paramount in the development of effective and sustainable natural resource management. One of the main activities undertaken through the AGILE process was conducting a status assessment of existing farmer groups, their activities, strengths and perceived weaknesses.[3] AGILE built upon these studies and a supplementary institutional analysis in natural resource management to initiate negotiations for a change process. The negotiation was based on identified strengths and complementarities among relevant stakeholders: individual farmers, farmer groups, community based organizations, non-governmental organizations, local

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[1] ICRAF has been working with Landcare groups in the Philippines for more than a decade resulting to a robust and dynamic movement where more than 300 groups from five municipalities in northern, central and Eastern Mindanao are involved.
[2] This reflects the understanding of the approach by the Landcare East Africa team members
[3] See AGILE publications CITE specific ones as you would in a peer-reviewed journal.

government and quasi-government bodies (i.e. the National Environmental Management Authority and the Uganda Wildlife Authority).

In the 3 district level sites that AGILE operates in Uganda, farmer groups developed criteria for strong farmer-led organizations. Table 1 highlights the perceived strengths and weaknesses of farmer-led organizations in their districts. The major characteristics developed were compared amongst the sites in relation to current development initiatives within the district.

Table 1: Farmers assessment of characteristics of Strong farmer led organizations

Characteristics	Bundibugyo	Kabale	Kapchorwa
Sense of ownership & accountability	Strength	Strength	Strength
Clear mission not influenced by outsiders	Strength	Weakness	Strength
Knowledge and experience	Weakness	Weakness	Strength
Autonomy from external influences	Strength	Weakness	Weakness
Gender sensitive	Strength	Weakness	Weakness
Rules, norms, bye-laws	Strength	Strength	Strength
Value own strength and build upon them	Variable	Weakness	Strength
Knowledge of political context and opportunities	Variable	Weakness	Strength
Income source and financial stability	Weakness	Weakness	Weakness
Know weakness and ability to out-source	Variable	Variable	Weakness
Clear objectives and action plan	Strength	Strength	Strength

All the farmer groups interviewed in the 3 districts deemed their groups to be characterized by a sense of ownership and accountability. This can be attributed to the fact that the selected groups were those that were self initiated and already had a development agenda based on their needs. Groups in Bundibugyo and Kapchorwa had a clear mission and no outsider influence as strengths, while Kabale recorded it as a weakness. Kabale’s situation could be explained by the fact that there are a big number of NGOs and CBOs engaged in various activities that influence the direction and purpose of the various groups in the district, while this was not the case in the other two districts. The consulted farmer groups from Kapchorwa district considered knowledge and experience as an organizational characteristic that they possessed. They attributed this strength to their ability to stay focused and demand capacity building on their main activities (conservation agriculture). This was done with every subsequent development related NGO, the local government and other partners that got involved with them. The ability to seek assistance from various development related bodies was limiting for the farmer groups in Bundibugyo and Kapchorwa, where historical isolation due to distance and conflict has limited the number of development actors. Where shared problems or constraints had already been identified, groups in all three sites were able to understand and articulate the issues as well as probable solutions. In this regard, knowledge of identified problem areas was considered a strength by the farmer groups.

As illustrated in Table 2, the context shaped the aspirations and priority areas of farmer groups, who exhibited eagerness to take up innovations that they believed would address their needs. The farmer groups were also aware that solutions existed in a variety of domains. Some needed technological interventions while others needed policy and institutional interventions. What proved difficult was where various intervention measures were called for to address a particular domain. Interactions with various organizations in various aspects of NRM were also deemed positive as the farmer groups were able to apply knowledge gained in their day to day endeavors. Work done in Kabale on policy and bye law formulation was positively influencing governance and interaction of the various groups, while calamities suffered as a result of land degradation as well as periodic insecurity lent the farmer groups in Kapchorwa and Bundibugyo a sense of urgency and commitment towards resolving some of the identified issues. Whereas they were very eager to partner with organizations that projected objectives that were mutual, they were equally impatient with institutions that focused on different priorities.

Table 2: Farmer Institutional assessment

Area	Characteristic	Context specific issues
Kapchorwa	- Knowledge and experience in conservation Agriculture	- Declining productivity resulting from declining soil fertility and unaffordable inputs
	- Knowledge of political context and opportunities	- Land tenure and protected areas, displaced peoples(the Benet)
	- Clear mission and purpose, not easily influenced by others	- Developed community based organization specifically geared towards capacity building of farmer groups
Bundibugyo	- Autonomy from external influences	- Bordering Congo, and having insecurity at some point in time. Very few development partners.
	- Knowledge of weakness and ability to out-source	- Periodic landslides, diminishing land area
	- Knowledge of political context and opportunities	- Sandwiched by two protected areas, insecurity in neighboring areas, displaced peoples (the Batwa)
Kabale	- Sense of ownership and accountability	- Development initiatives from food security assurance into income generation.
	- Rules, norms & bye laws	- Population increase and pressure on land, limited resource commons.
	- Democratic decision making	- Capacity building by NGOs for many of the farmer groups on governance and accountability.

Technological approach to land degradation in a smallholder farmer landscape context

Though most of the technologies and farming practices that address land degradation were readily accepted, their implementation and usage did not meet expectations. Experiences in the AGILE process has shown that technologies on offer are but one component of a larger system or process that needed to be in place before desirable results could be achieved. This evidence questions the viability of a prescriptive approach to addressing landscape level concerns amongst smallholder farmers. Discussions among farmer groups on the development of solutions to land degradation are illustrated in Table 3.

As illustrated in table 3, farmers are very much aware that there was no single solution to their farm level issues. The envisioned approach involved a cocktail of various components that had to be put together in order to achieve the desired results. As shown in table 3, policy support was considered very important in creating a conducive environment for the implementation of best practice natural resource management measures at the landscape level. There was also need to link environmental conservation with livelihood concerns, providing an incentive for landscape level natural resource management.

The farmer groups developed criteria for the assessment of user friendly technologies (Table 4). These were ranked based on perceived importance to the adoption process. The criteria developed were further subject to other conditions such as policy, facilitation, and partnerships being favorable. The ranking was done based on individual category assessment, where factors were ranked high (maximum 10) if considered important and low (least 1) if considered low.

Table 3: Farmers' articulated needs and recommendations, summarized across AGILE pilot districts

Technology needs	Research needs	Dissemination strategy	Principal Partners	Facilitation	Sustainability
Soil erosion control	identify & share existing & emerging knowledge	Farmer to farmer training & other participatory method	Local government, Farmer Organizations	Training Toolkit	Farmers to do the work
Soil fertility Improvement	Identify, clearly articulate link between environment and livelihood	Involve private sector and research institutes	Networks amongst farmer research groups	Training on methodology, tools	Farmer participation in experiments
Afforestation & Agroforestry	Research on high value trees, local species improvement	Demonstrations & extension visits	NRM based institutions	Funds for species development	Policy support in conservation and marketing
Landslides	Mapping through GIS & assessment of mitigating measures	Awareness building and feedback workshops	Local government, and research bodies, development bodies	Early warning training	Policy support in land tenure and protected areas
Introducing alternative enterprises e.g. mushrooms	Varieties and productivity, post harvest handling, marketing	Demonstrations , extension visits, species introduction and multiplication	Research institutions, local government and private sector	Training in technology application, savings and investments	Policy support in marketing & infrastructure

The criteria developed were based on reasons for acceptance or rejection of technologies. Factors that make a technology appealing were then explored. Priority factors were then evaluated based on a matrix ranking in three categories, namely, factors considered essential for the adoption of technologies, those considered necessary and finally a ranking based on factors critical for adoption of technologies. In the factors considered critical for the adoption of technologies category, the scores dipped noticeably, apart from the factor on the effectiveness and user value factor that maintained the same high score.

Table 4: Criteria for farmer utilization of conservation technologies

Criteria for technology utilization	Matrix scoring (1=least, 10=Most)		
	Essential	Necessary	Critical
Meeting farmers needs	8	7	6
Simple and affordable	7	6	4
Addressing existing problems/issues	9	9	8
Can be modified or adapted	8	7	5
Sustainable and long term	9	8	7
Effective, has value to user	9	9	9
Culturally and environmentally acceptable	8	7	3
Maintenance friendly and labor saving	7	6	4

Plotting a line across the three categories per factor based on the matrix scores, and calculating the rate of change from one category to the next would therefore constitute a risk aversion index. The higher the risk aversion index i.e. where it was (>0<1) the greater the likelihood of the adoption of a particular technology. As described in Table 4, farmers were very particular on the effectiveness and use value of the technologies proffered. They were also keen that the technology on offer addressed existing problems and issues. The sustainability of technology in terms of its re-use value as well as impact was also a matter considered as very important. There were some factors such as cultural and environmental acceptability which, though considered essential and necessary, were sacrificed where a technology was perceived to have more appealing attributes. The more exposed the farmers were in terms of environmental awareness, the less the likelihood of abandoning this factor when selecting technologies.

Towards tailor made policies for smallholder natural resource management

A favorable policy environment was considered essential by the smallholder farmers in the AGILE process. The farmers interviewed were able to highlight specific policy areas and initiatives they considered to be assets. They were also able to suggest areas for improvement, as shown in Table 5.

Table 5: Examples of policy assets, integrated across AGILE pilot districts

Policy action	Farmer understanding and suggestions
- Wildlife Authority policy on collaborative management	- Communities closer to the park benefit and only if the tourism industry is fully functional
- Local participation of community members in bye-law making in environmental conservation	- There is a big role of the local government in supporting, and championing these efforts
- Use of indigenous knowledge and culture	- The role of sacred places and totems in conservation was currently overlooked
- Relationship between national level policy formulation and local level implementation	- There exists a disconnection between national level policy formulation and local level implementation; mechanisms for participation and implementation are not fully thought out.
- The principles driving the policy making processes	- There is need for awareness creation and transparency to guard against hijacking of the process for selfish interests.

In the articulation of policies that were conducive to farmer groups' livelihood and environmental conservation activities, a number of considerations emerged. First, the policies needed to be easily understood, if possible expressed in local languages. This would ensure greater understanding on the advantages and disadvantages of particular policies. Secondly, policy should be formulated with the full participation of the communities for their mutual benefit. In this regard, it was imperative that policy meets the needs of both the community and the government.

There was general agreement among the interviewed groups that good policies should integrate national and local level policy concerns and implementation mechanisms. Table 6 describes some policy attributes and suggested implementation mechanisms at each level.

For policies to be not only effective but also community friendly there is need for the involvement of the local people. This not only creates acceptability and credibility but also serves to inform the policy markers on the more intricate and area specific community level issues. There was also need to harmonize different sectoral policies for a better focus. There were just too many separate policies addressing similar issues and this was counter productive.

Table 6: Farmer consideration of good policies and suggested implementation mechanism

Policy attributes	Implementation possibilities	
	National	Local
Enforceable	Policing, legislation, taxes	Culture, collective action, local government, fines
Not punitive, depriving people off their livelihoods	Consultation with local government, community level leadership	Collective action, consultation with household level members
Addressing threats as determined by science and local knowledge	Consultation with professional bodies , research and local cultural authorities	Local government, NGOS, civil society and collective action
Enabling legislation needed	National level laws	By-laws, rules, collective action fines and incentives
Should be possible to monitor especially at local levels	Local government	Collective action, networks and lobby groups
Policy should have concrete benefit, improve health, productivity and land security	Multi-stakeholder involvement	Collective action and the local government

From understanding to implementation: Toward an African landcare concept

The implementation of the AGILE process was highly influenced by lessons generated by initial studies[4] on collective action that sought to understand whether Landcare as practiced in other regions could provide an inspiration to communities and improve natural resource management efforts in Sub Saharan Africa. It further reviewed Landcare concepts with the aim of structuring Landcare to build on African institutions and innovations. The lessons gathered thus greatly played a big part in community level interactions and the development of the AGILE concept to Landcare approach in Africa.

Farmer institutional development

The capacity building activities amongst the groups play a big role in the farmer institutional development. Farmer groups develop as farmer institutions and adjust accordingly to meet the changing circumstances and the evolving roles. The more developed a group is, the more likely it is to determine its own direction. By using the assistance from development partners they fine tune their activities to meet emerging demands from their communities (see case study 1).

The farmer institutional development process is accelerated through the identification and support to catalyst groups such as the one described in case 1. These groups are able to identify and create ownership of advocated

[4] See the following AGILE study documents:

1. *Incorporating a Landcare approach into community land management efforts in Africa: A case study of the Mount Kenya region by Joseph Tanui (2002)*
2. *Research on Collective Action and Grassroots Innovation in Natural Resource Management: Uganda Case Studies by Deb Johnson (2002)*
3. *Landcare/Africa—AGILE—Western Kenya Report by Nelson Mango (2002)*

practices; they are able to sell the same to the rest of the farming communities and are active in identifying niches for the improvement of community livelihoods. The groups also act as good indicators of community priority areas but fare poorly with respect to exclusivity, as membership usually involves the more active in society. The group is also not able to bring out the intra household perspectives on development initiatives, requiring separate studies identify the winners and losers of interventions at community and household level. The major challenge of the development partners is engagement with the groups without unduly influencing the group's direction or creating a dependence syndrome. Another challenge is in identifying such catalyst groups over a short span of time given that there greatest asset is their ability to evolve with time. It is also necessary to identify factors that enable the groups to act as catalysts and develop a process for imparting the same among other groups.

Case 1: The evolution of a farmer group in response to unfolding niche

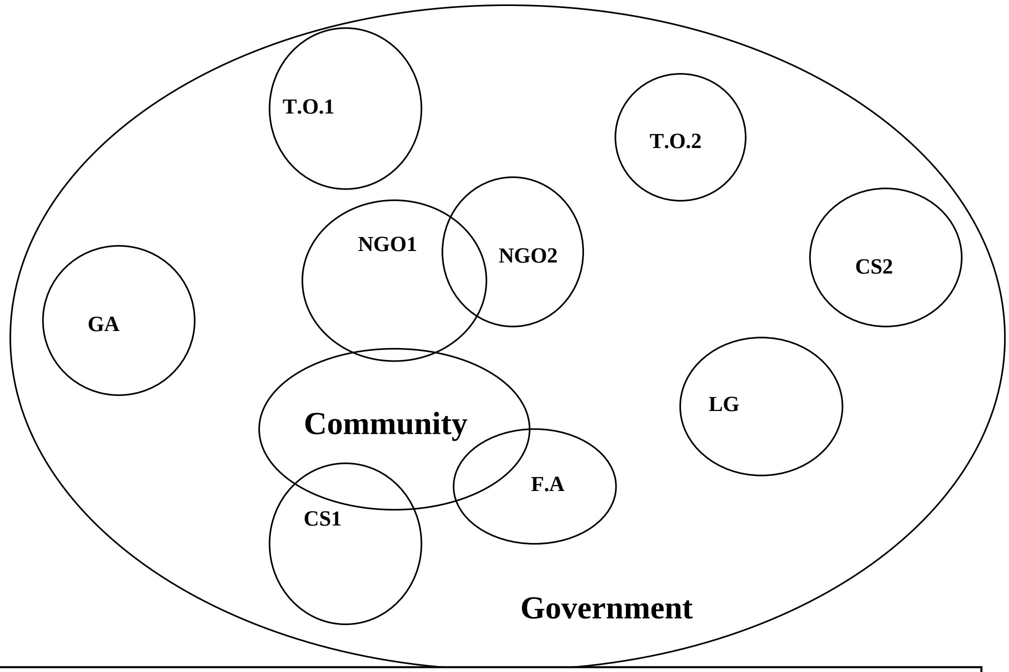
Tuban Organic Farmers Association (TOFA) is a Community Based Organisation (CBO) which is located in Tuban parish, Tegeres Sub-county in Kapchorwa District. TOFA was formed in 1999 as a youth group, with coffee nursery establishment as an activity. This came after attending a training on organic farming at St. Jude Rural Training Centre (Masaka) facilitated by Uganda Red Cross Society. Through a concerted effort by the group leaders and their involvement with other NGOs such as Action Aid, the group evolved and widened its scope of activities to include the following:

- Coffee and tree nursery management
- Fish farming
- Train farmers on organic manure preparation and application
- Bee keeping
- Training in both traditional and improved banana management
- Passion fruit
- Soil conservation
- Conduction reflects circles
- Kitchen gardening and vegetable growing
- Establishment of zero-grazing units
- Currently amongst its achievements the organization has the following:
- TOFA has trained 148 farmers on organic farming for sustainable agriculture and other groups
- 5 reflect learning circles and facilitators
- TOFA has an operational office with furniture
- Increased crop production
- Soil conservation
- Formation of more groups
- Exposure of more groups
- Exposure visits (18 farmers)
- Wrote a proposal which was funded
- Improved banana suckers demonstrations

Partnership building and stakeholder involvement

In practice more stakeholders exist in community development than partners. Lessons emerging from the AGILE activities are that individual player's ability to comprehend the bigger picture away from their individual institutional mandate allows the latitude for a more community responsive partnership. In the development efforts the clients are ultimately the communities to decide on whom to have their opinion on the various organizations that they interact with. Case 2 is an illustration of the community perceptions of institutions working with a community in one of the AGILE sites. Through the illustration, the community who were represented by farmer group members gives reasons for their perceptions on the usefulness or remoteness of the various institutions they interact with. Further, they describe areas of improvement so as to work better with them.

Case 2: Community partner interactions



Key
T.O.1: Representation of tribes on conflict resolution
T.O.2: Tribal elders association
NGO1: Non governmental organization, dealing with agriculture, NRM and health
NGO2: Non governmental primarily dealing with land issues
CSI: Civil society lobby group, representing disadvantaged and excluded tribal grouping
F.A: Farmer association dealing with conservation agriculture
CS2: Civil society dealing with human rights
GA: Government agency on natural resources
LG: the local government

From the Vern diagram the closer an institution to the community the better it was able to interact and understand the community's needs and priorities. The further away from the community circle, then the harder it is for that particular organization to meaningfully engage the community in development.

Case 3: A security issue with a technological solution

Kapchorwa is one of the border districts situated in eastern Uganda in the Mount Elgon ranges where it borders the republic of Kenya to the east, and to the north Moroto district, home to the Karamojong a fierce pastoralist group. The mountainous landscape and the high population pressure resulting from the populace settling on a narrow margin of the total land area are conducive to land degradation. The population is restricted to a narrow margin of area due to the fact that one third of the total area is mainly park land, while the final third is deserted or free land due to the cattle rustling activities by the Karamojong warriors from the north and the Pokot from Kenya. The Sabiny people, the major inhabitants of Kapchorwa district have from time immemorial relied on cattle keeping for their livelihood. The security situation has not only environmental consequences but has also narrowed the livelihood options of the people. The reduced number of cattle has dietary implications. The sabiny decry the fate of their cattle and a means to livelihood, but the Karamojong and Pokot are much stronger and have superior weaponry. Though there are efforts at peace building through POKATUSA (an association of all the tribal groupings involved in the cattle rustling issues), there is an urgent need for improving the livelihood options. In the district AGILE planning process, various farmer groups discussed their livelihood options basing on the assets they possess. A number of groups involved in the planning process believed that a clear policy direction on protected areas, benefit sharing and the issue of land tenure was imperative. On the security situation various options were discussed and they advocated for the introduction of the improved dairy cattle. The Karamojong and Pokot always raid the indigenous cattle breeds, which are hardy and could move over long distances in rough terrain. In contrast, the improved breeds are not only delicate but need more care as well as feeds. The improved breeds had much higher milk production and much fewer in numbers were required to maintain an adequate production level. Further, the groups felt that given the limited grazing area, they needed alternative feed options such as the use of fodder trees e.g. Calliandra, and Lucaena. In the planning sessions a number of technologies were identified and also partners were identified. Capacity building requirements were also identified. It was felt that the development and dissemination of improved breeds would inadvertently reduce the incidences of cattle rustling, improve security and hence allow resettlement in the areas previously deserted due to the insecurity situation. In the medium term, there would therefore be a reduced pressure on land and hence less pressure on the environment.

Sustainability

The AGILE concept places a premium role to facilitation of development and environmental conservation processes. Facilitation needs to be based on value addition of community aspirations. This is easier said than done due to the need for a holistic process. The facilitator is therefore seen as the trigger for a domino effect for a sustainable community driven process. This makes it a delicate process as the arena is strewn with many situations and the processes triggered must be seen to have an overall positive effect than being retrogressive. Case 3 illustrates the interconnection between different components and how these complement each other for the good of the community in a holistic system.

Conclusions

Applying theory to practice is fraught with more questions than answers. For sustainability of initiatives in livelihood and environment, there is need to evaluate who are the winners and losers in various interventions that have been undertaken. There is also need to reexamine the term community and to single out specific member groupings that need special attention. Further, it is imperative that an intra household analysis be undertaken which should form a basis for prioritization of various community level activities. There is need for a lobby on favorable policies to enable communities to inculcate conservation in their livelihood initiatives. Sustainable development requires the development of a marketing economy; this brings out the need for a functioning infrastructure as well as possibilities for public/community/private partnerships. Lesson learning in such areas would therefore provide the necessary information in the capitalization of community initiatives. There are some market opportunities which are pervasive and which may in the long run create dependency rather than sustainability. Case 4 illustrates such as situation where the development of a market economy has resulted not only in the destruction of the general environment, but also created alcohol dependency amongst some community members. This situation arises out of many other factors as illustrated in the case study. The case study finally describes the possibilities for collective action in solving some of the issues in contention.

What is clearly unfolding is that not only is their no quick fixes to community level issues especially those pertaining to NRM, but that answers unfold gradually. More cooperation amongst various institutions, through networking and collaborations is essential. The key word for development amongst partners is therefore value adding. There is need to improve upon what is existing and hence collaboratively embark on tackling the more complex issues.

References

Babu, S. and P. Hazel, 1998. Growth, poverty and the Environment in the Fragile lands of Sub Saharan Africa. Paper presented at the international conference on strategies for poverty alleviation and sustainable resource management in Uganda.

Cernea, M.M. 1994. Environmental and Social requirements for resource-based regional development. Regional development dialogue, 15(1) pp 186-200.

Collchester, M. and L. Lottman, 1995. The struggle for Land and the fate of the forests., WRI. The ecologist Zed books.

Davison, J. 1986. Who owns what? Land registration and Tension in gender relations of productions in Kenya. (Unpublished)

Deb, J. 2002. Research on Collective Action and Grassroots Innovation in Natural Resource Management: Uganda Case Studies.

Leach, M. and R. Mearns (eds), 1996. The lie of the land; challenging received wisdom on the African environment, London and Portsmouth.

Lomborg, B. 2001. The skeptical environmentalist. Cambridge Univ. Press.

Nelson M. 2002. Landcare/Africa—AGILE—Western Kenya Report (Unpublished).

Powelson, J. and R. Stock, 1990. The peasant betrayed. Cato Institute Washington DC

Scoones, I. and C. Toulmin, 1999a. Soil nutrient budgets and balances: what use for policy? Managing Africa's Soils no. 6, IIED, Edinburgh.

Scoones, I. and C. Toulmin, 1999b. Policies for soil fertility management in Africa, Institute of Development Studies, Brighton.

Tanui J. 2002. Incorporating a Landcare approach into community land management efforts in Africa: A case study of the Mount Kenya region (Unpublished).

UNEP 1997. Global Environment outlook. Oxford University Press, New York and Oxford.

UNEP/ISRIC 1990. World map of the status of human-induced soil degradation. Wageningen, The Netherlands.

The Role of Social Capital in Enhancing INRM Innovations in Lushoto, Tanzania

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Abstract

The adoption of natural resource management technologies occurs as a result of decisions made by a wide range of people. Social capital yields a flow of mutually beneficial collective action, contributing to the cohesiveness of people in their societies. Many natural resource management practices cannot be effective if adopted by a single farmer but require coordination across farms or even communities. This paper provides some findings on how social capital can serve as the basis for enhancing sustainable resource management technologies to improve productivity, equity, and the environment in the Baga watershed in Lushoto District, Tanzania. Findings highlight multiple natural resources management activities that capitalize on social capital. AHI's present success is attributed to its strategies to strengthen and capitalize on existing social capital within the community. Kinship, community and other informal networks played a crucial role in enhancing wider spread of banana technology and market access. FRGs formed a forum for social learning, working together towards some common goals and thus assisted in building a sense of shared values, identity and common purpose. As a result, forms of social capital such as increased trust, new norms of behavior, commitment to reciprocity have been developed slowly with in the community.

Introduction

Sub Saharan Africa (SSA) faces remarkable challenges of poverty and unsteady food supply. This is the consequence of extensive macroeconomic, political and sectoral reforms that have fundamentally failed to enliven substantial agricultural productivity improvements. The question of improving smallholder natural resource management (NRM) practices lies at the heart of the broader imperative for sustainable agricultural intensification in Africa today. Barrett *et al.,* (2002) commented that improved NRM is every bit as much about increasing productivity and incomes for the current generation as it is about preserving the quality of resources to safeguard the livelihoods of the future generations. The adoption of improved NRM techniques occurs as a result of decisions made by a wide range of people, each influenced by the incentive and constraints they face.

The strong presence of social groups within the Baga watershed provided a good avenue for AHI activities. Through a sensitization workshop held in Lushoto in March 1998 the AHI identified different partners which included researchers, extensionists, farmers, production organizations, NGOs and input stockists. Different partnerships were established including researchers, extensionists and farmers; partnership between researchers, extensionists and production institutions; and partnership between researchers and stockists. Partnership with farmers was based on utilizing the Farmers Research Groups (FRG) formed based on research themes. Farmers in the research groups provided land and labor, they tested, monitored and evaluated different technologies and picked up the best bets. Farmers shared their indigenous knowledge with researchers and extensionists. Researchers provided technical backstopping while extensionists offered advice and worked more closely with farmers to assist them in monitoring and evaluation. This paper was prepared with the aim of examining the role and aspects of social capital that influence enhancement of integrated natural resource management technologies in the Baga watershed, Lushoto District, Tanzania.

Background

The term social capital captures the idea that social bonds and social norms are important for sustainable livelihoods. Putnam (1993, 1995) and Pretty and Buck (2002) defined social capital as features of social organization such as networks, norms and social trust that facilitate coordination and cooperation (*collective action*) for mutual benefit. Bourdieu (1986) defined social capital as "the aggregate of the actual or potential resources which are linked to possession of a durable network of more or less institutionalized relationships of mutual acquaintance and recognition". Coleman (1988) attends that the concept of social capital cannot be captured by a single definition. However, recurring elements are that social capital involves social structures or networks which enhance certain actions, such as the adoption of a technology or practice, and trade. Social capital thus encompasses elements such as obligations, expectations, channels of information and social norms. Relationships with other actors are crucial in the concept of social capital. Social capital can be regarded as an input or production factor.

Common rules, norms and sanctions give individuals the confidence to invest in collective or group activities, knowing that others will do so too. Individuals can take responsibility and ensure that their rights are not infringed. Mutually agreed sanctions ensure that those who break the rules know they will be punished. These are sometimes called rules of the game (Taylor, 1982), the internal morality of a social system (Coleman, 1990), the cement of society (Elster, 1989), or the basic values that shape beliefs (Collins and Chippendale, 1991).

Studies by Pretty and Hine (2000) and Sigh and Ballabh (1997) showed that when people are well organized in groups with their knowledge sought, incorporated and built upon during planning and implementation, they are more likely to sustain activities. In their study of Philippines, Gabunada and Barker, (1995) found that membership in networks was positively correlated with adoption of soil conservation technologies. Nyangena (2004) found that households with more social capital have better ways of alleviating constraints and sharing information leading to more soil and water conservation (SWC) adoption. Palis *et al.,* (2002) found that kin networks, house neighborhood, farm neighborhood and membership in a farmer association are major sources of social capital among Filipinos. Social capital plays an important role in fostering the social networks and information exchange needed to achieve collective action - and in sustaining a social and institutional environment that is ready to adapt and change (Allen *et al.*, 2001). Isham (2002) reported that though Ujamaa failed but it left a legacy of local social systems that are unique in Africa: local organization, network and norms that were shaped by forced migration and government intervention.

Traditional social structures were significantly altered. Ujamaa affected most Tanzanian villages to foster active social organizations such as women's groups, burial societies, youth groups and local political groups, combining social activities with economic and political activities. Religious groups (Christian and Muslim-based groups) and economic cooperatives (farmer cooperatives, primary societies, dairy groups and credit associations), which have different purposes than social organization are also prominent in most villages. Etzioni (1995) stated that a high social capital implies high internal morality with individual balancing individual rights with collective responsibilities.

NRM technology adoption studies have handled the farmer- user ("demand") side reasonably well. Supply side issues, such as the role of social capital, extension services, private traders, and community organizations in information flow and adaptation of on-the-shelf technologies to local conditions, are increasingly recognized as important, but remain understudied (Place et al., 2002). Therefore, very little is known on the importance of collective action, the use of social capital in information flows regarding new technology options and adoption procedures, and the actual ways in which communities enhance their collective welfare as a consequence of individual farm level growth.

Methodology

Research was conducted in Baga watershed area, Lushoto District in the East Usambara Mountains of Tanzania. The research site is characterized by high population density, natural resource degradation and decline in agricultural productivity – posturing significant contest to farmers in providing for the ever-growing population while sustaining the productivity of basic resources. The watershed provides a typical topographic representation of West Usambara Mountains. The watershed is in the *"humid-warm"* agro-ecological zone with altitude ranges from 800 to 1500 m a.m.s.l with an annual rainfall that ranges between 800 and 1700 mm. Cash crops grown in the zone include coffee, tea and vegetables. Food crops include maize, banana, potatoes, cassava and beans. Livestock is characterized by zero grazing practices. Population Density ($/km^2$) ranges between 200 and 300.

Different participatory methods and tools were used to collect information in this study. Focused PRA, village meetings, group discussions and interactions with key informants and influential people were employed to achieve the objectives of the study. Interviews were done for different categories of farmers based on location in the landscape (upper, middle or lower slopes), wealth (poor, rich or middle according to criteria of wealth established by the communities) and gender (male, female, youth, and elders). Ranking was done by the different farmer categories mentioned above. Identified local institutions were also ranked to determine their level of influence and importance in NRM. Historical trend analyses were conducted to capture some historical trends of some important events. The relative importance of organizations to diverse villages and social groups was analyzed. The social organizations in each village were characterized and descriptive data on local institutions for each village compiled in the form of a table addressing diverse dimensions (strengths, weaknesses and their potential role in mobilization for NRM for non-leaders).

Results

EXISTENCE AND FORMS OF SOCIAL CAPITAL IN NRM IN THE BAGA WATERSHED

In the Baga watershed area, the governance was under local chiefs, known as 'Zumbe'. Traditional legal systems were the main check for the internal moral standards. Taboos on NRM focused on water and forests. These include forbidding cutting of some trees spp such as *Ficus thonningii* (Mvumo), *Ficus sycomorus* (Mlui), *Syzygium cordatum (*Mshiwi) *and Albizia gummifera* (Mshai) believing that whoever cuts would be attacked by evil spirits and bring disasters to the family and community in the watershed and if such trees are used as fuel wood, their smoke would kill livestock. This was a strategy to protect the environment. Women were restricted from using sooty cooking pots for drawing water from springs or rivers, with the belief of avoiding drying up of the sources. However this was set up to maintain water quality and sanitation. Maintenance of the buffer zone around water sources was done by restricting tree cutting around water sources with beliefs that there were big snakes around. *'Hande'* is a very interesting case of collective action for pest control in the sense that everyone has to apply it at the same time and the need for cultural rules against non-compliance.

During the colonial era, the Germans (1880s -1920s) and the British (1920s -1960s) colonial governments made laws and regulations to protect natural resources. Cultivation on un-conserved steep slopes would result into a 3 month's jail term for an offender. All un-conserved steep slopes were supposed to be planted with banana. There was strict enforcement of the government's laws on natural resources management thus people in the watershed feared the government. This was a formal aspect of social capital. After Independence (1961 to 1970) chiefdoms were abolished leading to the weakening of traditional common rules, norms and sanctions aspect of social capital. This period experienced a lot of changes in NRM where most practices such as ridging and terracing were abandoned and replaced with flat cultivation. There was indiscriminate forest clearing to open new land for cultivation. Abuse of water sources, streams and rivers was evidenced. During the same period cultivation on slope land, valley bottoms and swampy areas started, consequently increasing incidences of soil erosion.

In the early liberalization era (1980s) there was an increase in uncontrolled tree cutting and wild fires, cultivation very close to water sources, increase in vegetable cultivation on valleys, free grazing and non use of soil and water conservation measures, leading to further natural resources degradation. This was due to poor and or complete lack of enforcement of the by-laws that governed natural resources management. The consequences are depleted water resources including drying up of some water springs and low level of water flows in streams and rivers, reduced soil productivity and rampant and serious soil erosion, evidenced by complete drying up of some springs, increased seasonal availability of waters from some springs that also lead to low levels of water flows in streams and rivers. In the late liberalisation era (1990s to 2000s) there was a move to strengthen NRM by establishing, Joint-NRM committees e.g. Joint Forest Management Initiatives, Community Based NRM initiatives and Community Based Organizations, to minimize these NRM resultant negative effects.

CHARACTERISTICS OF SOCIAL GROUPS IN THE WATERSHED

Social groups found in the watershed are presented in Table 1. There are different types of local institutions in the watershed based on what they do. These are production (crop and livestock), mutual assistance (locally known as Kiwili/Ngemo, Ngwe), educational (schools), religious, recreational (sports and traditional dances), conflicts resolution (elders council) economical (credits) and health (mid-wives) institutions.

Table 1: Social groups existing in the five villages of Baga watershed

Village	**Type of social group**									
	Product-ion	Educatio-nal	Religious	Gender	Tradi-tional	Sports	Social service	Econ-omic	Environ-mental	Total
Kwalei	3	1	1	0	2	1	1	1	0	9
Dule	1	1	0	1	1	1	1	0	0	5
Kwekit	2	2	0	1	0	1	1	0	1	6
Kwado	1	1	0	0	1	0	0	0	0	2
belei	1	1	0	1	1	1	1	0	0	5
Total	8	8	1	3	5	4	4	1	1	27

These groups offer greatest opportunities for scaling out and up of technologies in the watershed. The presence of social groups is strong within communities in the watershed and hence a good avenue for AHI activities. The current Baga watershed community is mostly characterized by connectedness, networks and group aspects of social capital. The nature of relationships is a vital aspect of social capital. A number of social networks and collective activities were identified in the Baga watershed. Such activities are community collective action (Gunda), mutual labour assistance, sports, administrative, dairy keeping, religious, pottery, women's helping/prizing after giving birth (Ntambo), Kwalei SACCOS, Kwalei information centre, seed multiplication, mutual credit/merry-go-round (Kibati), vegetable selling, women traditional dancing (Kidembwa), and poverty alleviation. There are many different types of connections between these groups (trading of goods, exchange of information, mutual help, provision of loans and common celebrations, such as prayer, marriages, and funerals). They may be one or two ways and may be long-established (and so not responsive to current conditions) or subject to regular update. High social capital implies a likelihood of multiple memberships of organizations and links between groups. The case of mutual credit groups is one important example. These groups permit the poor to overcome one of their main constraints, namely access to credit. The case of Kwekitui village is presented in Table 2.

Table 2. Local institutions in Kwekitui Village and their characteristics

Institution	History	Strengths	Weaknesses	Linkages with other groups	Purpose	Importance to diverse Actors
Primary schools Kwekitui	Started 1974	Educate pupils	Worn few classes	Linked firm collective action	Education	Very important
Kwekitui nursery	Started 1972	Preparing pupils for P/school	-	-	Preparing children for Pr. school education	Very important
Msikiti (Mosque)	1997	Worshiping Law & order Social norms	Services Buildings Water	Facilitate collective action	Building proper moral social conduct	Very important
Midwives group (Men)	1999	First aid services	Poorly equipped	Linked to all other women group	Give midwives services to Kwekitui women	Very important
Energy saving cookers group (Men)	2002	Reduce fuel (wood) use Reduce cooking time.	_	Linked all women & collective action	Reduce fuelwood use	Very important
Kwekitui Vegetable group (Men)	2000	Practice organic agriculture	Poor equipment. Need education.	_	Cultivating vegetables using low external inputs	Very important
Umba sports Club	1991	Bring youth together Exercisers and Health	-	Has collective action m ode of operation	Promoting sports for youths	Very important
Old men group	Ancient tribal history	Uphold customary values (rain making	Diminishing membership	Uphold collective action	Preserving and promoting social customs	Very important
Mpae water pump	2003	Promoting irrigation. Training.	Yet to start	Yet to start was done via collective action	Promoting irrigated agricultural production	Very important
Livestock keepers group	2001	Credit heifer exchange	-	Linked to all	Raise farms income. Milk, nutrition	Very important

SOCIAL CAPITAL AND TECHNOLOGY DEVELOPMENT

Collaboration with production organizations was confined to seed multiplication (mainly bean and maize) where by AHI worked closely with women groups. The role of the partners here was to provide land and management. They were then supposed to sell the produce at a marginal profit to enable the poor farmers afford quality seed as most farmers could not buy improved seed because of the high prices set by stockists. Moreover, some of the seed sold by stockists is not always genuine. Collaboration with stockists was aimed at attracting them to stock inputs required by farmers. The role of the partnership was to link farmers with different input providers. Most partners are still working with AHI whenever AHI needs their inputs. The Kwalei and Mbelei women groups were engaged in seed production. The groups offered land, their labour and very good working relations. Most partnerships were mainly one way where AHI was the one who needed and demanded for the partnership with others. So a lot of energy (resources, convincing meetings) was required to win other partners. The most successful partnership has been with Irente farm, the partner who has been working with AHI on a “give and take” basis while the others have adopted the “the one way traffic approach”. Allen *et al.,* (2001) stated that two-way relationships are better than one-way. However, such relationships build up slowly as partners build up trust gradually. Therefore, AHI has enhanced a desired natural capital improvement, thus has a positive feedback on both social and human capital. In this case AHI has enhanced local and external connections with watershed communities in natural resource management for integrated watershed management.

SOCIAL CAPITAL AND NRM TECHNOLOGY ADOPTION

Research and Development practitioners are increasingly recognizing the importance and need for social capital to foster adoption of many technologies and integrated natural resource management practices, but sustained local involvement requires more than just establishing organizations on paper. One of the technologies that received high reception by the communities in the watershed is the improved banana varieties. A farmer-to-farmer exchange of banana seeds without AHI interventions resulted into a large scale adoption of improved banana in and outside the watershed area. Preliminary technology tracking studies showed that kinship, community and other informal networks initially played a crucial role in diffusion of technology and in production and distribution of banana suckers. This is a form of cognitive/bonding social capital that enhanced wider spread of banana technology.

Farmers in each village organized themselves to produce and supply the banana suckers. The farmers in four villages decided to form 'Banana Multiplication groups' (Table 3) whose roles were to manage the banana plot and eventually sell the suckers to other farmers.

Table 3: Banana suckers produced by village and variety

Village	Number of suckers produced by type per village				
	Paz	Williams	Grandnain	Mbwailuma	Total
Mbelei	5	5	5	7	22
Kwadoe	6	9	5	5	25
Kwehangala	5	10	7	7	29
Dule	7	9	6	9	31
Kwalei	6	8	5	6	25
Kwekitui	7	7	8	5	27
Total	36	48	36	39	159

ROLE OF AHI IN STRENGTHENING SOCIAL CAPITAL

The case study of soil conservation groups MOTO MOTO (hot hot), NGUVU KAZI (labour force) and UMOJA NI NGUVU (unity is strength)] in Kwlei village revealed that between 2000 and 2003, the number of farmers in the groups increased from 24 to 98 farmers. Physical conservation measures implemented were 6958 m of Infiltration ditches (Fanya juu), 9515 m of bench terraces, about 280 m of diversion channel. About 5800 multipurpose trees were planted. Farmers applied farmyard manure at different rates ranging between 1.5 tons/ha to 2.5 ton/ha. Results show that all farmers who conserved their land had a yield increase between 3 and 5 times. This is one of outstanding successes AHI experienced in Lushoto, and is attributed to AHI's strategies to promote and build social capital as well as taking advantage of existing social capital in the Kwalei community. Through collective action and willingness to work together, various groups of farmers were organized to explore market of their produce outside the watershed. This was an initiative from farmers themselves under their local connection. Farmers in Kwalei established savings and credit cooperative society (SACCOS) to overcome problems of getting credit for inputs. They also established an information centre to enable farmers to access information on NRM technologies and enabled the farmers to get access to information. The degree of integration within the community is evidenced by high level of farmer participation in farmer research groups during the technology development phase, eagerness to take up AHI technologies, fast spreading of technologies such as improved banana, tomato and soil and water conservation techniques and eagerness of surrounding villages to join the present AHI phase of scaling out. The AHI farmers' groups formed a forum for learning, working together towards some common goals and thus assisted in building a sense of shared values, identity and common purpose. As a result, outcomes of social capital such as increased trust, new norms of behavior, commitment to reciprocity and channels of information have been developed slowly with in the community. Consequently the learning that occurs within groups is not only restricted to technical skills and knowledge on integrated watershed management but has been extended to other areas.

Conclusion

Through AHI, the Baga watershed communities have become sensitized about integrated watershed management and are building upon, and added to, the existing social capital to tackle significant aspects of natural resources management. AHI has increased shared understandings and collaborative action in the watershed communities and stimulated strength of other social networks that were disintegrated due to decline in rural values. Importantly, move to seek district level support is geared to develop macro elements of social capital that will be essential to the success of the AHI approach. As a consequence, it is foreseen that AHI impacts in Kwalei and presently involved villages will gradually effect changes in attitude and social-norms of other surrounding farming communities, and therefore more sustainable farming practices will become acceptable and more generally promoted at wider scale.

References

Allen, W., M. Kilvington, G. Harmsworth and C. Horn, 2001. The role of social capital in collaborative learning.

Gabunada, F and R. Barker, 1995. Adoption of hedgerow technology in Matalom, Leyte Philipines. Mimeo

Barret, C. B, F. Place and A. A. Aboud (eds.), 2002. Natural Resources Management in African Agriculture: Understanding and Improving Current Practices, Wallington, U.K, CAB international Publishing.

Bourdieu, P. 1986. The forms of capital. In Handbook of Theory and Research for the Sociology of Education. Westport CT: Greenwood Press.

Coleman, J. 1988. Social Capital in the Creation of Human Capital. American Journal of Sociology. 94:321-351

Coleman, J. 1990. Foundations of Social Theory. Cambridge, MA: Harvard University Press.

Collins C. J. and P. J. Chippendale, 1991. New wisdom: The Nature of Social Reality. Acorn Publications, Sunnybank, Queensland

Elster, J. 1989. The cement of Society. A study of social order. Cambridge University Press, Cambridge.

Etzioni, A. 1995. The Spirit of Community: Rights, Responsibilities and the Communitarian

Palis, F. G., S. Morin and M. Hossain, 2002. Social Capital and Diffusion of Integrated Pest Management Technology: A Case Study in Central Luzon, Philippines Paper presented at the Social Research Conference, CIAT, Cali, Columbia, September 11-14, 2002.

Isham, J. 2002. The Effect of Social Capital on Fertiliser Adoption: Evidence from Rural Tanzania. Journal of African Economies, Oxford University Press, vol. 11(1), pages 39-60, March.

Place, F. B.M. Swallow, J. Wangila and C.B. Barrett, 2002. Lessons for natural resources management technology adoption and research. In Barrett C. B., F. Place and A. A. Aboud (eds). Natural resources Management in Africa. Understanding and improving current practices. ICRAF-CABI Publishing. pp 275-287.

Pretty J. N. and L. Buck, 2002. Sociall capital and social learning in theprocess of natural resource management. In Barrett C. B., F. Place and A. A. Aboud (eds). Natural resources Management in Africa. Understanding and improving current practices. ICRAF-CABI Publishing. pp 23-34

Pretty J and R. Hine, 2000. The promising spread of sustainable agriculture in Asia. Natural Resources Forum (UN) 24, 107-121.

Putnam, R. 1993. The Prosperous Community-Social Capital and Public Life. American Prospect (13): 35-42.

Putnam, R. D. 1995. Bowling Alone: America’s declining social capital. Journal of Democracy, 6(1) 65-78.

Singh, K. and V. Ballabh, 1997. Cooperative Management of Natural Resources. New Delhi: Sage Publications.

Taylor, M. 1982. Community, Anarchy and Liberty. Cambridge: Cambridge University Press.

Processes and Lessons from FRGs in Galessa, Central Ethiopian Highlands

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Abstract

Farmer research groups (FRGs) are believed to be an important means for individual farmers to share their experiences, increase their ability to innovate and speed up technology sharing and adoption. Researchers and local development agents in consultation with farmers established three FRGs at Galessa (Western Shewa Zone, Ethiopia) in 2001 to introduce soil, crop and tree-related technologies to farmer groups; upgrade farmers skill base through training and visiting forums; and document experiences and lessons from the evaluation process. The FRGs were formed and named according to specific activities (agroforestry, barley cultivation, gulley stabilization). After highlighting diverse aspects of FRG formation and organization, the paper discusses activities and strategies used to enhance the performance of these groups. The paper synthesizes lessons learnt on the objectives of forming FRGs, entry points, follow up of FRGs activities, awareness creating forums, and continuity and replication of FRGs.

Introduction

Improved crop varieties, soil conservation techniques and adaptable tree species are the most important interventions for Galessa area (Kindu and Taye, 1997; Amsal and Bekele, 1997). The existence of technologies from the research system was an opportunity to introduce and test them with individual farmers. However, dealing with individual farmers would not speed up promotion of technologies and bring the desired changes. In 1999, the Holetta Agricultural Research Center (HARC) in collaboration with International Fund for Agricultural Development (IFAD) and other stakeholders established the farmer field school (FFS) approach in Galessa for empowering and supporting farmer participation and implementation of integrated management of late blight (Olanya *et al*., 2000). Since 2001, HARC in collaboration with African Highlands Initiative (AHI) has run research on natural resources management (NRM) interventions with farmer research groups (FRGs). Three FRGs were established at Galessa (Western Shewa Zone, Ethiopia) in 2001 to introduce soil, crop and tree-related technologies to farmer groups; upgrade farmers skill base through training and visiting forums; and document experiences and lessons from the evaluation process.

Background

Farmer Research Groups (FRGs), Farmer Field Schools (FFSs) and Local Agricultural Research Committees (known by their Spanish acronym, CIALs) are some of the most widely applied participatory research approaches. The size of FRG members varies from 10 to 45 (Knox and Lilja, 2004). Composition of members in FRGs took three forms: groups whose members were only women; members only men groups; and mixed groups. Farmer Research Groups are important for farmers pursue wider concerns, initiate new activities, organize collective action, and develop linkages with external organizations (CIAT, 2003). Working in FRGs makes it easy for farmers to learn from one another; allows scientists to work with more farmers; and increases the overall efficiency of innovation (Johnson and Morris, 2002).

Many countries in the developing world have adopted the FRG approach to enhance the skills of farmers and promote various practices and technologies. FRGs have been operational in Kongo, Ethiopia, Kenya, Madagascar, Malawi, Rwanda, Uganda and Tanzania. Lessons from FRGs in these countries showed that the number of farmer groups were high when a new development program was introduced. This is because of the expectations of handouts from the new development programs, and many such groups collapsed once they realized that the new program was not providing handouts. A study of 21 FRGs in Uganda indicated that participation in these groups followed a U-shaped pattern. Participation was initially high when groups were formed, then declined as members dropped out and motivation waned. Once groups showed successful results, more farmers joined the group. The poorest farmers appeared to participate in equal numbers with less-poor farmers, and women tended to dominate FRG membership, although men tended to occupy leadership roles in mixed groups (CIAT, 2003).

FRGs operating on long-term investments such as tree planting and natural resources management are limited. The focus of the FRGs in most African countries is on variety development. Experiences in Tanzania showed that through FRGs approach farmers could reduce the problem of potato late blight, increase the yield of potato tuber, improve storage of new seed varieties, and improve communication with other farmers, government and NGO (Farm Africa, 2004). Moreover, FRGs through field days could provide opportunities for none member farmers to assess crop varieties in the field and make informed decisions about using them in the future.

Formation and Evolution of FRGs

Initiation of FRGs: The site team went to Areka (southern Ethiopia), visited the AHI benchmark site, discussed with researchers and managers, and went to the field to learn about participatory research experiences. Researchers found out from Areka that groups are formed based on farmers' interests. Upon return from Areka, training on participatory resources management; group formation; and responsibility sharing was given to more than 35 farmers at Galessa. Through frequent contact and discussion, some farmers showed interest to be members of FRGs for enhancing their capacities and overcoming some of their problems.

Establishment of FRGs: FRGs were formed and named on the basis of activities (agroforestry, barley and gulley stabilization). It is only those farmers who tested the barley varieties, the tree species, and were involved in gully rehabilitation that were considered members of the FRGs. Other farmers visited those FRGs and contributed ideas to the experimental plots. The GULLY group has been operating since 2001. The BARLEY group started in 2001 and phased out in 2002. The TREE group has been operational since 2002. The number and composition of the three FRGs was not uniform. The members for the TREE, BARLEY and GULLY groups were ten, seven and over 29 respectively. Fifty percent of the members of the TREE group write and read. Eyob and Hailu (1997) categorized the farmers at Galessa into upper, middle and low wealth categories. Majority of the TREE group (60 %) is in the middle wealth category (Table 1).

Facilitation of FRGs: The researchers and the development workers facilitated the establishment of the research groups. Election of the chairman and secretary was executed for each group. Farmers considered dedication, facilitation capacity and respectfulness as major criteria while electing their chairman and secretary. The roles of different FRG members were clearly identified. The chairman of the different groups facilitated group work, meetings and experience sharing field visits. The secretary assisted the chairman and prepared reports for various issues that took place during the meetings and field visits. The chairman and the secretary served on voluntary bases. No special benefits were allocated to the two positions. Members of each group were responsible for allocation of plots for experimentation, proper management of research activities and sharing of experiences to group and none group members.

Selection and Testing of Technologies

GULLY group – The communities and the researchers identified three gullies. One gully was treated with loose-rock check-dam, the second with a brushwood check dam and the third with a combination of loose-rock check-dam and brushwood check dam.

TREE group – Initially, three tree species that adapt in the Galessa environment and contribute to the fulfillment of needs of farmers for fuel, fodder and soil fertility were identified. The three species were *Chamaecytisus palmensis*, *Acacia decurrnse* and *Hagenia abyssinica.* Each farmer in the TREE group received

150 seedlings from three tree species. The farmers planted the seedling on available sites around their homesteads and proceeded to manage the seedlings.

BARLEY group – Released barely varieties (3369-19, HB-42, *Shege* and *Ardu*1260B) and a local barley variety (Baleme) were evaluated with two fertilizer levels (F1 = 21:23 and F2 = 41:46 N: $P_2 0_5$ kg ha^{-1}). Researchers provided the varieties and the fertilizer to farmers, while farmers allocated land for evaluating the packages and managed the plots from land preparation to harvest.

Organization of capacity building forums

Field days: Researchers, in collaboration with members of the FRGs and development agents, organized two field days to share experiences from on-going activities. More than 400 farmers visited activities carried out by each FRG. (Figure 1).

Figure 1: Evaluation of gully stabilization activity by farmers, researchers and extension agents

Trainings: The researchers organized two training programs for farmers, development agents and other stakeholders. The training for the TREE group included methods of tree seed collection, raising of seedlings, methods of planting seedlings, tree management, protection and utilization. The BARLEY group, on the other hand, were provided with information on barley production systems,characteristics of some released food barley varieties, cultural practices and barley utilization.

Field visits

The researchers organized one experience exchange sharing visit and discussion forum in Galessa. In this occasion farmers from different districts and kebeles, farmers within the same kebele, development agents and local administrators were invited. Trees planted by the TREE group and the barley plots managed by the BARLEY group were visited and experiences shared.

Motivation

The researchers created a forum and rewarded innovative farmers. The reward was in the form of a certificate and material incentives. The farmers themselves selected the innovative farmers. The farmers that were first received one sickle, shovel, digging hoe and a certificate. The second farmer was awarded a certificate, hoe and shovel. The farmer that was third received a certificate and a hoe.

Methodology

Secondary information, observation, discussion and process documentation are some of the methods used for the study. Description of farming systems, wealth ranking of farmers, major problems, existing opportunities and proposed interventions of the area were obtained from previous PRA study documents. Site selection for gully rehabilitation, testing of varieties and tree planting was conducted through observation of communal lands and individual farm holdings. Performances of activities for FRGs in the field were evaluated through observation. Discussion was used during group formation, and planning of interventions, implementation and feed backing. The whole stories of the FRGs were made available through process documentation.

Results

Entry points: Farmers were able to produce both in the short and long rainy seasons, and sell 100 kg of good quality potato seed with 300 Birr (exchange rate was USD 1 = Birr 5 at the time) from introduced potato varieties. As confirmed from farmers and development agents, the entry point was successful and gap filling. As a result, farmers developed confidence in researchers and this led to the current good rapport among researchers, FRGs and non-FRG members.

Participatory approaches: The knowledge of some researchers and technicians with regard to participatory approaches and their application was not adequate. The researchers and technicians who facilitated some of the FRGs lacked experiences on how to involve farmers in the research process. There was a case where members of FRGs at Galessa could not tell the objectives and processes of experiments that had been carried out on their farms. Some researchers had also carried out inadequate process documentation of research activities conducted by members of FRGs. When thinking of forming FRGs, it is essential either to provide trainings for researchers and technicians or include researchers and technicians that have good background on participatory research and development approaches.

Objectives of FRGs: Farmers are familiar with compensations or handouts especially when they handle on-farm research activities. Sometimes they go to an extent of asking payment for cultivating, weeding and managing their own on-farm plots. The experience from homestead tree planting at Galessa showed a high level of farmers' handout expectations (Personal observation). Farmers expected the researchers to provide wood for fencing planted trees and other tree management tools. Researchers used to offer seedling of tree species and yearly payment for the land planted by trees. Making the objectives clear for members of FRGs from the beginning and involving farmers in the planning process minimized handout expectations. It also enforced farmers to be innovative and depend on their own available resources.

Meeting and working dates: Farmers at Galessa do not conduct farm activities on dates like 5th, 12th, 19th, 27th and 29th because of spiritual beliefs. Organizing visits, trainings and meetings sometime in the forgoing dates helped to involve many of the farmers.

Awareness creation forum: The different awareness creation forums (field days, trainings, field visits and motivation) assisted the laggards to learn from the innovative farmers, the farmers to know more about the research outputs and the researchers to understand more of the farmers' needs and priorities.

Stakeholders' participation: Development agents, local administrators, primary school head master and teachers actively participated in the field day and other capacity building forums. The involvement and awareness of the local administrators in the FRGs activities had multiple advantages. First, the administrators could get information on some issues that need policy considerations. For instance, in the case of gully lands, gullies are properties of communities. If the landholders adjacent to the gullies are secured with use rights of gullies, they can handle and manage them better than distant farmers. Farmers that are far from the gullies do not feel the effects of the gullies as those farmers who hold pieces of farmland close to the gullies. The local administrators who participated during some of FRGs field days observed the problems related to ownership of gullies. Secondly, participation of the administrators helped to create smooth relationships and identify further collaborations. In addition to local administrators, participation of development agents, primary school headmasters and teachers in FRGs events facilitated dissemination of information to non-participating farming communities. By working closely with the development agents, the researchers and technicians could limit frequencies of traveling to the benchmark site.

Provision of awards: Awards encourage farmers and create a competitive but healthy atmosphere as they try to outsmart one another. Most farmers in the TREE group demonstrated better management of planted trees. This happened after attending the first award ceremony. Every farmer tried his best to be a winner for other possible awards.

Follow up of FRGs: Farmers initially showed a high level of interest to be members of different FRGs. For instance, at the initial phase, some members of the TREE group planted, protected and managed seedlings poorly. Others in the middle of the process left out the seedlings unweeded and unfenced. There were also innovative farmers that properly planted, managed and protected the seedlings. Through frequent follow-ups and backups, it was possible to lift up laggards up to a level where they can at least manage the trees and see a difference.

*Establishment of FRGs***:** Most of the gully stabilization and tree management issues required time and dedication. Since most farmers live in a hand to mouth situation, they frequently run for short-term benefits. It is therefore better to approach farmers, local decision makers and development actors very closely, discuss the seriousness and extent of the problem and start forming FRGs with potential interventions.

Replication of FRGs: So far, there is less concern for the continuity and replicability of the three FRGs operating at Galessa. No one cares about continuity once a specific FRG program is terminated. Financial limitation is one of the factors that retards the continuity and replicability of FRGs. Nevertheless, an activity phasing out strategy needs to be designed before the formation of FRGs in order to sustain and broaden some of the lessons.

Conclusion

Most farmers in the FRGs have been impacted in terms of knowledge and outputs from tested technologies. Strong ties among researchers, farmers and other development partners have also been built while implementing FRGs. The trainings, field visits and other experience sharing mechanisms have been found instrumental for the farmers to learn more and continue as volunteer members in the FRGs.

Clarification of objectives of FRGs at the beginning minimized handout expectations and enforced farmers to depend on their own available resources. Similarly, frequent follow-ups and backups promoted laggards to a level where they could at least manage trees and crops, and see differences. The involvement and awareness of the local administrators in the FRGs activities was useful to enable them get information on some issues that need policy considerations, create smooth relationships and identify further collaborations.

Experiences of the three FRGs entail to consider the following for successful operation of FRGs in the future:

1. Members of FRG are better not to live far apart to enhance day-to-day communication and exchange of experiences.
2. Researchers and technicians who facilitate formation and operation of FRGs need to have better skill or exposure of participatory research.
3. Women farmers are very few in the FRGs. It can be helpful to evaluate the composition of members while forming FRGs.
4. Periodical experience sharing among participating and non-participating farmers, and development agents, local administrators and researchers is essential to evaluate failures and strengths.

References

CIAT, 2003. Farmer research group dynamics in eastern Africa. Highlights, No. 8, Kampala, Uganda. p 2.

Kindu M. and B. Taye, 1997. Soil and trees sub-system. *In*: Kindu M., Hailu B. and T. Alemu (eds). Natural resources management at Galessa Kota Gisher and Garie Arera peasant associations, Dendi Wereda, Western Shewa, Ethiopia. PRA survey report. Institute of Agricultural Research, Addis Abeba. Pp 2-10.

Amsal T. and B. Bekele, 1997. Crop sub-system. *In*: Kindu M., Hailu B. and T. Alemu (eds). Natural resources management at Galessa Kota Gisher and Garie Arera peasant associations, Dendi Wereda, Western Shewa, Ethiopia. PRA survey report. Institute of Agricultural Research, Addis Abeba. Pp 11-25.

Eyob M. and B. Hailu, 1997. Social sub-system. *In*: Kindu M., Hailu B. and T. Alemu (eds). Natural resources management at Galessa Kota Gisher and Garie Arera peasant associations, Dendi Wereda, Western Shewa, Ethiopia. PRA survey report. Institute of Agricultural Research, Addis Abeba. Pp 31-41.

FARM-Africa. 2004. Tanzanian smallholder farmers link with the private sector and win FARM-Africa's first innovation award. News release, Tanzania. p 4.

Johnson S.E. and T. Morris, 2002. Farmer Research Opportunities: Resources to test your ideas on your farms. The Southern New England Farmer Research Network, *The Natural Farmer*, USA. p 4.

Knox A. and N. Lilja, 2004. Collective action and property rights for sustainable development. Farmer research and extension, 2020 Vision for Food, Agriculture, and the Environment, Colombia. Focus 11, Brief 14 of 16. p 2.

Olanya O.M., Bedewy R. E, Ewell P.T., Hakiza J.J., Alacho F., Ngombe B., Kassa B. and G. Woldegiorgis, 2000. Integrated management of late blight through farmer field school: Achievements and constraints in Uganda and Ethiopia. In: African Potato Association Conference Proceedings, Vol. 5. pp. 337-345. African Potato Association, Uganda.

Safeguarding the Rights of the Poor to Crucial Land and Water Resources: The Evolving Links Between Land Rights and Water Access in the Nyando Basin of Kenya

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Abstract

The Nyando basin of Western Kenya is an area of variable population density, high and variable poverty, agricultural stagnation and severe degradation of land and water resources. The Nyando basin covers 3500 km2 of Nyando, Kericho and Nandi districts and drains into the Winam Gulf of Lake Victoria. Most households in the basin lack access to safe drinking water and water associated diseases are a major cause of morbidity and mortality. Households that want to use water for irrigated agriculture or confined livestock production generally need to haul water over long distances, especially in the dry season. Yet the river Nyando has an extensive system of tributaries, flooding is a perennial problem in many lowland areas, and a high percentage of total water yield is deposited in Lake Victoria.

It is postulated that one of the constraints on water access in the Nyando basin, and elsewhere in Kenya, is the system of individualized land tenure that pertains in the region. Indeed, the Kenya Ministry of Water Resource Management and Development is raising this as a key issue for the ongoing Kenya land policy review. In this paper we review evidence on this issue from villages across the Nyando basin.

Information on community development priorities from 20 villages in Nyando and Kericho districts indicates that 10 of the 20 villages rated inadequate supplies of safe drinking water as one of their top 5 priorities, with two villages indicating safe water as number one priority and four villages indicating safe water as number two priority. Surveys in 12 villages across the basin indicate that most households rely on water from a limited number of water points, mostly places where roads cross rivers and some springs. Women and girls have primary responsibility for collecting water for home use and women bear most of the costs associated with poor health.

The pattern of individualized land ownership clearly limits access to water, despite cultural norms that everyone has a right to water and laws that stipulate that riverine areas are public land. In practice, individual households farm land right to the river edge particularly in areas that have been subdivided by land buying companies. Access to rivers is easiest near bridges which are on public land. Other access routes all across through land of particular farmers who may only tolerate such access. Farmers often erect fences and other barriers that have the de facto effect of denying access to water points.

Springs are a point of particular opportunity and conflict. Spring water is generally of high quality. Impact assessment studies show that spring protection can be very effective for enhancing water quality, reducing the amount of time that women and children spend collecting water, improving family health, and reducing environmental damage through uncontrolled water flow and uncontrolled livestock grazing. However, almost all springs are located on the land of individual households – those households must agree to set aside part of their land for the spring and allow people to pass through their land to access the spring water. There is a strong need for formal or informal easements on private land to allow easier access to springs and other water points.

Gender Analysis in the Adoption of NRM Technologies in the Highlands of Kabale

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Abstract

The decline in agricultural productivity caused by the degradation of natural resources is one of the root causes of poverty in the highlands of Kabale District, Uganda. In recent decades several natural resource management technologies have been developed and introduced to farmers. However, their adoption and impact appears to be limited and there is little systematic or empirical evidence for their use by poor farmers. This study hypothesized that neglect of gender variables in the technology development and diffusion processes is one of the reasons for lack of adoption of natural resource management technologies. The study assesses the constraints faced by women and men farmers in applying various natural resource management technologies, and explores opportunities for integrating gender into research and development activities and natural resource management policy formulation. Participatory rural appraisal methods were used in conjunction with conventional household sample survey questionnaires (120 respondents) disaggregated by gender. Data was analyzed by using a combination of qualitative and quantitative techniques. Several factors were found to influence a farmers' adoption decisions. These include: the degree to which the technology is appropriate for farmers' conditions, compatibility of the technology with the local farming systems marketing opportunities, and how the technology is presented by extension and other information systems. The paper concludes with a discussion of strategies for incorporating gender to increase the participation of both men and women in sustainable management of natural resources.

Fostering Social Organization for Strengthening the Demand Side in R&D: Lessons from South Western Uganda

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Abstract

The African Highlands Initiative (AHI) fosters social organizations (farmer research groups) as avenues for enhancing engagement of research and development partners with target rural communities. Farmer research groups and local level research committees have been formed and their capacities to manage research activities enhanced since AHI's inception in 1995. The social organizations are aimed improve the impacts and benefits on a wider scale than that achievable through an individualized approach to community engagement. In collaboration with CIAT, AHI trained researchers in basic principles of farmer group formation and management. With time, the new National Agriculture Advisory Services (NAADS) emerged and contracted AHI and collaborating partners to foster farmer institutional development to demand and contract agriculture services providers in a policy context of declining government extension services. Participatory processes such as appreciative inquiry and stakeholder dialogue and consensus building were used to inventory farmer groups and train them to demand for priority agricultural services from private service providers. Results indicate that while many farmer groups emerged at the onset of NAADS in 2001, their capacity to contract service providers was weak, as was their capacity to influence policy change and action. This undermines NAADS objectives of empowered farming communities demanding for services. The success of this paradigm is undermined by power dynamics, limited capacity for consultation and decision making on community priorities, poor management of financial resources, and lack of rigor in selection of technologies and innovations intended for training and dissemination . The lessons shared in this paper highlight principles to be considered as new ways of working with farmers and partners emerge.

Enhancing Gender Inclusion, Equity & Social Awareness: Approaches, Lessons and Implications for Watershed Management

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Abstract

Most agricultural research and development initiatives are increasingly making claims of farmer empowerment, gender equity and poverty focus. However, despite progress in creating awareness of these issues, there are concerns that most projects have not improved gender relations, and that women, the poor and other social categories may be in fact excluded from participatory projects. There is a tendency to count the numbers, desegregate data by sex and wealth categories or describe the roles and constraints of men and women, or different categories of farmers, with little systematic effort to understand the dynamics of social relations and other forms of social differentiation within the community. The narrow focus on gender and poverty issues, often limited at identifying different needs, roles and constraints of women or women's issues, obscures other aspects of social differentiation inclusion, equity and social differences within and beyond communities. This paper presented an overview of approaches, achievements, best practice and gaps for integrating scientific use of gender and social analysis, as an integral part of research process. Approaches used for social inclusion, gender, equity and social awareness have largely focused on participatory rural appraisal (PRA), which has become equated to doing participatory research, and empowering farmers. However, their one-off event and lack of attention to process issues limit their usefulness to address inclusion and equity issues. Similarly, local institutions created as part of participatory approaches, whether farmer research groups, watershed committees, farmer field schools, may exacerbate existing forms of social exclusion, particularly for women and poor farmers, who may not be able to absorb the cost of participation and experimentation. The use of concepts such as farmers, communities, groups, watershed committees, associations mask important social differences. Questions of who participates, who decides, who benefits, and how are left unanswered.

The paper explored barriers for participation and inclusion of different gender categories and for enhancing equity and social inclusion in participatory research and development initiatives. It also highlighted approaches and strategies to build more inclusive, longer term participatory approaches for engaging with different categories of farmers and stakeholders, through more interactive, participatory learning and action research approaches, rather than quick technology and organizational model fixes for watershed management. Unless concerted proactive efforts are made to enable effective social inclusion, gender, equity and social awareness, claims of inclusiveness and equity of participatory watershed management will rather remain rhetoric.

Cultural Limitations to Women's Participation in Integrated NRM in Lushoto, Tanzanzia

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Abstract

Degradation of natural resources has had different impacts on the livelihoods of different gender groups in the highland ecosystems in East Africa. Historically there are different divisions of labor in the farming societies where women, the youth, men, elders etc have specific roles to play for the social and economic well-being. However the existing gender relations marginalized women and placed them at the backside, hiding their potential to contribute to technological change, improved natural resource management and livelihoods. A follow-up on the impact of AHI and partner intervention through participatory research approaches in the Baga watershed revealed that community involvement, changes the attitudes of the people, women themselves and the whole community towards women, recognizing them as equals and it becomes supportive. Women are very active participants in the technology transfers and adopters of different technologies.

Chapter 5:

Technology Uptake Mechanisms and Pathways

Understanding Effective Technology Dissemination Approaches: Comparison between FFSs, FRGs and Conventional Extension Approach in Kenya

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Abstract

In Kenya, extension agents have used several approaches to transfer technology from research to farmers. Analysis of these approaches reveals that there exist conflicts between the farmers' goals and the national goals. The national goals are broad and do not focus on farmers' needs and thus lack effective farmers' participation in their design. Various agencies in Kenya have shown a necessity to change in agricultural development towards farmer's participation to increase effectiveness and enhance efficiency in agricultural production. Farmer participatory research emerged as a response to the generation of appropriate technology by the scientists at research stations whose work was based on the transfer of technology model. The major objective of the people working in participatory research was to develop more efficient research approaches that would generate more appropriate technologies to solve the production problems of the farmers. There has been a lot of evolution of research and extension participatory methodologies since 1966. The move towards demand driven extension and farmers participation in technology development and transfer calls for cost-effective dissemination approaches. In western Kenya, African Highlands Initiative programme has funded projects since 1995. In 1997, the programme started its Phase II, which focused on community participation through farmer research groups. Later the program realized that there was need to identify and facilitate a cost - effective dissemination approach for the technology by farmers culminating into formation of three farmer field schools. Two of the groups were extension – led and one was farmer-led. The purpose of the FFSs was to build capacity of the farmers so as to enhance their ability to sustain some of the technologies at the benchmark sites and to equip them with knowledge and skills for further dissemination of technologies. This paper examines the two models of FFS, the farmer-led farmer field schools and the extension-led farmer field schools currently used in western Kenya in context of technology development and transfer, and compares them to the farmer research groups and conventional extension approaches in enhancing the adoption of relevant soil management technologies. The results presented from the schools indicate that, FFSs have a positive impact on farmer participation as evidenced by increase in group dynamics and commitment to technology adaptation and adoption. Graduate farmers from FFS have gained new knowledge and skills, which they are transferring to other farmers. The paper concludes that FFS (the farmer-led farmer field schools and the extension-led farmer field schools) is adoptable, sustainable and has significantly contributed to the increase of income and improved livelihoods of the participating farmers.

Introduction

The Ministry of Agriculture (MOA) and other development partners have applied several approaches to disseminate appropriate technologies to farmers in Kenya. These include conventional extension methods like using the progressive farmers or contact farmers who were referred to as the diffusion multipliers; the commodity extension approach, the training and visit (T&V), integrated rural development approach (IRDP), and the farm management approach. Analysis of these approaches has revealed that the technologies were not adopted by farmers either because the technologies were developed and recommended without considering the socio-economic conditions of farmers or there existed a trade off between the goals of the farmer and the national goals in that, if the national policy would be interested in increasing farm production, for securing foreign exchange earning while pursuing weak food policy then there can be a problem.

In realization of the weaknesses of the conventional extension approaches as dissemination pathways, the farming systems practitioners and proponents of participatory research developed approaches with stronger farmer participation. The development of farmer participatory research and extension approaches has evolved from farming systems research (FSR) in 1966 to more recent farmers field schools (FFSs) in1995. What are key differences in these approaches as they evolved? What sets them apart from the earlier ones that were less successful? CITE relevant literature, and develop into a full Literature Review section.

Background

In Western Kenya, the conventional research and extension approach used a 'linear' transfer model in which the information was generated by the researchers without the involvement of the extension agents and the farmer. The extension agents were used as conduits to transfer the innovations/technologies to the farmers without necessarily getting feedback. However, with the emergence of T&V, the researchers were occasionally invited to facilitate during the fortnight extension training sessions at the farmers training centre (FTCs).

Vihiga is one of the districts in western Kenya, which has benefited from many projects being funded by research and other development partners. Despite its geographical suitability for agricultural development, there is no FTC and the Ministry of Agriculture has to rely on Maseno FTC in Kisumu district and Bukura FTC in Kakamega district for training their staff and the farmers. However, the extension agents in the MoA have continued to use the several extension approaches to disseminate technologies to the farmers.

Despite, the development of several extension approaches in the last decade, there has been little impact with the research and extension approaches. There is a growing concern about farmer participation in dissemination and adoption of technologies in advent of high extension turn over with reduced budgetary allocation to extension services. These problems can only be solved if extension services, adopts new cost- effective and sustainable dissemination approaches, like FFS. (Roy 2000, Rola et.al 1996)

In order to reduce fiscal burden, and thus encourage sustainability, the principle of farmer-trainer has to be taken on board. The concept is to encourage FFS graduates to train other farmers (Farmer-to-Farmer extension) and there by reduce the dependence of FFS on significant official funding support. For this purpose, selected and interested FFS alumni are invited to attend special training of trainer (TOT) sessions so that they themselves become schooled in experience-based learning methods and can organize and facilitate their own field schools using local resources (Quizon et.al 2000)

This paper examines two models of farmer field schools; the farmer-led and the extension-led currently used in western Kenya in context of technology development and transfer and compare them to the farmer research groups and the conventional extension approaches in enhancing adoption of relevant soil improvement technologies.

Research Objectives

- To assess and compare the working principles, practices and effectiveness of the conventional extension approaches with the farmers participatory research approaches (AHI approach, Farmer Field Schools) of technology dissemination.
- To determine the limitations of the conventional extension approaches in effective dissemination of technologies.
- To establish if the farmer's participatory research approaches can empower the farming community to sustain the learning process, build their own capacity to be able to innovate and experiment with the technological options for improved livelihood and farm productivity.

Methodology

The study adopted a four-stage approach in information gathering and synthesis. This included review of the literature, community fora, and individual household visits and focus group discussions. The selection of the four stage approach was due to the fact the farmers' participation in research is a new development and needs extensive discussion to gather relevant information. Some of the members of the FRGs and FFSs were youngsters and had no knowledge of the conventional extension approaches and could only benefit from focus group discussions and community fora.

Literature review was done to get more insight on the conventional extension approaches and the farmer research approaches so as to strength the already available information. The information gathered on conventional extension was later validated for reliability through face-to-face discussions with the District Agricultural Officer of Vihiga District.

The community for a were organized to attest the view of the FRGs on various technological options, which they had implemented, between 1997-2001. The community forum was organized on 14th November 2001 at Mukhombe primary school, Emuhaya Division in Vihiga District. The forum was attended by all FRG members from the five villages (Emanyonyi, Mukhombe 'A', Mukhombe 'B', Muhonje, Wobaria and Mwilonje) and others from the neighboring villages who had developed interest in the technologies, eight research officers (7 from Kari-Kakamega and 1 from TSBF-Maseno) who were the principal investigators (PIs) of the options, four divisional extension officers, the social development assistant, the local provincial administrator and the community facilitator. The PIs highlighted on their activities and the FRG members were invited to comment on the presentations. The FRGs comments were captured, analyzed and were used to follow up individual technology uptake.

Two research officers and the community facilitator conducted individual household visits. The members of the FRGs joined the team and assisted in translation of language incases of misunderstanding on some technical issues. The activity took one week. During the visit, a checklist which was used contained some of the concerns of the FRG members captured during the community forum and other cross cutting issues on the technological options selected at implementation. The results of the individual visits were analyzed and used to categorize the FRG members into different technological options of: high quality manure group, green manure group, striga tolerant varieties group and the improved fallow group for focused group discussions. The focus group discussion was the last stage of assessment of technologies dissemination approaches and was facilitated by the researcher to the FFS participants.

Focus group discussions were organized for the three FFSs, the two extension-led and one farmer-led. The researcher had a series of prepared questions on the different approaches (conventional extension, FRG and FFS) but centered on the technological options tested at farm level. The questions were subjected to a test by cross-examining the extension-led facilitator and farmer-led facilitator on the developed school curriculum. This was done to ensure that the facilitators covered the relevant issues as some of the focus group discussion questions were drawn from the curriculum. The focus group discussion was conducted on Tuesdays and Thursdays for the extension-led field schools and on Fridays for the farmer-led field school. Three visits were made to the field schools to accomplish the information gathering process. The FFS participants' responses were captured, analyzed and documented. All the information gathered through the four-stage approach was by process documentation.

The sample of the study was all members of the community from 5 villages who participated in the FRGs and FFSs who are small-scale farmers that are faced with low productivity, all extension agents in Emuhaya division and the District Agricultural Officer.

Results

The Extension agents in the MoA, until very recently rarely acknowledged farmers' traditional knowledge to integrate technologies in their farming system so as to innovate. The extension agents would not avail enough time to understand the farmers' socio-economic circumstances and farming aspirations and were busy pushing technologies developed from the research stations. Neither the extension nor the farmers had the deep understanding on some of technologies that the farmers were expected to adopt.

There was no proper feedback mechanisms in case of a technology failure to meet the farmers need. Feedback could be awaited from the researcher during the fortnightly training session or occasionally when farmers had a chance to attend the annual ASK shows. This type of approach was referred as conventional model of technology development and transfer and commonly known as top-down approach. Farmers lacked ownership of the whole technology development and could not query any shortfall. This led to low adoption of technologies and the cause of increased and continued poverty.

African Highlands Initiative (AHI) an eco-regional programme in collaboration with KARI-Kakamega has promoted participatory research activities in Vihiga district, western Kenya since 1995. The programme borrowed and integrated different perspectives in solving farmers' production problems. During 1995-1996 (phase I), it adopted the conventional research approach, which focused on technology development with individual farmers through small grants. After one year, it was realized that majority of the farmers involved in the trials did not benefit from the technologies developed as most of the researchers focused more on academic centered research without considering the farmers socio-economic circumstances and constraints. There was no farmer participation. The lessons learnt after that period (1995-1996) assisted the programme to make a shift in the approaches. Since 1998 various farmer participatory methods have been used for testing and development of technologies related to soil fertility management, varietal trials, and pest and disease management. The overriding advantage of farmer participatory research was to make use of farmers indigenous knowledge and circumstances and to exploit their experimental capacity on how the technologies could be applied. AHI used learning groups of farmers, called FRGs. FRGs identify and prioritize their problems and also agree on some of the collective actions to engage in collaborative research in which the researchers and farmers participate. The FRGs enhanced farmer livelihood strategies to drive technology development.

EVOLUTION OF VARIOUS EXTENSION APPROACHES

Conventional agricultural extension approach

The conventional agricultural extension approach (CAEA) was post a independence (1960's-1970's) approach, developed for all farmers but because of fewer extension workers who were well trained to teach farmers, target groups were frequently identified. These were referred as diffusion multipliers and were mainly demonstration farmers, progressive farmers or contact farmers. Despite the popularity of the CAEA in the early decades, it had weaknesses especially at individual farm level and at the national level as it (CAEA) focused more on products that earned the country foreign exchange but gave little attention to food policy.

The concentration on a few progressive farmers was meant to be seen as a means of multiplying extension effort to many farmers who could not be reached by meager extension personnel. The contact and progressive farmers who were the beneficiaries of the technology in most cases were well-to-do people. Although majority of the contact/progressive farmers had very little interest in dissemination of the technologies, the proponents of the approach assumed that since the technologies were given to the rich people, then definitely the poor would adopt. This type of well-to-do farmers could not be accessible by the under privileged or resource poor farmers within the neighborhood. It was also found that some of the technologies given out to these contact farmers did not meet their farming aspirations but were accepted for social status in the community. Since the extension officer only concentrated on one contact farmer, the other members in the community developed negative attitude towards whatever was demonstrated in such farms. This approach created serious economic and social disparities among farmers. The idea of giving free inputs to the farmers so as to encourage them to farm was not sustainable and contributed to the collapse of the approach. Some of the early conventional approaches were:

Farm Management Approach to Extension

This was the first post-independence extension approach, introduced in 1960's and was aimed at encouraging farmers to adopt farm management principles to run a farm as a business. It was basically intended to cater for farmers who had acquired land from the white settlers and were interested in commercial farming, but later extended to cover all the farmers including small-scale farmers. It involved assisting farmers to draw up plans and budgets to be used when applying for loans. The extension agents of the MoA did the implementation of the approach after the loan approval and follow-up. The project was a joint venture of the Land and Farm Management Division of the MoA and the Agricultural Finance Corporation. The project's weakness was that it focused more on loan recovery without understanding the level of farm productivity and it did not put measure of sustainability of the credit scheme. The approach faded with the discontinuation of credit.

Integrated Extension; Integrated Agricultural Development Project (IADP)

This approach started in 1976 and was aimed at addressing and eliminating input and marketing constraints of the farmers. The approach mainly focused on arid and semi-arid areas. It was a donor-assisted with its own management and technical systems. It was production oriented and emphasized on integrated approach, often in specific geographical areas. The approach focused on provision of inputs, credit extension, marketing and other agricultural services, which were provided as a package and also supported construction of access roads. However, the project proved unsuccessful due to administrative problems and poor loan recovery. This was one of the approaches, which could have uplifted farm incomes and improved the farmers' livelihoods since it took care of non-extension factors that affect production.

Training and Visit System (T&V)

This approach introduced in 1982 as the National Agricultural Extension Project (NEP 1) was meant to improve on the effectiveness of the conventional extension with the objective to increase individual farm production and income. The basic assumption was that if farmers increased their production and incomes, the national agricultural production would also increase. T&V aimed at improving the conventional extension approach by improving the technical skills of the extension workers through regular (fortnightly) training and progressively monitoring and evaluation of extension workers and also to improve the linkages between the extension and other information users. The training sessions were normally conducted at the government farmers training centers (FTCs). The FTCs which were supposed to be avenues of dissemination of technologies, were also faced with financial problems. Kandie (1997) reported that the FTCs were under utilized with only 15% of boarding capacity per year being utilized. Moreover, real farmers' courses constituted only 21% of the courses conducted, the rest being non-agricultural courses. For this reason, the FTC contribution to dissemination of new technologies to farmers was almost negligible and the implementation of T&V were grounded almost to stand still as resources needed for regular training were unavailable hence the researchers were not able to participate. Those who designed the T&V system of agriculture extension assumed that the problem facing farmers was not due to available technology but deficiencies by the then existing extension services. The solution therefore was to create a better extension service where farmers could get timely and appropriate information about agricultural technologies, which they could adopt without question. However, the proponents of T&V approach did to provide tools for management of the flow of scientific knowledge from the research to the farmers and therefore T&V failed to serve the needs of small resource poor farmers because it was not equipped to deal with farmers' complex reality. The T&V was created to disseminate recommendations on agricultural technologies only but farmers did not perceive their problems as due to lack of technology. Agricultural technology is just one element that must be taken into account in developing solutions to the complex problems faced by farmers.

Despite the failure of the T&V approach to address the farmers' problems as was anticipated, it was an improvement from the earlier conventional approaches in the sense that, it attempted to introduce a single direction of technical-support and administrative control, change the multipurpose role of the extension agents, improve the technical skills of the extension agents through frequent fortnightly training, improve linkage between the extension and the farmers and create a comprehensive monitoring and evaluation of extension agents. The systematic training of extension agents envisaged by T&V proponent did not materialize due to lack of funds for materials and human resources for training activities. This scenario led to lack of effective communication, inadequate feedback to the farmers and reduced facilitation from the research. The extension recommendations often required external inputs, consequently technologies were not adopted because small scale farmers lacked access to inputs and credit, the farmers were not visited by extension agents on regular basis due to lack of transport and as a result they did not receive appropriate and timely information and that feedback from farmers to extension agents and then to researchers was inadequate due to lack of effective channels of communication. Although the approach worked for more than 13 years, it proved too expensive and also was top-down oriented.

CURRENT TECHNOLOGY TRANSFER STRATEGIES AND TRENDS IN VIEW OF MORE PARTICIPATION

African Highlands Initiative program adopted the conventional research approach during 1995-1996 (phase I) of AHI-projects, where the researchers from various institutions in Kenya, namely KARI-Kakamega, Egerton University, Maseno University, ICRAF-Maseno, KEFRI-Maseno, CARE-Kenya and Nairobi University were given small grants to implement activities in key thematic areas of integrated pest management (IPM), improvement of soil fertility and characterization and design. The focus was top-down approach since the individual researchers identified problems to address without considering a systems approach. Each researcher concentrated on solving problems of the individual farmer. Most of the earlier proponents of research and extension approaches assumed that farmers were passive recipients of technologies and had little to contribute in the whole process. Some of the results of conventional research through small grants which were used as key entry points within the farming communities indicate that all the nutrient source (DAP, FYM, GM and Urea) had higher seed yield (table 1). However, the best yields were obtained with DAP and FYM. The results obtained were later given to farmers as technological options during the implementation of AHI-phase II projects through FRGs.

Table 1. Mean effect of nutrients on plant tolerant to Bean root rot (BRR) in western Kenya

Nutrient score	Yield Kg./ha.
Farm Yard Manure (FYM)	896.7
Di-ammonia phosphate (DAP)	860.8
Green Manure (GM)	629.6
Triple super phosphate (TSP)	512.7
Urea	437.4
Control	373.0
LSD (0.05)	66.1
CV	15.8

Source: Otsyula et al. 1996

Farmers Research Groups (FRGs)

In 1997 (Phase II), the AHI programme shifted its focus on community participation through farmers research groups (FRGs). The FRGs were formed from the members of the community from 5 villages where the researchers conducted the first PRA to identify farmers' constraints. The local Provincial Administration assisted the researchers to mobilize the community to attend an organized community forum. At the forum, members from a particular village grouped themselves and formed a village group referred to as a FRG. Each FRG was then taken through the available technological options and later chose what to test. The approach focused on integrating various systems using PTD. Farmers were given a range of integrated nutrient management options to select, test and modify where possible adopt. The FRGs undertook the activities for four years.

In the approach, the indigenous knowledge of the farmer and their capacity for experimentation was the key aspect. For both the researchers and the farmers, knowledge was crucial in the development of the technologies that fitted into the local environment and social circumstances and were likely to solve the farmers' problems. More emphasis was on promotion of low cost technologies and minimization of external inputs by using locally available resources like the farmyard manure (FYM), Tithonia, compost and Sesbania and strengthening the farmers' experimental capacity. The features were aimed at sustainable and environmentally sound development.

The technologies were developed and evaluated on the site with farmers' active participation in on-farm experimentation and determination of the viability of the technologies using their own (farmers) criteria. At an on-farm trial for improving soil fertility with green manure and herbaceous legumes (Mucuna, Crotalaria, Dolichos lablab and Soya bean) on a bean-maize intercrop in a farmer's field in Vihiga district, the results indicated that there were significantly better yields on bean crop (Table 2). Farmers appreciated the technologies and through farmer to farmer information exchange there was success in dissemination of resistant BRR varieties. The 6 farmer to farmer trainers who were involved in the initial bean trials were able to train a total of 450 farmers. Out of these 420 (93%) adopted the disseminated bean varieties (Otsyula et al., 1997).

Table 2. Effects of herbaceous legumes species on bean yield, Vihiga District, western Kenya

Legume Species	Yield kg./ha
Crotolaria	1211.0
Mucuna	1023.0
Dolichos lablab	794.0
Soyabean	721.0
Control	364.8
LSD	67.6
CV	6.3

Source: Otsyula et al. 1997

FRGs in the AHI project site benefited from participatory bean breeding in testing and selection of promising high yielding bean varieties resistant to bean root rot and bean stem maggot and adopted three bush bean varieties KK8, KK15 and KK22. Through collaboration work undertaken on identification and testing of 6 Striga tolerant sorghum varieties, the FRGs were able to select three promising varieties, IS 21055, IS 8193, and Seredo varieties which proved superior to the local varieties in terms of yield and Striga resistance both under the farmers' fertility and recommended fertility and also adopted the maize variety KSTP94 (open pollinated, high yielding and tolerant to Striga). Farmers who planted maize with high quality manure obtained a significant high yield increase in the 3 villages. The farmers used 5 tons high quality manure with content of 60kg N and 22.5kg P_2O_5. Most farmers had maize yield increase more than five times as indicated in Table 3.

Table 3. The effect of high quality manure on the yield of Maize in Vihiga district, western Kenya

Village	**Pre-Test kg/ha.**	**Post-Test kg/ha.**
Mukhombe 'A'	50	562.5
Mukhombe 'B'	100	400
Wabaria	175	1350

Source: Ogola Aloo (2001) AHI annual project report

The development of high quality manure by FRGs who participated in the AHI project is a clear manifestation that farmers who go through PTD have improved their knowledge and skills and offer challenge to proponents of top-down extension approach. By adopting the use of green manure legumes, some of the FRG members managed to get sorghum yield of 80kg in an area where no yield had been recorded for the last 20 years. The significant role played by FRGs during PTD has improved the household income for bean farmers. Due to improved yields resulting from the technologies developed by the FRGs, there has been increased bean production which in effect has caused a reduction on farm gate prices from 120/= to 50/= per tin.

The knowledge and skills of the FRGs was used to advance the high quality manure technology to other farmers through experiential learning in the FFSs. The FFSs linked up with the group that demonstrated on the use of high quality manure preparation to achieve this task.

Despite, the promising results from the FRGs; there were some weaknesses which were reported to have affected the diffusion of the technologies. Some of the participants cited that the researchers identified individual farmers from the FRGs who were interested in some technologies and paid more attention and forgot about the group. This was reported to have created individualistic attitude and the technology ownership shifted from group to individual. It was also reported that the researchers centered approach to individual farms limited farmers' ability to underscore the importance of group participation an element the farmers appreciated in FFS approach. Some farmers also reckoned that during testing of the technologies there was little researcher-farmer exchange of views and sharing of experience, which the farmers felt, limited their ability in terms of knowledge and as future diffusion multiplier.

Farmers Field School (FFS)

Farmers' field school (FFS) is a participatory approach to extension, which gives farmers an opportunity to make choice in the methods of production through learning based approach. The "Field Schools " are actually a group of farmers who meet regularly over a course of several growing seasons to experiment as a group with new production options. Ministry of agriculture (MOA) extension staff and some non-governmental organizations (NGO's) introduced Farmers Field School (FFS) in Kenya with assistance of Food and Agriculture Organization's (FAO) special programme for food security in 1995. Farmers are using the approach in western Kenya as an extension methodology in dissemination of technologies.

The objective of the FFS approach is to increase the capacity of farmers in terms of knowledge and skills to respond adequately to changing farming situations. Farming circumstances are being transformed by periodic changes in technical, economic, social and environmental factors that force farmers to change their production and / or management practices. To achieve this, farmers have to become more experimental and innovative. A farmer's capacity to respond to changing circumstances becomes all too much important where farmers have no access to regular and reliable technical support from extension agencies (FAO, 2000). Farmers' learning is directed by goals and needs looking for solution to real life problems. Experiential learning advocates the establishment of optional learning environment in which participants have a sense of belonging, security, and freedom to make choice (Miagostrich, 1999).

In the year 2001, which marked the end of the fourth year of the FRGs' activities, there was an interphase before the programme embarked to phase III. During the interphase it was important for the FRGs to sustain the technologies at their disposal. To achieve this, the programme identified and instituted the formation of three farmer field schools. The FFS were envisaged to build the capacity of the farmers so as to enhance their ability to sustain the practiced technologies and equip them with knowledge and skills for further dissemination of the technologies. The FFS build up its activities from the technological options developed and tested by the FRGs.

Three farmer field schools of at least 30 participants each were formed in three selected villages for scaling up and dissemination process of technologies. The participating farmers planted the selected test crop using the selected soil improvement options on the field school. The participants and the school facilitators went through a process of participatory technology development (PTD) using the selected soil improvement technologies and some selected test crops. The participating farmers were taken through a well-designed curriculum from which weekly lessons were prepared. The facilitation was done for a whole period of selected test crop growing season. The soil improvement options were tested on three crops: kale, maize and beans. After the maturity of the test crop, it was harvested, and participants taken through to evaluate and select the best soil improvement option that gave the highest yield. The farmers after testing and evaluation adopted the use of DAP+FYM in Kale. The yield performance of the tested crops using various selected soil improvement options are presented on table 4. The low yields from FYM were due to inadequate amount applied as majority of the farmers have only 1-2 cattle in their farms and the yields of kale have been derived from the harvest of 6 months harvested using 70kg bag.

Table 4. The Yield of the crops obtained from various nutrient sources at Emanyonyi Extension – led farmer field school in Vihiga district, western Kenya.

Crop type	Nutrient Source	Yield/ha.
Maize	DAP +CAN	20 bags
	DAP+FYM	10 bags
	FYM	5 bags
	Nil application	2 bag
Kales	DAP+FYM	6250 bags
	DAP+CAN	5000 bags
	Tithonia	625 bags
	Tithonia+DAP	2500 bags
	FYM	2500 bags

Source: Gideon Omito and J.Ogola (2004) (FFS – Graduate)-Emanyonyi Farmers Field School,Vihiga District

While undergoing the season long training, the participating farmers replicated the same technologies in their farms and used the same to build the capacity of other non-participating farmers within their neighborhood. After graduation, seven members comprising of five women and two men (FFS-Graduates) who participated at the Emanyonyi FFS, formed their own facilitation group culminating to Emanyonyi farmer-led field schools in 2002 with the objectives of ensuring that the farmer graduates continue practicing the technologies and also assist other farmers who were interested in adopting the technological options. This was the stage when the facilitation and leadership of the school were handed to the graduate farmers (farmer-led field school). The Emanyonyi FFS graduates continued to facilitate and retained their original name (Emanyonyi FFS) for identity. The graduate farmers felt secure since Emanyonyi was already registered and had recognition (Gideon Omito and John Ogola, 2004).

The farmer led FFS focused on empowerment of farmers by exploiting the potential of local community as resource persons. This assisted the diffusion of acquired knowledge more rapidly by encouraging the farmer graduates to share their knowledge and learning experiences with other farmers within their village and elsewhere. In 2003, three FFS graduates recruited a total of 45 farmers from the neighboring sub-locations who were interested in testing the soil improvement technologies through FFS approach. Despite, the enthusiasm the FFS graduates had in dissemination of technological options, the facilitation stopped at some stage since the FFS graduates were intimidated for lack of authenticated certificate of practice (Gideon Omito, 2004). The FFS graduates feel that they have the capacity to improve the livelihoods of their community following the number of requests they have attended to in regard to technology dissemination if only they can formally graduate and be issued with certificates.

To assess the changes in yield with the participating farmers, a record of the pre FFS crop yields were compared to the post FFS yields whose results are presented in table 5. The test crops were planted using a combination of 2.5 tons Tithonia (80kg N and 7.5 P_2O_5) and 5 tons high quality manure (60kg N and 22.5kg P_2O_5). These were the available sources of nutrient within the farms.

Table 5. Yields of some test crops obtained from Mukhombe Farmer Field School in Vihiga Dist, W. Kenya

Crop	Pre-FFS	Post-FFS	
	(kg./ha.)	Year 1 (kg./ha.)	Year 2 (kg./ha.)
Maize	50	500	1500
Beans	25	300	912.5
Kales	50	1000	2500
Sorghum	0	200	600

Source: Walter Munywere, Community Facilitator -Mukhombe FFS, Vihiga District

Farmer to farmer training is viewed as a promising route to multiplying FFS coverage with the sustainability of the overall field-school approach resting on the spread and effectiveness of farmer-led schools as exemplified by one school (Mukhombe). All farmer graduates were encouraged to communicate information to their non FFS counterparts within the village and the neighborhood, and especially trained farmer trainers were expected to become the dominant element in organizing and facilitating FFS but this did not materialize, as there was no funding during the inter - phase.

The proposed strategy of promoting soil improvement technologies through the FFS assumed that farmer knowledge would be improved thus is more efficient in decision-making. One of the aims of the school was to sharpen farmers' abilities to experiment. Experimentation allowed the knowledge gained from the school to be re-created in farmers particularly in subsequent season. The potential of FFS to address farmers' problems due to its unique approach of experiential learning through discovery made the AHI programme to adopt its applicability in dissemination of technologies in Vihiga district in western Kenya.

The approach, adopted by AHI programme during the inter phase from phase II (community participation on adaptive research through FRGs) to phase III (watershed) was aimed at exposing farmers to a learning process in which they were gradually presented with new technologies, new ideas, new situations and new ways of responding to problems. The knowledge acquired during the learning process was to build on existing knowledge to enable the participants to adapt the existing technologies developed by the FRGs so that they could become more productive, more profitable, and more responsive to changing conditions, or to develop new technologies.

Conclusion

The early conventional approaches did not consider ecological diversity and complexity in the production system faced by the resource poor farmers, and also did not consider building on farmers' knowledge. This created a technological adoption and diffusion gap. Despite the introduction of some of the promising approaches like the Farm management and IADP which offered farmers better opportunity to access credit and create better infrastructure and marketing with less and in some cases no conditions at all, the farmers did notl respond to the supply. Farmers' needs at the time of loan advances were not well understood. The proponents assumed that by supplying credit to farmers, they would automatically adopt, farmers' socio-economic conditions notwithstanding. The extension managers' failure to put up better loan recovery instrument in place and by adopting a top-down supply driven to credit through input supply contributed to the collapse of the approaches.

The FRGs formation followed the path of the villages identified and selected for testing technologies. Each of the 5 village members came together to form a group (FRG).The only group cohesion during the formation was the village. The researchers did notl consider other social dynamics within the village set-up. Although the farmers tested similar technologies across the village site, there was more of individual researcher to farmer contact during implementation at plot level. This was a challenge to the researchers, as they did not integrate principles of participatory approaches into the village set-up. This implied that majority of the researchers lacked the capacity of integrating the principles and concepts of participatory methodologies to the participating FRG members which resulted to farmers' incompetence to disseminate technologies and led to individualistic attitude and limited spillover and adoption.

The AHI programme entry to the community through adopting the FRG approach was challenging since some of the technologies were accepted by the farmers due to the financial support to labor and in form of input during the implementation of the projects. This was established after a follow-up was made to determine the spillover effect of the technologies. It was found that majority of the farmers had abandoned all the technologies that had financial and labor requirements. This implied that farmers were not well sensitized on their roles and in regard to sustainability. It could also prove the high dependency syndrome farmers have while participating in development projects. This is a challenge to the researchers during the implementation of watershed project in the new sites.

Farmers realized the gain attributed to working with researchers and more so during PTD. As the AHI programme was changing its focus from working with FRGs to watershed management, the farmers deplored the need for continuity. This was the stage when farmers proposed their interest in forming FFSs. This implied that through the learning process in their FRGs, the farmers become well equipped with knowledge which they were willing to share with other farmers. It also implied that a proper project strategy should have been put in place for continuity and sustainability of the developed technological options. The fact that some of the members of FRGs have also started their own community bean seed production is a clear indication that FRGs offer better opportunity for dissemination of technologies. However, the low FRG bean yield as compared to conventional research done by Ostyula et al. (1997) in the same area is a challenge on the farmers capacity to implement and manage some of the technologies.

Farmers who participated in the FFS activities acknowledged that learning through discovery during the PTD empowered them to have practical experience. This implied that farmer field school approach offers an alternative to the conventional extension approach in which farmers were passive recipients of externally formulated extension messages that are demonstrated to farmers by the field extension assistants. And also reinforces that farmers easily adopt the technologies they participated in developing and familiar with.

The understanding of the FFS principle and practice at plot level during the agro-ecosystem analysis and evaluation of crop yield indicate that technical inefficiency or the knowledge gap was envisaged when the yield performance of some (best) farmers were higher than that of other (average) farmers at the same level of inputs. This implied that experiential learning offers better opportunity so sustaining technologies and that FFS approach encompass and build farmers skills on participatory monitoring and evaluation. The FFS can offer a better opportunity in future for the researcher as a better and sustainable strategy so long as there can be commitment of facilitating the take-off stage. This was the opportunity, which the AHI-project neglected after formation of the FFS in Vihiga.

The use of farmer-led field schools to disseminate soil improvement options can be cost-effective in complimenting the work of the researchers and the extension agent. Encouraging local community as field school facilitators can enhance faster integration and acceptability of the existing technologies in the watershed and create more sustainability, increases household income and improves livelihood of participating farmers.

References

FAO, 2000. Guidelines and Reference Materials on Integrated Soil and Nutrient Management and Conservation for Farmers Field Schools

Kandie, E.K. 1997. Agricultural Extension Policy Project to improve Effectiveness of the Agricultural Extension Services in Kenya. Ministry of Agriculture, Livestock Development and marketing

Munywere,W. 2003. Community facilitator, Emanyonyi Extension-led Farmer Field School, Field School Progress report submitted to Team leader, AHI- Capacity building project

Ogola, H.A ,K. Otieno and C. Mwango, 2001. On-farm demonstration on preparation and effectiveness of high quality farm Yard Manure

Opiayo, M. 2003. Community facilitator, Mukhombe Farmer-Led Field School, Personal Communication

Ool, Peter A.C. 1998. Beyond the Farmer field school: IPM and empowerment in Indonesia. Gatekeeper Series No.78. International Institute for Environment and Development

Otsyula,R.M and S.I Ajanga, 1996. On-farm testing of organic and inorganic phosphorous interaction and the effects on bean root rot severity. In African Highlands Initiative Technical Report End of Phase 1 (1995-1997)

Otsyula, R.M, Nderitu,J and P. Nekesa, 1997. Integrated control of bean root rot and bean stem maggot in Western Kenya. In African Highlands Initiative Technical Report End of Phase 1 (1995-1997)

Omito, G. 2004. Community facilitator, Emanyonyi farmer-led Field School, Personal Communication on August,31st

Omito, G and J.Ogola, 2004. Community facilitator, Emanyonyi farmer-led Field School, Personal Communication on August,31st

Rola A.C, T.B. Quizon and S.B. Jamias, 2001. Do farmer field school graduate retain and share what they learn? An investigation in Iloilo, Philippines. Institute of Strategic Planning and Policy Studies.
Roy, N. 1996. IPM by Farmers. The Indonesia Pest Management Program. Republic of Indonesia.

Patterns of Technology Uptake by Smallholder farmers: Experiences with AHI Interventions in W. Kenya

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Abstract

Participatory community-based research under the African Highlands Ecoregional Programme was undertaken in five villages of Ebusiloli sub-location in Vihiga District of western Kenya between 1998 and 2002. One of the objectives was to undertake research and development on soil fertility improving options that integrate different technical and social disciplines and enable farmers to innovate and better manage their resources. A number of participatory tools were used to characterize the farming systems and identify the farming constraints and potential solutions. A series of meetings with farmers were held to discuss and reflect on the findings before farmers were presented with a "menu" of technologies to choose from. A total of eight primary technologies were implemented by representative farmers from each village on behalf of the village. Farmer research committees were appointed to coordinate the activities in each village. The activities were periodically monitored and evaluated in a participatory manner by the farmers and the researchers. The results after three years of implementation showed the highest increase in the number of farmers implementing the technologies to have been achieved with high quality manure (600%) followed by organic-inorganic interactions (460%), soil conservation (300%), improved bean varieties (179%), striga control (175%), biomass transfer (17%), improved feeds and feeding (13%), with the least uptake being achieved with improved fallows which had a 7% drop. The explanatory variables that seem to have influenced the patterns of uptake include (i) whether farmers were familiar with the technology (ii) the demands placed on the farmer by the technology in terms of land, labor, time and skills (iii) how complex the technology is (iv) the associated benefits that came with the technology (v) how long it takes to realize the benefits from the technology, and (vi) the level and intensity of engagement of the farmers by the research team. The observed patterns of uptake and the possible determinants illustrate the importance of the technical, social and methodological components of a participatory community-based research approach in technology uptake.

Introduction

Participatory community-based research under African Highlands Initiative (AHI) was initiated in 1995 within the intensive land use systems of the Eastern African Highlands with the goal of contributing to the reversal of land degradation, and the amelioration of poverty and related social and environmental problems. The AHI's participatory community-based research in Vihiga District of western Province was effectively launched in Emuhaya Division in November, 1998 and implemented up to the end of 2002. The AHI goals during this period were to be achieved by providing the resource poor farmers with technologies and managerial knowledge and skills that will enable them to improve agricultural productivity while sustaining their natural resource base. Within this overall goal, one of the main objectives of the project was, therefore, to undertake participatory research and development on soil fertility improving options through integrating different technical and social disciplines and to enable farmers to innovate and better manage their resources. It was envisaged that the successful implementation of the research will, among other things, lead to (i) an improvement in farmers' skills through training and participatory implementation of the research activities. This in effect would enhance community cohesiveness and therefore better participation in natural resource management (ii) improved nutrition through sustainable increase and diversification of food production (iii) improved production of food crops, cash crops and livestock products leading to improved household incomes and livelihoods (iv) improved soil productivity through a reduction of soil erosion and increased soil fertility by use of appropriate erosion control structures and soil management options (v) reduction of the impact of pests and diseases on crops and livestock through the use of resistant/tolerant crop varieties and appropriate pest and disease control measures in livestock, and (vi) increased environmental awareness and better conservation of the natural resources through a combination of policy initiatives and appropriate NRM options.

This paper examines some of the technologies promoted and processes developed during that period and the patterns and possible determinants of their uptake by the resource poor farmers in Emuhaya Division.

Methodology

RESEARCH SITE

The research was undertaken in North East Bunyore location of Vihiga district in western Kenya. This is one of the four locations in Emuhaya division. The division covers approximately 75 km^2 and has a population of over 89,000 people. With a population density of about 1,199 persons per km^2, it is one of most densely populated divisions in Kenya. It has 11,244 households and farm sizes of on average 0.4 ha. The location has an estimated population of 30,000 people and is made up of five sub-locations (Ebusiloli, Ebunangwe, Emusutswi, Ebusamia, and Ebuhunza). The AHI activities were mainly concentrated in Ebusiloli sub-location which is generally representative of the division and is made up of five villages viz. Emanyonyi, Wobaria, Mwilonje, Mukhombe "A", and Mukhombe "B'. The research was undertaken in all the five villages. The sub-location falls within the upper midland agroecological zone (UM_1) with average farm sizes being 2.5 acres per households of a family size of about 8 persons. It receives on average between 1,800 and 2,000 mm of rainfall annually with a bimodal distribution, the long rains falling between February and July and the short rains falling between August and December.

The majority of farmers in the division are subsistence oriented growing maize and beans as intercrops with minimal use of external inputs. The farming systems are characterized by low productivity of both food crops and livestock. Low soil fertility is the main factor responsible for low crop yields. The low fertility is due to the small holdings (average, 2.5 acres/household) which are cultivated continuously leading to depletion of nutrients and this is exacerbated by soil erosion. On average, only 360 kg/acre and 40 kg/acre of maize and beans respectively, is realized during the long rains. As a result of the poor crop yields, food deficit occurs for between 9-12 months for maize and 5-7 months for beans during each year.

RESEARCH PROCESSES

The implementation of the research involved a series of major steps, sub-steps and tools as represented in figure 1. As an entry point into the study community, participatory rural appraisal (PRA) was undertaken by the research team in November, 1998. A number of PRA tools were used in order to characterize the farming systems and identify the farming constraints and potential solutions. A transect walk covering 14 km was undertaken through the division aimed at providing general overview of the existing farming systems, soil types, vegetation, infrastructural facilities, farming constraints and socio-economic status of the inhabitants. This was complimented with individual farmer interviews, using a check list, in selected sub-locations including Ebusiloli. At the end of the transect walk and the farmer interviews, group discussions were held both at Esiembo chief's camp attended by 42 farmers, and Emakakha attended by 32 farmers, to triangulate on and validate the information gathered during transect walk and farmer interviews.

The general characterization having been accomplished, more detailed diagnosis of the study community was undertaken through resource flow analysis in individual farms and wealth ranking and social differentiation of the farmers. Resource flow analysis was aimed at determining the net farm nutrient balances; to gain an understanding of whether the resource inflows are targeted to specific farm niches; and to examine the relationship between the types of resource flow and the socio-economic circumstances of the farmers. Farmer group meetings were held during which farmers stratified themselves into wealth categories using their own wealth indicators. Individual follow up visits were done with a few farmers representing each wealth category to have a more detailed inventory of their resources.

A series of planning meetings were held by the research team to reflect on the information gathered and shortlist the available technologies that would address the identified farming constraints with specific focus on soil fertility improvement. Once the "basket" of technologies was ready, a meeting was held with the research farmers during which each technology, its components, the research contribution and farmer's role was described in detail to the farmers. Farmers then chose the technologies they wanted to implement. Each of the five villages involved selected individual farmers to host the trials on their behalf, the selection being based on the resource endowment (specifically land) of the particular farmer, his/her knowledge in farming and ability to work harmoniously with others. The farmer's resource endowments were determined through a participatory wealth ranking and social differentiation analysis. During the analysis, farmers stratified themselves into six groups (Table 1) based on wealth indicators as perceived by the community.

A total of about eight primary technologies (Table 2) were introduced by the research team and implemented by the community. The technologies were mainly focused on soil fertility improvement. Both the farmers and the research teams had defined responsibilities under each technology (Table 2). There were also a series of technical trainings held by the research scientists for farmers undertaking similar technologies. Farmer Research Committees (FRCs) established in each village occasionally organized farmer-to-farmer tours and there were also exchange tours organized by the project to other districts for farmer representatives from each village. A joint participatory monitoring and evaluation of the herbaceous cover crops and tree fallows by farmers and a group of scientists from different institutions (KARI, ICRAF, TSBF/CIAT, Rockefeller Foundation, AHI-Regional office and Ministry of Agriculture, Extension) was held in February, 2000. This was followed by a survey by the research team in August, 2000 to establish farmer's views on the same technologies.

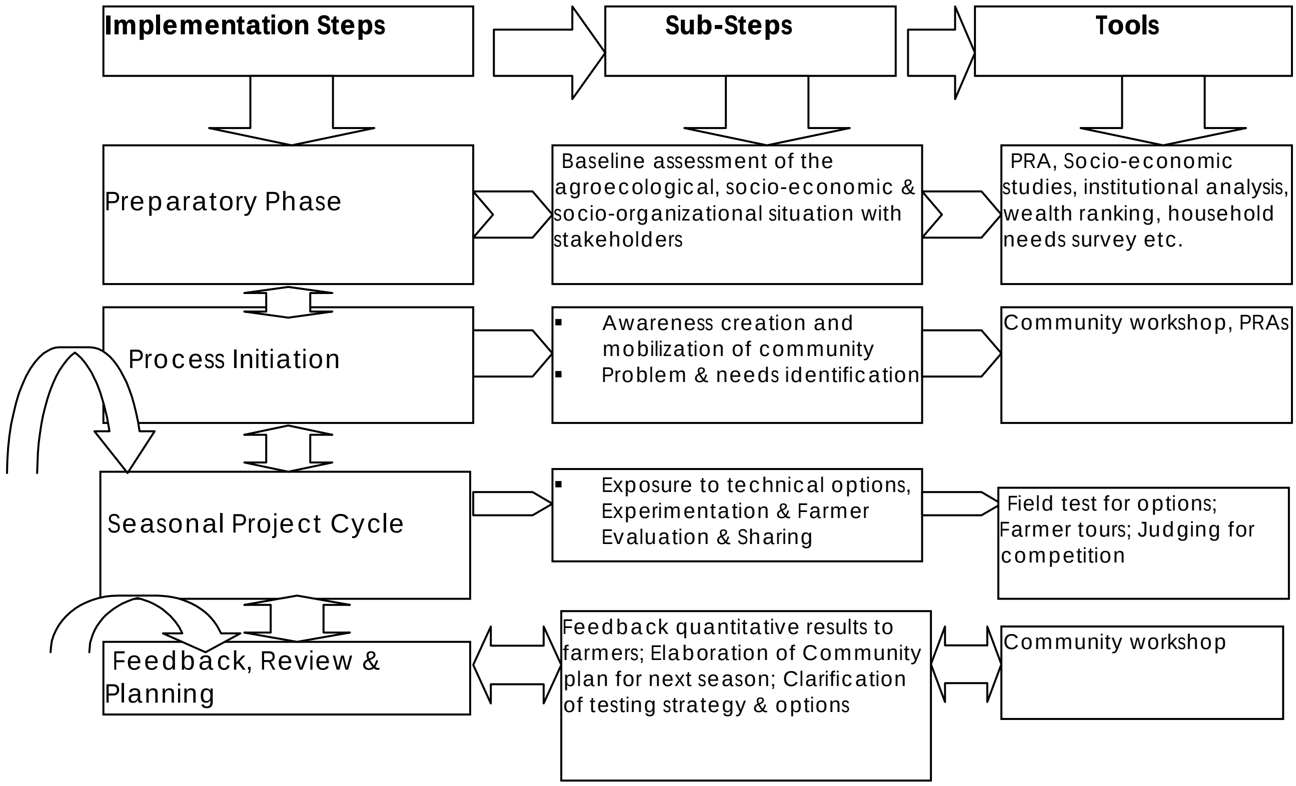
Table 1: Farmer stratification into wealth groups based on key local wealth indicators

Indicators	Wealth groups					
	1	**2**	**3**	**4**	**5**	**6**
Farm size	At least 2 acres and has other pieces elsewhere	At least 1.5 acres but has rented more land elsewhere	At least 0.8 acres but with no extra rented land	Has less than 0.5 acres	Has less than 0.5 acres but rents it out	Has less than 0.4 acres
Tea farm	Has no Tea	Has more than 400 Tea bushes	Has no Tea	Has no Tea	Has no Tea	Has no Tea
Cattle	At least 3 grade (crosses) cows	At least 3 grade (crosses) plus zebu	At least 1-2 zebu	At least 1-2 zebu	One zebu or none	One zebu or none
Milk production	10-15 treetop (750 ml) bottles/day	2-6 treetop bottles/day	2 treetop bottles/day	1.5 treetop bottle/day	1 treetop bottle/day	1 treetop bottle/day
Livestock feed	Has own Napier and buys more. Feeds dairy meal	Has own Napier. Occasionally feeds dairy meal.	Has some Napier on soil conservation terraces	Some plant Napier but sell	Some plant Napier but sell	Has no Napier
Poultry	Has local birds	Has local birds. Some have exotic birds	Has local birds	Has local birds	Has local birds	Has local birds
Soil fertility	Has fertile land and uses own manure	Has fertile land. Some buy manure.	Declining soil fertility	Declining soil fertility	Declining soil fertility	Declining soil fertility
Use of farm inputs	Uses fertilizers, certified seed and pesticides	About 75% uses fertilizers, certified seed and pesticides	Some use fertilizers, certified seed and pesticides	Some use certified seed but none uses fertilizers or pesticides	Do not use farm inputs	Do not use farm inputs
Sources of income	Good income from off farm	Income from employment or pension and from farming	Mainly artisans, or have income from horticulture and selling of local brews	Income from off-farm labor, sale of Napier or sale of local brews	Income from off-farm labor or sale of Napier.	No known regular source of income
Level of education	Are enlightened and have their children in high cost schools	Mostly upto standard 8 level and their children have upto form 4 and above	Mostly form 4 leavers	Mostly standard 4 leavers	Mostly standard 4 leavers	Below standard 4 or none
Age bracket	45-65 years	45-60 years	30-50 years	50-70 years	Over 65 years	Over 65 years
Type of house	Permanent	Either permanent or semi-permanent	Semi-permanent but a few permanent	Semi-permanent	Semi-permanent with few grass thatched	Semi-permanent and grass thatched
Source of farm labor	Has at least farm laborers	1-2 farm laborers	Uses own labor and sometimes sells out labor	Uses own labor and sometimes sells out labor	Uses own labor and sometimes sells out labor	Uses own labor
Family size	4-6 children	6-8 children	6-8 children	8-10 children	8-10 children	8-10 children

Table 2: Technologies introduced to farmers in Emuhaya by the AHI Research team

Technology	Description of key components	Initial status of technology	Research intervention	Farmer contribution
1. High quality manure	The technology involved the preparation of well decomposed high quality compost for planting crops.	Farmers with livestock were collecting and heaping manures for use but quality was low.	Community mobilization, technical backstopping, and monitoring of implementation.	Provision of labor for digging of compost pits, collecting and composting the manure.
2. Organic-inorganic interactions	This involved mixing of different proportions of inorganic fertilizer and organics for use at planting. eg. Triple Supper Phosphate (TSP) plus either Farm yard manure (FYM) or *Tithonia diversifolia*.	The technology was not very common with farmers in the community.	Testing with farmers the different combinations of organic and inorganic in order to select the best option. Research provided the inorganic.	The farmers provided the organics and labor for planting, weeding and harvesting test plots.
3. Soil conservation	The technology involved mostly establishment of multipurpose tree legumes along the soil conservation terraces and cut-off drains in order to reinforce these structures and also provide fodder for livestock.	A lot of work had been done in the area by the Ministry of Agriculture's soil and water conservation program and because of this many farmers had the soil conservation terraces.	Community mobilization, provision of multipurpose tree legume seedlings and monitoring of implementation.	Reworking the terraces, establishment of the tree legumes and maintaining them.
4. Improved beans	Based on the premise that the soil improving technologies will improve the fertility status of the farms, it was felt logical to provide farmers with improved crop varieties to exploit the improved fertility. Bean varieties tolerant to bean root rots were therefore introduced.	The bean crops in the area had been devastated by the bean root rot-bean stem maggot complex to the extent that farmers were no longer harvesting any beans.	Provision of the tolerant bean varieties for seed bulking and technical backstopping.	Land preparation, planting and weeding the bean crop.
5. Striga control.	Trap crops were used to stimulate striga germination and reduce striga infestation.	Generally the area is infested with Striga weed and farmers were growing susceptible maize varieties leading into low yields.	Provision of the seed for the trap crops (two bean varieties: L44 and GLP2); a commercial maize variety to plant in rotation with trap crops as a test crop.	Land preparation, planting and weeding the crop. The harvest belonged to the host farmer.

6. Biomass transfer	The technology involves harvesting the naturally existing *Tithonia diversifolia* hedge species, transferring the material to the farm and incorporating into the soil at planting time.	Some form of biomass transfer was taking place but to a minimum extent. Traditionally some farmers were aware of the fact that land under *Tithonia* was usually more fertile.	Technical backstopping and monitoring of implementation.	Land preparation, biomass harvesting and incorporation and crop establishment.
7. Improved feeds and feeding	The technological intervention was mainly the introduction of *Desmodium* Greenleaf as a high quality fodder to livestock farmers for relay in rows of Napier grass which they had already planted. Accompanied with this were training sessions on livestock feeding.	The majority of livestock keepers have local breeds which are mainly kept under semi zero grazing mostly involving tethering in non-cropped areas with occasional supplementation with Napier grass.	Provision of *Desmodium* seed, technical backstopping and monitoring of implementation.	Land preparation, planting of the fodders and feeding livestock.
8. Improved short duration fallows	This involved the relay planting of fast growing trees (*Tephrosia vogelii*, *Sesbania sesban*, *Crotolaria grahamiana*) in a maize crop after second weeding and ploughing in of the same, after 1-2 years, for maize in the subsequent season or the planting of herbaceous legume cover crops (*Crotolaria ochroleuca*, *Mucuna pruriens, Canavalia ensiformis*) and incorporating after 3-6 months to improve soil fertility.	Although farmers maintained some non-cropped areas as fallows and for tethering livestock, they were not improved in any way.	Provision of seeds for the fallow species, provision of seed for the maize test crop, technical backstopping and monitoring of implementation.	Land preparation, planting of the fallow species, incorporation into the soil and planting crops.



(Adapted from Hagmann et al., 1997)

Figure 1: Participatory Community-based Research Steps for Technology Innovation, Adaptation and Wider Dissemination.

Results

After the three years of active engagement with farmers in Ebusiloli, certain patterns of technology uptake emerged. A total of 164 farmers (*a farmer having more than one technology has been counted more than once*) were implementing the eight primary technologies with the highest number of implementing farmers being in Mukhombe "B" (14) followed by Mwilonje (13), Emanyonyi (13), Wobaria (12) and Mukhombe "A". The highest increase in the number of implementing farmers was achieved in high quality manure (600%), followed by organic-inorganic interactions (460%), Soil conservation (300%), improved bean varieties (179%), striga control (175%), biomass transfer (17%), and improved feeds (13%), with the number of farmers implementing improved fallows dropping by 7%. The number of farmers implementing each of the technologies in each village as at 2002 is shown in figure 2.The number of technologies being implemented differed between the villages with high quality manure being in all the villages; organic-inorganic interactions, improved beans, and biomass transfer were in four villages; improved feeds was in three villages (Mukhombe 'B', Emanyonyi, and Mwilonje) whereas striga control was only in two villages (Mukhombe 'A' and Mukhombe 'B').

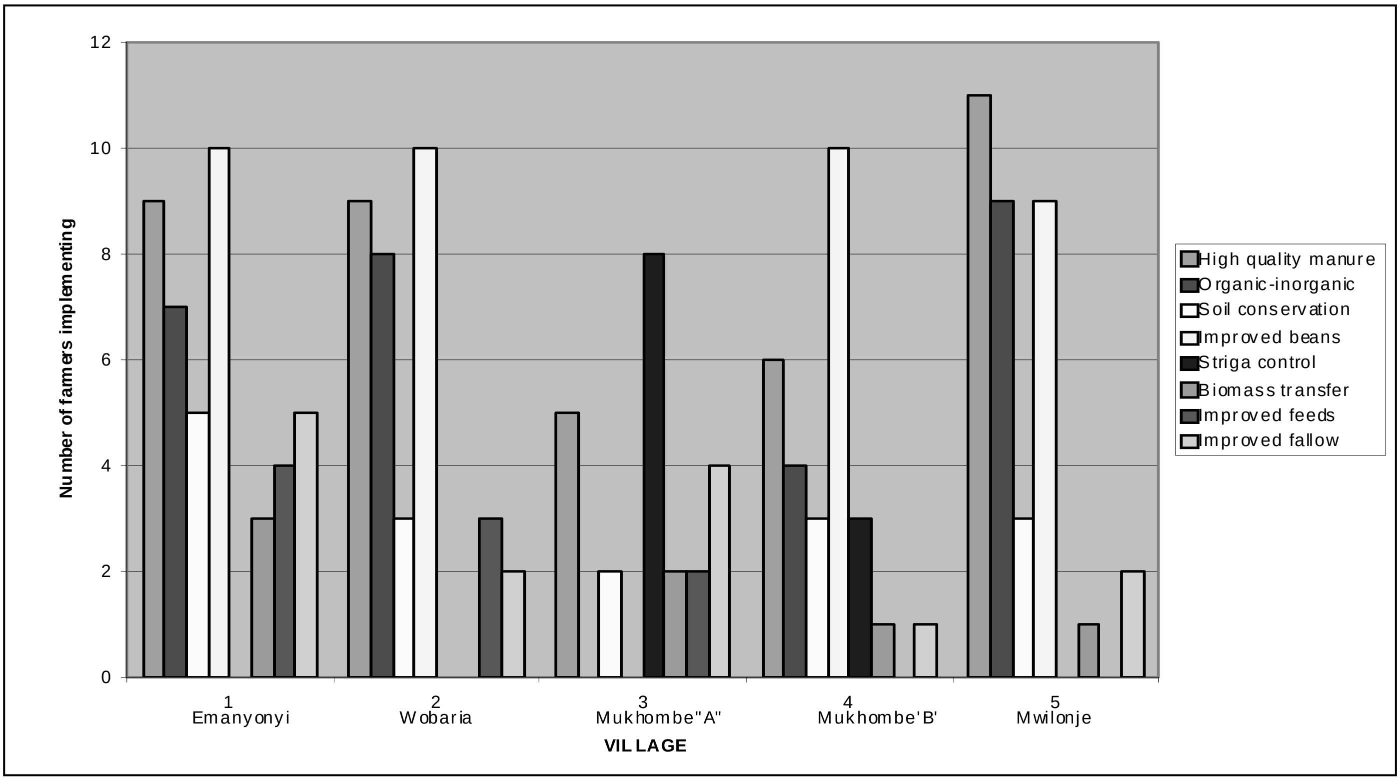


Figure 3. Number of farmers implementing each technology per village in Emuhaya in the year 2002.

Table 3 gives a summary of some of the general observations made during the monitoring and evaluation exercises undertaken in the year 2002. The majority of the participating farmers (45%) were in wealth category 4 followed by those in wealth category 3 (25%), and category 2 (16.7%). There were no farmers in either wealth category 5 or 6 (table 4). Mukhombe'B' which had the highest number of farmers implementing the technologies also had the highest number of implementing farmers in wealth category 4. The salient features of wealth category 4 are the declining soil fertility, none use of fertilizers or pesticides, and reliance on income from off-farm labor or sale of Napier grass or local brews in some cases.

Table 3: Observations made during an evaluation of the use of herbaceous legumes and fast growing tree species in soil improvement by farmers.

Representative farmers	Technology	Farmer observations
1. Mr.Mukora From Mukhombe "A"	Improved tree fallow	The farmer relayed *C.grahamiana*, *T.vogeliii*, and *S.sesban* in a crop of maize after second weeding of the maize during the long rains of 1999. The trees were cut and incorporated into the soil before the establishment of maize in the long rains of 2000. The farmer observed that *C.grahamiana* was a better species since it produced more biomass and its thick canopy assisted in reducing the growth of weeds. The species was, however, more prone to insect pest damage of the pods thus reducing seed yield. The establishment of *S.sesban* was poor and therefore had the lowest biomass yield. Moreover, it had to be planted in furrows rather than in holes and this meant more labor. The species was also not easy to remove from the field once established due to deep roots.
2.Mrs. Khayanje From Emanyonyi village	Herbaceous legume cover crops	The farmer had established *C.ensiformis*, *C.ochroleuca*, and *M. pruriens* on separate plots during the short rains of 1999 and by the time of the evaluation she had incorporated the biomass in the farm in readiness for maize planting in the long rains of 2000. According to the farmer *M. pruriens* was the most preferred species since it was easy to establish due to large seed size; it had a dense creeping canopy thus suppresses weeds and good in soil moisture retention; high biomass yield due to broad leaves and the soil texture under the crop improved. *Crotolaria ochroleuca* was the least preferred based on these criteria. The species had a lot of leaf fall which therefore reduced the canopy cover; its pods were prone to damage by pests and was generally considered to have more pests compared to the other two species.
Key issues from the evaluation It was realized that there was no information on the exact time to cut and incorporate the biomass so that nutrient release coincides with crop demand. Farmers wondered whether it would not be less demanding to simply incorporate the biomass without chopping first. Farmers preferred green manure systems that take shorter time to give results. There was a concern on what were the trade offs for the additional labor input on green manure systems, given that labor was a constraint. There was a concern on the possibility of the green manure species introducing new crop pests in the community. Farmers raised concerns on the future sources of seed for the green manure species given that they were supposed to cut and incorporate the species before seed development. For the tree species farmers opted to continue with *T. vogelii* and *C.grahamiana*, while they chose *M.pruriens, C. ensiformis* and *C. ochroleuca* for the cover crops.		

Table 4. The distribution of participating farmers in each village according to wealth category

VILLAGE	Number of farmers in each wealth category					
	1	***2***	***3***	***4***	***5***	***6***
Emanyonyi	2	3	2	6	0	0
Wobaria (Obaria)	1	4	2	5	0	0
Mukhombe "A"	1	0	3	4	0	0
Mukhombe "B"	2	1	3	8	0	0
Mwilonje	2	2	5	4	0	0
TOTALS	8	10	15	27	0	0

When the distribution of participating farmers by wealth category is analyzed on the basis of four selected technologies (table 5), it is notable that the majority of the farmers (50%) implementing the herbaceous legumes were in category 4 while the majority of those implementing improved tree fallows (60%) and organic-inorganic interactions (42.9%) were in category 3. The majority of farmers implementing improved livestock feeds (62.5%) were in category 1. When the four technologies are compared, the majority of farmers (42.4%) regardless of wealth category were implementing organic-inorganic interactions.

Table 5: Distribution of farmers in each wealth category across selected technologies implemented in 2000

Technologies	**Number of farmers in each wealth category**						
	1	**2**	**3**	**4**	**5**	**6**	**Total**
Herbaceous legumes	1	1	1	3	0	0	6
Improved Tree fallows	0	1	3	1	0	0	5
Organic-Inorganic Interactions	1	4	6	3	0	0	14
Improved livestock feeds/feeding	5	2	1	0	0	0	8

Discussion

The available data and information gathered both formally and informally from the trial site shows the number of factors that influenced singly or in combination, the patterns of technology uptake observed among the farmers of Emuhaya. Some of these factors are discussed below.

Awareness and familiarity with the technology

One of the key factors is whether the farmers were aware and familiar with a technology, or some aspects of it, or whether the technology was relatively new. Technologies such as high quality manure, organic-inorganic interactions and soil conservation were not entirely new. Farmers were already keeping some manure and were quite aware of its value. Other than the prohibitive cost of inorganic fertilizer, farmers were aware of its potential in improving crop yields. Soil conservation work had been going on in the community for some time and therefore not an entirely new innovation. The project was, therefore, only improving on the conservation terraces through the establishment of fodder legumes to stabilize the terraces and also provide feed for livestock. The same level of familiarity was not there with a technology such as the improved short duration fallows. The technology involved not only a new practice but also brought in some new plant species not familiar to the farmers. The improved feeds and feeding also brought in the green leaf Desmodium *(Desmodium intortum)* which farmers were not familiar with. Moreover, the production system in the division was largely semi-zero grazing involving tethering in non-cropped areas and therefore the use of cut-and carry fodders such as Desmodium is not a common practice. Some technologies were not adapted to the farmer's own productive logic. Take the example of the use of beans as trap crops in controlling striga. Farmers knew about beans as source of food and therefore their productive logic was to get varieties that are high yielding and with desirable food qualities. It was therefore not easy for them to conceptualize how one can simply grow beans to control striga. A series of trainings had to be held to enlighten the farmers on striga biology and how the beans were useful in controlling it.

While awareness of the potential and techniques of applying a technology are known to be a major prerequisite condition for deciding whether to adopt or not, the length of time farmers are exposed to a technology is equally crucial. In a study undertaken both in western Kenya and Trans Nzoia districts to assess diffusion and potential for farmers' uptake of various components of the introduced green manure legume technology, no farmer adopted the technology in Kakamega out of the 29% who were aware that green manures (*Mucuna pruriens* and *Crotolaria ochroleuca*) could be utilized to improve soil fertility. In Trans Nzoia only 4% of the 54% who were aware adopted. This low adoption rate was attributed to the short period of only one year during which farmers were exposed to the technology (Odendo *et. al*., 2000).

The demands by the technology

The technologies differed in terms of the demands they placed on the farmers for land, labor, time and managerial skills. Although there may not have been an additional demand on land by the technologies since farmers were supposed to implement within their existing holdings, the demand on the other factors of production were critical. In all the technologies farmers had to provide some labor as they often do during their normal farming activities. However, some technologies required more labor over and above the normal. For example, biomass transfer required additional labor for harvesting, chopping and incorporating the biomass. Some of the farmers who were implementing green manure technology decided to modify the technology by uprooting and directly incorporating the herbaceous legume cover crops instead of cutting and chopping first in order to save on labor. Improved fallows also required additional labor for planting the fallow species, harvesting them and incorporating into the soil. For example, farmers preferred *Crotolaria grahamiana* to either *Tephrosia candida* or *Sesbania sesban* because it was easier to cut, chop the leaves, twigs and stems and incorporate. Studies by Kipsat (2001) and Kipsat *et al* (2004) showed that the cost of labor form a major part of the total cost in the use of organic materials in western Kenya. Labor was shown to form over 60% of the total variable cost of production in maize and bean intercrop when the organic matter technologies are used. This is because the use of organic materials is labor intensive.

The demands a technology places on family labor is thus a key determinant of technology uptake and this has been shown by other studies. In a study by Pisanelli *et al* (2000), in western Kenya to assess farmer's expansion in the use of improved fallows after initial testing and to describe how they were modifying and adapting improved fallows to their needs and circumstances after three years, the farmers gave lack of labor, land, seed and technical assistance as the main reasons for not continuing to plant improved fallows. Some technologies had added financial costs to the farmers. For example, farmers who were implementing the organic-inorganic technology would have liked to increase farm acreage under Tithonia with Triple super phosphate (TSP), and Farm Yard Manure (FYM) with TSP, but were not able since they could not afford the TSP.

According to household economics theory, farm households often seek to minimize the costs of producing goods for their own consumption so as to maximize returns to the labor time of its members which is a basic resource of households. From this perspective, utility is thus maximized by producing the desired set of goods with the least cost in terms of this basic resource. Given the many demands for family labor in farm and non-farm activities, market and non-market production, and work and leisure, family labor is at premium, with the major objective being to employ it in alternative uses as efficiently as possible (Low, A., 1986). This implies that households seek to maximize the subjective return to the labor of their members and that what tasks are performed and by whom depends on the opportunity costs of member's time. Opportunity time costs are thus generally determined in terms of alternative farm activities or of wages that can be earned off the farm. It varies over time and at any one point in time among household members of different genders, ages and skills. Even in times of little farm activity, the demands on family labor are many and it cannot be assumed that when there is little farm work to do the opportunity cost to family labor is negligible. The farmers' objectives include not only production for subsistence and sale but also activities to "kill time" and break the monotony and tedium of living in rural areas (Okigbo, B.N., 1986). The value you put on an hour spent looking after children, or collecting firewood or drinking beer with friends is certainly not 'zero' just because these activities do not relate to farming. Technologies that do not necessarily increase productivity per unit of land but which save family labor-time are often attractive to small scale family farm units. In Emuhaya, farm labor for most households is provided by the family except in few cases such as land preparation when hired labor is used. Daily wage rates for hired labor are expensive given that in addition to cash payment the workers have to be provided with meals.

The specific attributes of the technology

In the case of the herbaceous legume cover crops (LCCs), the specific attributes of the different legume species was of major consideration by farmers as a selection criteria. During a feedback session with farmers in February, 2000 after a joint farmer-researcher evaluation of the herbaceous LCCs on farmers' fields, a number of criteria used by farmers in selecting the species were generated. These criteria were then used by farmers in ranking the species (Table 6).

Table 6: Farmers' criteria for selecting legume cover crops using scores of 1 to 3 (the highest score being 3 and 1 being the lowest).

Selection criteria	**Scores by species**		
	Crotolaria ochcroleuca	*Mucuna pruriens*	*Canavalia ensiformis*
Ease of establishment (large seed, readily available)	1	2	2
Ease of germination (good viability, good stand)	3	1	2
Ease of weeding (less dense, easy to work through)	3	1	2
Ability to suppress weeds (dense canopy)	1	3	2
High biomass yield (more leaves within a short period)	1	3	2
Improving soil texture (darker, softer soils under crop)	1	3	2
Ease of cutting and incorporating (softer stems)	1	3	2
Total Scores	11	16	14
Rank	3	1	2

The overall ranking by farmers showed *Mucuna spp.* to be the most preferred followed by *Canavalia spp*. *Crotolaria spp.*, on the other hand scored poorly in all the criteria except in 'ease of germination' and 'ease of weeding'. It had a lot of leaf fall making the available leaf for incorporation less. It would have been interesting to sample and analyze the soils under each cover crop to determine the potential contribution to soil improvement of the fallen leaves. According to the farmers, *Mucuna spp.* was the best in terms of controlling weeds because of its creeping nature and good ground cover. Its biomass also showed the best promise in improving soil fertility and moisture retention. Although the demand for labor did not come out on its own as a criterion, farmers felt that the adoption of green manures could result in additional labor requirements which must be compensated with additional benefits. When the farmers used ease of uprooting, susceptibility to pests and diseases, and quality of firewood in addition to the above criteria in ranking tree fallow species (*Tephrosia candida*, *Crotolaria grahamiana*, and *Sesbania sesban*), *Crotolaria* emerged the most preferred species followed by *Tephrosia*. *Sesbania* was less preferred due to the difficulty in its establishment since the seeds have to be drilled in furrows, has less biomass, and is more difficult to uproot once established. In similar participatory evaluation of LCCs by farmers in Areka, in the Southern Ethiopian Highlands, almost the same selection criteria were used (Amede *et.al*.,2004). Similarly, *Mucuna* followed by *Crotolaria* was ranked the overall best candidate for the farming system of Areka. In the case of Areka, soil water content under the canopies of LCCs was measured at five months of age and the results showed that the highest soil water content was under *Mucuna* which also had the highest ground cover. This self-mulching habit implies that the species could improve soil water availability and may not compete for water if grown in combination with food crops.

Complexity of the technology

The complexity of a technology manifests itself in the form of the number of "dos' and "dont's' that come with it. The technologies introduced in Emuhaya were not complex as such but some of them required the farmer to be rather more "systematic", than 'systemic', and this is something that smallholder farmers who are constrained by labor and time do not like. Such technologies are also usually less divisible. For example, the improved tree fallows required planting of the tree species after second weeding of the long rains maize; leaving the fields fallow during the short rains; cutting back of the trees and incorporating the biomass just before the planting of the next long rains maize. The number of concerns that emerged from this technology thus reflects its complex nature. Technologies that come with what looks like an "operation manual" may also require a longer time for farmers to get used to it. Farmers may adopt the various components one at a time. In a study undertaken in South West Kenya to identify, among other things, the socio-economic and technical factors that hindered or facilitated the adoption of different combinations of organic and inorganic fertilizer technologies, Mose *et. al*. (2000) reported that there were discernible differences in the adoption of particular components of the technology based not only on farmer circumstances but also on the complexity of applicability of the components. For example, out of ten technological components (Table 6), time of FYM application was the most adopted technological component because it requires less skills and resources to implement.

Table 6: Pattern of adoption by technological component

Technological Component	% adopters (n=37)	% of total no. (n=307) of farmers	Rank
Time of compost application	56.8	6.8	4
Compost storage	56.8	6.8	4
Time of FYM application	91.9	11.1	1
Compost preparation	56.8	6.8	4
Compost handling	51.4	6.2	7
FYM handling	67.6	8.1	3
Compost method of handling	51.4	6.2	7
Time of inorganic fertilizer at topdressing	35.1	4.2	10
Recommended plant density	83.8	10.1	2
Inorganic fertilizer application rate at Top dressing	45.9	5.5	9

Adopted from Mose *et al*.(2000)

Associated benefits from the technology

Farmers are often keen in finding out what extra benefits, a project or a technology is bringing with it. In the organic-inorganic interactions technology, inorganic fertilizer and/or improved seed (maize and beans) were provided by the research team and therefore the technology had associated benefits which attracted the majority of farmers regardless of their wealth status (Table 4). Whereas these inputs were only components of the technology, to the farmers they were the technologies in themselves. Such "*runaway*" technologies or technology components can have the potential of overshadowing the actual technologies and thus emasculating the original objectives of a project. This is more so when the payback period of the primary technology is long and therefore the '*runaway*' technologies or technology components provide immediate benefits. For example, it takes at least three seasons to realize the benefits of using the bean varieties as trap crops in striga control. Over that period it may require something else to sustain the enthusiasm of the farmers. This is where the 'runaway technologies' can become handy in sustaining farmers' interest.

The length of time taken to benefit from the technology

Some technologies take too long before their benefits can be realized and because of this they may not be attractive to farmers who are experimenting with them for the first time unless they carry with them some attractive short term benefits. Those technologies that show results in the shortest time possible are likely to be taken up much faster. For example, the effects of using high quality manures in a maize crop was realized after only one season of planting. A farmer in Mukhombe 'A' village had a maize yield increase from 20 kg/acre without the use of any fertilizer to 225 kg/acre when he used high quality manure at the rate of 10 tonnes/ha. Another farmer in Wobaria village had an increase from 70 kg/acre to 540 kg/acre. Such dramatic and immediate benefits is further illustrated by one season results from a demonstration which was set up on three farms to show the benefits of combining organic and inorganic fertilizers (Table 7).

Table 7: Mean maize grain yield under different organic and inorganic nutrient sources

Treatments	Maize grain yield (90 kg bag/ha)
Control (Farmer's practice)	8
Improved Compost manure (20 t/ha)	16 (100%)*
Tithonia diversifolia (5 t/ha)	10 (25%)
Compost manure (10 t/ha) + 25 kgN/ha + 25 kgP/ha	26 (225%)
Tithonia diversifolia (2.5 t/ha) + 25 kgN/ha + 25 kgP/ha	22 (175%)
Recommended- TSP (60 KgP2O5/ha) + CAN (60 kgN/ha)	23 (187.5%)

* Percentage increase in yield over farmer's practice

Methodological factors and implementation strategy

According to the observations made by an external review team which evaluated phase II of AHI, Integrated Natural Resource Management (INRM) remains an elusive concept, its meaning being still evolving (Collinson *et.al*., 2000). According to the review team, developing a set of processes to achieve INRM, and building capacity to implement these, is a major undertaking, and therefore given the stage at which the AHI project in western Kenya was at that moment, a fifteen year period was needed. One important observation that is relevant here is that because of the short time spent with farmers, there was little integration between biophysical and socio-economic data that had been collected. This integration is important since, according to the external reviewers, farmers' enthusiasms, perceptions, and response to introduced technology is as important to AHI research as the rigorous statistically analyzed yield data.

Whereas one would have thought that the technologies presented to the farmers simply required further demonstration for wider adoption since they were proven technologies, the numerous questions that arose with regard to some technologies (table 3) and whose answers required further experimentation proved that there was still a need to further refine the technologies by incorporating farmers' perspectives and innovations before final recommendations were ready for wider dissemination.

Equally important is the fact that there were too many technologies being promoted at the same time, all addressing a single problem, that of low crop yields which had about three major interrelated causes (low soil fertility, striga, and low yielding crop varieties) and yet implemented as if they were targeting different and independent problems. Although it can be argued that these were technological options, they needed to be treated as though they were components of the same technology package addressing soil fertility and land degradation. For example, one of the observations made during a joint farmer-researcher evaluation of the herbaceous legume cover crops, improved tree fallow species, and relay intercrop with soybean, *Sesbania sesban* and *Crotolaria grahamiana,* was the lack of integration between the three activities. It was felt that these activities in reality were components of a single technology targeting different niches and species. The fact that the methodologies and the implementation strategies were in themselves going through a development process may have had an effect on the uptake of the technologies. For example, there was no clear generic methodology to facilitate and manage the changes that were occurring as farmers experimented with the technologies. The initial PRAs allowed the research team to learn about the farmers' and communities' problems, needs, hopes, visions and strategies but more effort was required in developing the farmer's competence in observation, experimentation, reflection, organization and negotiation for sustainable farming.

The level and intensity of engagement by research team

One other major impetus behind the levels of uptake that were achieved is the very intensive engagement of the farmers in the activities by the research team. However, since most of the technologies had been developed elsewhere, there may not have been enough time to incorporate farmer's experiences and local ingenuity. Moreover, the project ended just as new social arrangements such as the FRCs which could have been valuable in technology testing had just been formed as a result of the intensive group interactions with farmers.

Conclusion

The patterns of technology uptake observed in Emuhaya illustrate the importance of the technical, social and methodological components of a participatory community-based research approach. For greater uptake, the technologies have to be familiar in the sense that they incorporate not only the scientific knowledge but also the farmer's experiences and ingenuity. This may require that farmers are exposed to the technologies for a longer time to experiment with them so that eventually they become the owners of the technologies. Since the farmers in Emuhaya were only presented with a "menu' of technologies developed elsewhere to choose from, the technologies were largely external to their experience and so they needed more time to internalize them. Some of the technologies raised new concerns that needed to be experimented on further before being taken back to farmers.

Technologies that have additional demands on family labor or have additional financial costs are unlikely to attract many farmers unless the benefits are high and faster to realize. Specific attributes of a technology is another important factor. Those technologies with "soft" or "ease" attributes are more favored. They are less demanding in terms of labor, the benefits are high and take a shorter time to realize. This is clearly seen when farmers ranked Mucuna as the most preferred LCC based on its "ease" attributes (Table 5).

The uptake of a technology can also be determined by the complexity of the applicability of its components. The improved tree fallows, for example, has a list of specific things to be done at specific times in the season and it is not possible to do one without the other. Such lack of flexibility means that the technology is less divisible and therefore presents the farmer with not only a complex but also a rigid menu.

High initial levels of uptake of a technology can at times be as a result of the associated extra benefits that come with that technology. This is seen in the case of organic-inorganic interactions where farmers were given free supplies of inorganic fertilizer. It would be interesting to know what has happened since the project ended and farmers were now supposed to purchase the fertilizers on their own.

The length of time taken to benefit from a technology and the level of benefit derived is yet another determinant of rate and level of uptake of a technology. Figure 3 illustrates how the level of benefits and length of time taken to realize such benefits affect the rate of uptake of agricultural technologies and natural resource management practices. Technologies like improved beans have a short, usually seasonal, time horizon and a small spatial scale, and therefore the benefits are faster to realize and the rate of adoption is high. Other technologies such as erosion control require longer time horizons between their adoption and payoff. Moreover, such a technology operates at a larger spatial scale and this implies a greater need for collective action in order to implement.

Participatory community-based research being an evolving approach for technology development and dissemination requires a lot of interactions and reflections between the farmers and the research team in order to realize faster benefits. Although a number of technologies can be implemented at the individual farmer level, for certain technologies such as soil erosion control it would be desirable to enhance community rather than individual farmer involvement. To facilitate and manage the changes that result from the interactions require a well thought out generic methodology that would allow the research team to learn about the community and understand their aspirations as well as develop farmer's competence in experimenting, analyzing and reflecting on the processes.

References

Low, A. 1986. On-farm Research and Household Economics. In: Joyce L. Moock (eds). Understanding Africa's Rural Households and Farming Systems. Published by Westview Press, Inc. pp. 71-91

Amede,T., and R., Kirkby, 2004. Guidelines for Integration of Legumes into the Farming Systems of East African Highlands. In: Andre Batiano (eds).Managing Nutrient Cycles to sustain soil fertility in Sub-Saharan Africa. Academy Science Publishers (ASP) in association with the Tropical Soil Biology and Fertility Institute of CIAT. Pp. 43-64.

Bede N. Okigbo, 1986. Forward. In: Joyce L. Moock (eds). Understanding Africa's Rural Households and Farming Systems. Published by Westview Press, Inc. pp. xi

Collinson, M., E. Chuma, and B. Carson, 2000. A report on the evaluation of phase II of the African Highlands Initiative. Submitted to Association for strengthening Agricultural Research in East and Central Africa, International Centre for Research in Agroforestry (ICRAF), and AHI Donors.

Hagmannn,J., E. Chuma, K. Murirwa, 1997. "Kuturaya" : Participatory research, innovation and extension. In:Van Veldhuizen L., Waters-Buyer,A., Ramirez, R., Johnson D., and Thompson J. (eds). *Farmers research in practice; lessons from the field. IT Publications, London, pp.153-173.*

Odendo,M.J.K.,Barakutwo,N.,Gitari,M.,Kamidi,B.,Kirungu,E.,Lunzalu,J.G.,Mureithi,C.O.,Nekesa,J.,Ojiem,M.,Okumu,E.,Okwosa,R.,Onyango, and H.M., Saha, 2000. Potential for adoption of green manure legumes for soil fertility management in Kenya. In:J.G.,Mureithi *et al*.(eds).Participatory Technology Development for soil management by smallholders in Kenya. Proc. Of the 2nd Scienntific Conference of the soil management and Legume Research Network Projects, held in Mombasa,Kenya.

Kipsat, M.J. 2001.Economics of Non-Conventional Fertilizers in Vihiga District, Western Kenya. M.Phil. Thesis.Department of Agricultural Resource Economics, Moi University.Kenya.

Kipsat, M.J., H.K. Maritim, and J.R. Okalebo, 2004. Economic Analysis of Non-Conventional Fertilizers In Vihiga District, Western Kenya. In: Andre Batiano (eds).Managing Nutrient Cycles to sustain soil fertility in Sub-Saharan Africa. Academy Science Publishers (ASP) in association with the Tropical Soil Biology and Fertility Institute of CIAT. Pp. 43-64.

Pisanelli, A., S. Franzel, J. De Wolf, R. Rommelse and J. Poole, 2000. The Adoption of Improved Tree Fallows in Western Kenya: Farmer practices, Knowledge and perception. *Summarized by S. Mwai and S.Franzel (2000). Extension Brief, Western Kenya*

Mose, L.O., W.Nzabi, M.Onyango, A.B. Gor, S.A.N. Moruri, S.O. Makworo, E.N.K. Okoko, and D.J.K. Kwach, 2000. Inorganic and organic fertilizer use: potential for adoption at smallholder level in South West Kenya. In: J.G.,Mureithi *et al*.(eds). Participatory Technology Development for soil management by smallholders in Kenya. Proc. Of the 2nd Scienntific Conference of the soil management and Legume Research Network Projects, held in Mombasa,Kenya.

Supporting Alternative Seed Delivery Systems in AHI-Galessa Watershed Site

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Abstract

Generation of improved technologies by itself does not mean anything unless they have not been availed, readily accepted, properly utilised and boosted productivity at farm levels. To this effect, African Highland Initiative and Holetta Agricultural Research Centre started participatory research and development efforts at Galessa in Ethiopia with main objectives of improving natural resources management and agricultural productivity thereby contributing towards food and income security in Ethiopia. The efforts involve farmers' participatory technology evaluation/generation and transfer. Development and transfer of improved crop varieties particularly of barley and potato are among the main efforts under way in the AHI-Galessa Watershed Site. Improved varieties must be multiplied and made available to the needy farmers in a sustainable manner for the desired impact to be achieved. The present analysis is thus to assess the existing seed supply alternatives along with their associated problems and potentials to improve production and distribution of improved seeds in Galessa area. Different approaches were used to make the assessments including rapid surveys, review of similar experiences from secondary information, discussion with key informants and field observations. Results of the assessment, analysis of the existing seed delivery systems, possible ways of enhancing alternative and more effective systems have been discussed and recommendations were made accordingly.

Background

Crop production is the mainstay of the rural population in Ethiopia in general and that of the AHI-Galessa Watershed Site in particular. The sector's output has, however, been very low due to the biophysical and socio-economic challenges and inadequate technological interventions, including the seed delivery systems. The purpose of this paper is, therefore, to analyze the existing seed supply along with the prevailing problems, to assess potential of alternative seed systems and draw useful lessons for the betterment of the livelihoods of small-scale farmers via efficient seed delivery options.

Seed is one of the most important inputs in the crop production processes, and two different types of seed supply systems (i.e., formal and the informal) are widely known (Almekinders and Louwaars, 1999). In the formal sector, various organizations with chains of specialized activities are operating. The institutes of plant breeding develop new varieties, while various organizations of seed multiplying and distributing agencies are carrying out their duties of duplicating and dispatching new varieties to various users. The formal seed system is not well developed in many developing countries (van Gastel et al., 2002) including Ethiopia (Gurmu and Gudissa, 1998). The only organization in the formal seed sector is the Ethiopian Seed Enterprise, with its various branches in different parts of the country, which has only a limited capacity to produce the necessary quantity of seed to meet the national demand. This results in the shortage of quality seeds of improved varieties at farmers level. Moreover, the formal system is a complex scheme, with integrated organizational components including seed multiplication, processing, storage, marketing, and distribution units.

The formal seed production system in Ethiopia constitutes different classes of seeds. Plant breeders generate small amount of seed called the breeder seed. The breeder seed is first multiplied to produce the pre-basic seed, which in turn is multiplied to produce the basic seed. The basic seed is again multiplied to produce the certified seed, which is sold to the farmers for commercial production. Thus small amount of seed is gradually increased to produce the large quantities of certified seed needed to satisfy the entire seed requirement (Gemechu *et al*., 2001).

These different classes of seeds have to meet certain standard requirements of purity, quality, health and uniformity (Table 1) before they have to be advanced to the next generation or distributed to farmers for wide production. The flexibility of these requirements increases as the process proceeds from breeder to certified seed. The standards are stricter for early generations than for the later ones in the seed multiplication scheme. Some of these requirements are examined before planting, some when the seed crop is in the field and the rest require analytical examination in seed laboratory on seed samples taken from basic and certified seeds in the storage, marketing and distribution units.

Table 1. Minimum field and seed certification standards for maintaining quality barley seeds in Ethiopia (WANA, 1998)

Standards	**Seed classes**			
	Breeder/pre-basic	**Basic**	**Certified 1**	**Certified 2**
Field standards				
Rotation (min. years)	3	3	2	1
Isolation (min. meters)	5	5	3	3
Other varieties (max. %)	0.03	0.05	0.2	0.3
Noxious weeds (max. %)	Nil	Nil	Nil	Nil
Seed standards				
Pure seed (min. %)	99	98	97	97
Other crop seeds (max. %)	0.03	0.05	0.1	0.2
Weed seeds (max. %)	-	0.01	0.02	0.05
Infected seeds (max. %)	-	0.02	0.03	0.05
Inner matter (max. %)	1	2	2	2
Germination (min. %)	90	90	85	85
Moisture content (max. %)	12.5	12.5	12.5	12.5

- = Not yet decided

The informal seed system offers many opportunities for improving the seed security of small-scale farmers (Almekinders and Louwaars, 1999) for it was built on farmers' knowledge and capacities that have been widely recognized as a resource for development. Under many circumstances, farmers' practices and varieties have proved to be well adapted and the best option, in view of the local climate, soils, the limited resources and diverse needs of the household. Hence, building on the strengths of the informal system is very important, with their options of participatory varieties improvement, seed production practices, and diffusions of varieties and seeds. In contrast, the formal seed sector has been unsuccessful in meeting farmers' needs in less favourable and marginal production areas (Almekinders and Louwaars, 1999). In such areas production conditions are often complex and more risk prone. Factors, like low soil fertility, drought and other climatic hazards reduce the productivity of various crops. The availability and/or access to agricultural inputs (capital, land, labour, fertilizer, water, etc.) are generally limited, more expensive and more variable due to bad road systems and remote market channels. Under these conditions, the purchase of expensive seed may not be economical. This does not, however, imply that improved varieties are never successful in less favourable areas but they can very useful. Hence we have to compromise both seed delivery systems.

Methodology

RESEARCH SITES

Physical Environment

Galessa is located in Dendi district, western Shewa Zone of Oromia regional state in Ethiopia. According to Kindu et al. (2002), the altitude ranges from 2820 to 3080 m above sea level. Galessa's rainfall pattern is bimodal and the main rainy season is from June to September, while the short rainy season often runs from February to April. A range of soil types characterize the area classified by farmers as dimile (red); magala (brown), guracha (black), borelie (limestony), chiracha (sandy) and kossi (rich in organic matter) based on fertility, color and structure. Lab analysis showed that the soils vary from silt-loam to heavy clay in texture. The clay percentage ranges from 30-67%, whereas the pH values vary from 4.1 to 6.5. The organic carbon content is low except in magala and kossi soils.

Land Ownership

In Ethiopia, land belongs to the government and farmers have only the users' right. Hence, farmers are not allowed to sale or exchange land. Due to the increasing growing population, cultivable land is getting very scarce. Land renting is practiced in the area and those who do not have oxen and cannot afford to purchase inputs like seeds and fertilizers rent out their lands on sharecropping and contractual basis. Land is bequeathed to male family members at marriage, commonly at the age of 18. Women do not have right to own land except after marriage, showing the limited access of women to land. The size of land for bequeathing is getting smaller and smaller due to land fragmentation caused by the increasing numbers of the family members. The total cultivable land is estimated to be 680 hectares, with the average of 1.12 hectares per household.

Labor Sources

Almost all residents of Galessa belong to the Oromo ethnic group. According to the 1994 census of Dendi district, the estimated human population in Galessa peasant association was 2003, with 446 households (406 male-headed and 40 female-headed). Family size ranges from 3 to 15 persons per household, with an average of five people.

Farmers are traditionally categorized into upper, middle and lower wealth groups based on the size of cultivable land, number of livestock and enset plants owned, which are regarded as wealth indicators (Table 2).

Table 2. Wealth groups of Galessa based on amounts of land, livestock and enset plants (Kindu, *et al*., 1997)

No.	Indicators	Upper group	Middle group	Lower group
1	Cultivable land	2.52-3.78 ha	1.26-2.52 ha	0-1.26 ha
2	Livestock			
	Sheep	8-20	5-8	3-5
	Ox	2-4	1-2	0-1
	Cow	3-5	1-3	0-1
	Horse	2-4	1-2	0-1
3	Enset	100-200 plants	50-100 plants	0-50 plants

The household members are the main source of labor in the area. During the peak working period (land preparation, harvesting and threshing), collective labor, in which a group of farmers are invited to work on neighboring farmer fields as it is locally called dabo, is used. During this collective labor services, the host prepares food and drink for free.

Infrastructure and Major Constraints

Farmers live on cold and rugged mountains with limited access to transportation and markets. There is only one all weather road (100 km gravel road) that was built five years ago passing through Galessa, linking Gindeberet with Ginchi and then joins with the highway from Addis to Lekemet. Most of the time, farmers use pack animals to sell their produce at Ginchi market, which is more than 20 km away. At Galessa, shortage of food is high from April to November with reduced shortages from December to March. During the food shortage periods, farmers use potato and enset to overcome the problems. Food shortages attributed mainly to limited farm size per household. A survey (Kindu et al., 1997) identified the major problems in the area as deforestation, soil erosion, depletion of soil fertility, potato disease, feed and food shortages, poor diversification of crops, water shortage, high human population growth and low price of farm produce. In addition, Galessa farmers indicated that they have limited off-farm opportunities.

Major Crops and Yield Trends

Barley is the most prominent crop followed by potato and enset in Galessa. Barley covers almost all cultivated crop fields, while, potato followed by enset (*Ensete ventricosum*) dominates around the homestead. Some farmers also grow oats, locally known as shamame, wheat, Ethiopian mustard and garlic around their homestead, mostly for home consumption. Farmers reported that barley yields have been declining for the last 25 years. Currently, the yields range from only 1000-2000 kg/ha without fertilizers and 3000-4000 kg/ha with fertilizers. Several farmers associated yield reductions to lack of high yielding varieties, moisture shortage, reduced soil fertility, increased soil erosion, imbalance in amount and distribution of rainfall and severe frost and desiccating dry winds during grain filling periods of the crop. Moreover, mono cropping due to lack of crop and cultivar diversity also results in yield reductions.

Availability of Production Inputs

Improved seeds of the major crops (barley and potato) were not well known in Galessa area until very recently. Extension specialists of the district have recently started to provide improved barley and wheat seeds on credit basis through the extension program of the Ministry of Agriculture and Rural Development (MoARD). Fertilizer was initially introduced in 1977 and since then the trend of fertilizer use has been increasing. Farmers mostly apply fertilizer on reddish and grayish soils though small amount is also applied to the brown and black soils. Summaries of inputs, their application time, rate and method are given in Table 3. Manure is a type of input locally available for farmers who own livestock. However, the farmers purchase chemical fertilizers, herbicides, fungicides and improved seeds of some crops from nearby market and the MoARD district office despite the unavailability and higher prices.

Table 3. Input type, rate, time and method of application at Galessa (Kindu, *et al*., 1997)

No.	Input	Crop	Method	Time	Rate	Incorporation
1	Manure	Potato, nearby		At seed bed		
		Barley fields	Broadcast	Preparation	As available	Maresha plow
2	DAP	Barley (fertile soil)	Broadcast	At planting	1 bag/6 gemed	Maresha plow
		Barley (poor soil)	Broadcast	At planting	1 bag/4-5 gemed	Maresha plow
		Potato	Spot appl.	At planting	5 kg/1 gemed	Manual
3	Herbicide	Barley	Spray	3-4 leaf stage	1 cup/18 L water	No need
4	Fungicide	Potato	Spray	Disease onset	2 cup/18 L water	No need
5	Imp. seed	Wheat	Broadcast	June 27-7 July	150 kg/ha	Maresha plow

DATA COLLECTION METHODS

Rapid surveys and observations were undertaken to acquire information of indigenous knowledge on seeds and seed delivery systems in Galessa, integrating both individual and focus group discussions. These were supported by interviews with key informants and elderly farmers, and consulting secondary data from reports and publications of various authors. Participatory Rural Appraisal (PRA) approaches (historical trend analysis, focus discussion, interviews, transect walk and observation) that enable local people to share, examine, expand and analyze their own knowledge and conditions, needs and problems were also applied during the surveys and discussions.

Results

Analysis of Seed Delivery System

Farmers in Galessa mostly use their own seeds of local cultivars recycled from previous season except very recently, when seeds of improved varieties were supplied by the extension package of the MoARD, especially for barley and wheat.

Local Cultivars

Farmers perpetuate their own seeds of local varieties through their own seed system involving indigenous maintenance (utilization and conservation), enhancement (selection), post harvest handling (cleaning and storage) and diffusion (exchange, sale or gift). These practices are based on accumulated knowledge of farmers for generations. They also have their own descriptions for local cultivars that enable them to differentiate one cultivar from another of the same crop. They usually use qualitative characteristics related to morphological appearance, seed color and maturity periods. For instance, four barley cultivars with the names *balami*, *guracha*, *adi* and *shamareta* are produced in the area, *balami* being the most dominant. They select a specific cultivar depending on their purpose, locations of adaptability and types of soil for planting. Black and white seeded barley cultivars are grown on fertile and deep soils, while *balami* grows on all types of soils and frost prone areas. *Balami* is preferred for *injera* (local bread), while black seeded varieties are used for preparing *tela* and *areki* (local beverages). White seeded cultivars are preferred for preparation of various local foodstuffs.

Farmers may produce their own seeds of local cultivars, or they may also get them from friends and relatives, neighbors or they may buy from markets particularly following natural disasters (drought and frost) when they run out of seed. They may also introduce seed from distant places. For instance, some progressive farmers introduced potato tuber seed from Addis Ababa 50 years ago. Since then, farmers have been using only one better yielding variety that can easily be identified by its white flower. This variety is sometimes mixed with low yielding and purple flowered variety. Most farmers usually maintain the purity of potato varieties by rouging the off-types at flowering stage. For some exotic horticultural crops, particularly vegetables (carrot, red beat, spinach and salad), farmers do not have reliable seed sources and have to purchase seed produced elsewhere.

Farmers realize the value of a healthy crop for seed production, with seed selection occurring after harvest, or before harvest by walking through their fields and marking the plants suitable for seed based on certain criteria. Grain physical purity is not considered as a rigid quality parameter of seeds but they rather attribute more value to seed plumpness. Farmers believe that purity could be improved with sieving. A sort of germination test is also conducted when they suspect the viability of the seed purchased from the market. If the viability is found poor, the grain will be used for immediate consumption instead of propagation.

The seed mother of enset culture is usually selected based on the size of the corm; the bigger corm (*cobra)* being better. Some farmers may grow seed or planting materials for the next season in a separate plot with some extra attention compared to fields meant for food crops. For example, more attention may be given in terms of manure application, discarding undesirable plants and keeping the plot free of weeds. They also thresh and store seeds separately from grain for consumption or sale. Seed storage also gets more attention in terms of protection from storage insects using different sanitary measures. Therefore, prices of grains/ vegetative parts meant for seed are slightly higher than the ones meant for consumption. Potato tubers meant for planting are traditionally kept in the soil until planting, but these practices are changing as farmers are trained to use defused light stores (DLS). Farmers associate better seed retention practices with higher social values, using good seed preservation as indicator for well-behaved and respected family. They use or implement such values during engagements, marriages and local administrative exercises.

Improved Varieties

It is very recent that both formal and informal systems of seed supplying have been introduced in Galessa area and these systems are still in their infancy. These initial exercises are undertaken on crops like, potato, barley and wheat.

Formal System

Specifically, small subsistence farmers like those of Galessa have no access to quality seeds not only because of their economic background but also due to limited seed production and distribution. The relative importance of different seed quality components (Table 1) indicated that germination percentage, followed by seed health, genetic purity, moisture percentage, uniformity and size, physical purity and treatment, package and label are the most decisive factors in the given order (van Gastel, *et al*., 2002). Improved varieties of barley and wheat have been introduced and some amount of seed has been distributed in the area for the last three years through the extension package of the MoARD. However, unlike introduced wheat varieties, farmers indicated that the barley variety did not adapt to the area. In addition, they complain that the crop management and agronomic recommendations of both barley and wheat, particularly fertilizer and seeding rates, are not affordable in terms of cost. As a consequence, many farmers fail to apply them, preferring to follow their own indigenous management and agronomic practices than the improved varieties to reduce cost.

Informal System

Often times, the formal seed system cannot satisfy seed demand, particularly that of subsistence farmers like those of Galessa. It is therefore logical that the informal seed system should supplement seed available through the formal system to meet this demand. Experiences of the informal system with potato seed by HARC at Galessa itself and elsewhere in the surroundings clearly revealed the success story of informal seed system in areas where the formal system is non-existent or insufficient. Farmers were given high quality seed tubers of cultivars *Menagesha* and *Genet* that were produced by using rapid multiplication technique in screen houses at HARC. Sufficient clean seeds selected by farmers during the on-farm experiment were supplied to interested farmers for further multiplication. Proper training was given on seed standards and crop management and protection practices including a single supplementary spray of a fungicide, Ridomail-MZ 63.5 @ 2.0 kg/ha, against potato late blight disease. Training also covered clonal selection techniques at field level, maintenance of disease free seed tuber, intensive plot techniques to maximize tuber yield of good quality, and the construction and use of DLS for better post-harvest handling (Table 4). In addition to the economic benefits that accrue to the participant farmers, these approaches improved the sense of partnership among the different stakeholders, facilitated farmer-to-farmer technology and information transfer, and created a favorable working atmosphere and a sense of mutual accountability in solving agricultural problems.

Table 4. Good quality seed potatoes produced by farmers at Galessa and Jeldu districts under collaborative work with AHI and PRAPACE (Endale, *et al*., 2000)

Variety	Farmer	Yield t/ha	Site & Remark	DLS*
Genet	1	232	Jeldu (PRAPACE)	Constructed
	2	169	Galessa (AHI)	Constructed
	Mean	**200.5**		
Menagesha	3	430	Galessa	Constructed
	2	386	Jeldu	Constructed
	Mean	**408**		

* Diffused light store (for seed potato storage); total area planted per farmer was 1000m^2

LIMITATIONS OF THE FORMAL SEED SYSTEM

The limitations of the formal seed system may start from the relevance of the varieties to be multiplied under the conditions of resource-poor farmers living in marginal areas. Even though compatibility between the varietal selection environments vis-à-vis the actual target production conditions is generally considered as a linchpin to maximizing gains from breeding efforts, the tradition across most of the breeding programs in Ethiopia is to develop varieties under favorable and well-managed environments despite the fact that biotic and abiotic stresses and marginal management levels characterize the ultimate target production environments. Even though tangible scientific evidence from the Ethiopian context is scanty, the irrelevance of varieties developed under favorable selection environments for use under truly marginal conditions is currently coming into picture elsewhere (Ceccarelli and Grando, 1996). This might hold true in most marginal areas of Ethiopia in general and at Galessa in particular as significant yield gaps between selection and target environments could easily be realized for the most majority of farmers and for most of the crops.

Discussion

ENHANCING THE ROLES OF ALTERNATIVE SEED SYSTEMS

When and where the formal seed system failed to avail adequate amount of seeds of the required varieties, there is no doubt that an informal system involving decentralized seed production should be encouraged. The "village approach" based on decentralized modes of production could best serve as a supplement, or even alternative, to rehabilitating the existing capital intensive and centralized modes of seed production (Friis-Hansen, 1989).

Village-based seed production could come about by establishing small-scale farms that can produce sufficient improved seeds to satisfy the needs of the local community. The community itself could manage such farms but experiences show that group of progressive, flexible and influential farmers should be selected for the successful accomplishment. A few large farms are desirable for seed production than many fragmented small farms, be it for potential farmers, private investors or state farms. This is because large farms can be well equipped and easily supervised and managed. Therefore, it is advisable to organize seed producers, especially progressive farmers, into groups of similar interest and pool together their land and other resources so as to make them more effective and efficient (Gemechu, *et al*., 2001). However, care must be taken to ensure that the group approach is well managed, to avoid the pitfalls of "free riders" (farmers who benefit from the work of others and undermine group motivation), insufficient trust among members, and subsequent conflict of interest - as indicated by community elders during the PRA survey. It is therefore recommended that any such approach adhere to well-known collective action principles, namely keeping group size to a minimum, ensuring there is established trust among group members, and formulating by-laws that clearly specify the responsibilities of group members and consequences of non-compliance (Ostrom, 1990; Wittapayak and Dearden, 1999).

The decentralized seed farms could be supplied annually with basic seed from the research centers or seed enterprise, and could concentrate their activities on seed multiplication and marketing to the community. During the growing season, the village-based seed farms should receive extension advice from decentralized seed inspection units. When they have become familiar with the techniques, the farmers could take over the maintenance of the improved varieties and thus become self-sufficient with basic seed. This requires that the farmers be trained in maintaining the stability of the plant population and in avoiding genetic erosion of crop diversity. The needed improvements to the existing seed selection techniques and retention through mass selection could be taught to farmers within few weeks of training.

The amount of seed to be produced must be based on the current demand for improved seeds and therefore seed demand assessment is very crucial in planning seed production. Theoretically, the demand for seed depends, among other factors, on the proportion of improved seeds utilized in a given area, seed rate per unit area and the period required for seed renewal or technically called "generation control". Seed replacement rate for self-pollinated crops on average is 4-5 years while it is 3-4 years for cross-pollinated crops (Gemechu *et al*., 2001).

Conclusion

Improved varieties are the backbone of all crop development programs. If improved varieties meant for better productivity are not adoptable by farmers for some reason, all financial and human resources invested in their development will be wasted. It is crucial, therefore, that farmers be involved in the varietal development programs right from the inception (Almekinders and Louwaars, 1999). Breeders should also be acquainted with farmers' priorities and selection criteria for effective and efficient development of genotypes. Such an approach will help us to recognize farmers' unique situations, facilitate the development of appropriate varieties and effective transfer by improving farmers' sense of ownership of the varieties.

The release of varieties by itself may not mean anything if they are not available and utilized by farmers. It is hardly possible to say that most of the developed varieties have been accepted, multiplied, properly utilized and boosted productivity at farm levels as desired. The seed systems need to be organized in such a way that desirable relationships exist between formal and informal systems, fostering complementarities between them. The strengths of the informal seed scheme at Galessa by the HARC potato project need to be capitalized upon, continuing to improve weaknesses identified by farmers and researchers. Agricultural research and development policies are also required to accommodate both systems.

The majority of farmers in Galessa are resource-poor farmers and production is highly oriented toward subsistence needs. Under such conditions, risk aversion rather than yield maximization may be the top priority since the economic potentials of the farmers does not permit them to shoulder any level of failure. The risk aversion capacity of varieties could not be proved in a short period of time as it goes with unfavorable climatic conditions. Genetic diversity is the major risk aversion strategy practiced by the resource-poor farmers (Beets, 1982; Tilahun, 1995). Therefore, future endeavors of research and development (R & D) programs should consider and incorporate this aspect as well. Current efforts at Galessa to ensure that chosen crops and organizational arrangements enhance access by diverse types of households should be systematically evaluated for eventual scaling up in conjunction with the actual germplasm.

It was realized that farmers and researchers have their own unique and common know-how, which should be effectively exploited in the research process. Therefore, farmers should be encouraged to be fully involved in the planning and implementation of experiments, as they have an extensive and well-developed knowledge about their environments, crops, seeds and farming systems that has been built up over many generations. Farmers' selection of new varieties based on their own criteria and their participation in R & D is thus very essential. For effective participatory R & D, however, there must be appropriate mechanisms, including the release of improved varieties that are preferred by the farmers.

As the formal seed system is meant for officially produced varieties, the informal seed system whereby farmers themselves produce seeds with some technical assistance should be strengthened for producing seeds of farmers' developed varieties which may not fulfill the criteria for official release. Although farmers are enthusiastic to be involved in the R & D processes, a vast majority of them are resource-poor, production is highly subsistence-oriented, and production strategies cost- and risk-averse. Hence, a compromise must be made between conventional and participatory approaches to improve their integration and greater benefits to farmers. The conventional R & D approaches should take into consideration and simulate the actual circumstances of the target farmers to bring about sound and meaningful changes, especially in seed production and distribution. It is also advisable that breeding activities should address marginal areas, building on farmers' practices and experiences. For example, landraces are believed to be more useful for breeding in marginal areas than introduced materials as they offer genes responsible for a more stable yield over a wide range of environmental conditions. Testing of varieties under both optimal and sub-optimal conditions could also be one of the alternatives for developing varieties that suit both conditions. In short, we need to revisit and redirect our R & D strategies to meet farmers' real needs and circumstances, ensuring meaningful impact.

References

Almekinders, C.J.M. and N.P. Louwaars, 1999. Farmers seed production: New approaches and practices. Intermediate Technology Publications Ltd, London, UK.

Beets, W.C. 1982. Multiple cropping and tropical farming system. Gower Publishing Campany Limited. Gower House, U.K.

Ceccarelli, S. and S. Grando, 1996. Importance of specific adaptation in breeding for marginal conditions. pp. 34-58. *In* Hailu Gebre and Joop Van Leur (eds.). Barley research in Ethiopia: past work and future prospects. Proceedings of the 1st barley research review workshop, 16-19 October 2003, Addis Ababa: IAT/ICARDA. Addis Ababa, Ethiopia.

Endale Gebre, G/Medhin W/Giorgis and Bekele Kassa, 2000. Informal potato seed production at Galessa, Unpublished document. Holetta Agricultural Research Center, Ethiopia.

Friis-Hansen, E. 1989.Village-based seed production, LEISA 5 (4): 26-27.

Gemechu, K., Belay, A., Dereje G. and F. Rezene, 2001. A Guide for Faba bean & Field pea Seed Producers, Technical Manual No 14, EARO, Addis Ababa, Ethiopia.

Gurmu Dabi and Gudissa Shaka, 1998. The Ethiopian seed industry, Focus on Seed Programs, Seed Info 11: 1-13

Kindu Mekonnen, Bekele Kassa and Hailu Beyene, 2002. Experience of participatory research on natural resource management at Galessa. *In* Gemechu K., Yohannes G., Kiflu B., Chilot Y. and Asgelil D. (eds.). Towards Farmers Participatory Research: Attempts and achievements in the Central Highlands of Ethiopia, Proceed. Of Client-Oriented Research Evaluation Workshop, 16-18 Oct. 2001, Holetta Agricultural Research Center, Ethiopia, pp 44-55.

Kindu Mekonnen, Hailu Beyene and Alemu Tadesse, 1997. Natural resources management at Galessa Kota Gisher and Garie Arera peasant associations, Dendi *wereda*, western shewa, Ethiopia. Unpublished report, Institute of Agricultural Research (IAR), Addis Abeba, Ethiopia.

Ostrom, E. 1990. Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge, UK: Cambridge University Press.

Tilahun Mulatu. 1995. Indigenous risk management strategies of small farms in the Central Rift Valley of Ethiopia. *In* Mulat Demeke, Wolday Amha, Simeon Ehui and Tesfaye Zegeye (eds.), Food security, nutrition and poverty alleviation in Ethiopia: problems and prospects. Proceedings of the Inaugural and First Annual Conference of the Agricultural Economics Society of Ethiopia. 8-9 June 1995, Addis Ababa, Ethiopia, pp 85-108.

van Gastel, A.J.G., Bishaw, Z. and B.R. Gregg, 2002. Wheat Seed production. *In* Curtis, B.C., Rajaram, S. and Macpherson, H.G. (eds.), Breed wheat: improvement and production FAO Plant production & protection Series No. 30, FAO, Rome, pp 463-480.

WANA (West Asia and North Africa) Secretariat, 1998. WANA Catalogue of Field and Seed Standards: Ethiopia. Aleppo, Syria, ICARDA, pp 1-31.

Wittayapak, C. and P. Dearden, 1999. Decision-Making Arrangements in Community-Based Watershed Management in Northern Thailand. *Society & Natural Resources* 12:673-691.

Farmer Innovations in NRM: Lessons and Challenges

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Abstract

During phase 2 of the African Highlands Initiative, documentation of the farmer innovations emerged as an important theme. This paper discuses methodology used to document, the innovations documented so far, the benefits that farmers think they are realizing, the mechanisms for sharing innovations and the issues that arise and possible impact on the scaling out process from farm level to watershed level. It was evident that some farmers were making some innovations and adaptations to the technologies that they either tested or researched on with the researchers. Data collection was done through individual interviews where the farmers responded on how the technology was modified, the motivating factors for modification and the physical circumstances under which modifications were done. Farmers seemed to innovate on the introduced technologies to adapt and fit them into their farming systems, financial status, age and social circumstances and whether they need collective action to implement. However, the challenge remains: will the modified technologies be spilled over to more farmers?

Introduction

African Highlands Initiative (AHI) seeks to improve and enhance land productivity in a sustainable way within the intensive land-use systems of the highlands in eastern and central Africa by working with farmers to evolve policy and technologies that increase agricultural productivity while maintaining the quality of the natural resource base at the same time. In order to accomplish this, a participatory rural appraisal (PRA) was conducted in Kwalei pilot village in Lushoto in 1998, where problems and solutions were identified with farmers. Low productivity due to lack of awareness of improved farming was among the major problems identified by farmers. As a result, numerous linked technologies were introduced to farmers in 1998 and 1999 to increase productivity, household income and improve their livelihoods. Immediately after the introduction of technologies, farmers were found to modify some elements of the technologies in different ways and sometimes opposing some of the researchers' methodologies in their fields. When they were informally asked the reasons for the modification, they gave very meaningful answers such as experience of locally available alternatives. Upon seeing the validity of farmers' reasons, it was decided to conduct a formal survey to trace the innovations, search out the motivating factors for innovation and its effects on adoption. The objective of this paper, therefore, is to document and publish experiences of Lushoto farmers on their different innovations on introduced technologies. The paper will also highlight some recommendations and way forward.

Background

Since time immemorial, farmers have been improving their farming systems through innovation. When farmers are faced with problems that threaten their survival, they get courage and capacity to experiment and innovate and in so doing new solutions are devised. Farmers' innovations like plough and domestication of plants and animals that revolutionized (indeed invented) agriculture, date back over 10,000 years (O'Neil 1995, IFAD). Throughout the centuries, farmers out of their inner urgings, have devised, developed, adopted, adapted ingenious technological ways and means of ensuring food security and economic welfare for their extensive households (O'Neil 1995, Chinkhuntha 2004).

Several authors have defined what farmer innovation is and the majority of them seem to agree that 'farmer innovation' is a form of indigenous knowledge – is a process under which farmers themselves develop ways of, for instance, improving crop varieties through careful selection of seed, harvesting rain water from roads, soil conservation measures – often without any outside help (Reij and Waters-Bayer (2001), Critchley and Mutunga (2002), Chinkhuntha (2004)). The ingenious traditional irrigation (furrows by Chagga and Sonjo in Tanzania and Qantas in Iran) (Goldsmith 2003), local knowledge on weather forecasting (Kihupi et al 2003), biological control in soybean (O'Neil 1995), production of new pesticide concoctions (Minja et al 2003), use of different plants and roots for soil fertility improvement (Wickama and Mowo 2001) and cure for different animal and human ailments are some of the well documented farmer innovations. These innovations clearly played a significant role in the improvement of the rural communities and will continue to do so.

Unfortunately, this local knowledge, and its capacity for innovation, has been downplayed and neglected by scientists, especially since colonization. It is not surprising then that Egziabher (2001) commented that farmer innovations are positive developments that have never drawn headlines in newspapers yet they are remarkable and newsworthy. The curiosity to learn from indigenous knowledge had almost totally - but not fully – been lost until when some of very technically sound technologies did not fit in with the local production systems (Critchley et al 1999, IFAD). As a result farmers were said to be ignorant and not interested in saving their natural resources. Even today, more than 40 years after the cessation of the colonial rule, down playing farmers' knowledge still lingers in R & D staff. This is exemplified by farmers in Kwalei refusing to attend nursery plots because the type of cabbage brought by researchers was not of their choice (Urasa 2000. personal communication).

Nonetheless there are some success cases where farmers were noticed to be using their own technologies to deal with soil erosion, and pests. It is at this point, and only recently, that the scientific community started recognizing, studying and documenting about farmer innovation particularly in Africa. The majority of studies found that local people posses sophisticated knowledge about their environment and that this knowledge can aid in the sustainable land use. The studies emphasized that coupling the experimental protocols of the scientific method to the farmer's deep appreciation of their system would seem to be a powerful way to generate new agricultural practices (Simpson 1998, Winkelerprins, A.M.G.A., 1990, Barrios et al 2001, Reij and Waters-Bayer (2001)). A quote from O'Neil (1995) would be illustrative;

"Farmers are the ultimate integrators of the information they receive to increase production, stabilize yields, use pesticides etc. It is the farmer that 'lives the problem', gains the benefits and suffers the consequences. Therefore a combination of farmers' and scientific knowledge will increase the rate of success and identify new areas of effort that neither group alone would have discovered"

Scientists should treat farmers as equal partners and create a learning dialogue by accepting and respecting each other's knowledge. Scientists have important tasks to play by bringing in information, methods and analyses which complement what farmers already know and can do themselves." (ILEIA 2000, IFAD, Kihupi et al 2003). Research and extension practices that build on farmers' knowledge, engages farmers' creativity and allows for their active involvement in outreach activities is capable of producing results that far exceed and outlast those possible through more traditional approaches. Therefore the conventional 'transfer-of-technology' paradigm in which scientists develop technologies on station and extension workers pass these technologies on to farmers should change and start with what farmers are already experimenting to develop a joint research and development agenda. By including farmers in the research agendas, we will increase the number and diversity of approaches, and increase the likelihood of adoption of appropriate methods for natural resource management (O'Neil 1995, Simpson 1998, Winkelerprins, A.M.G.A., 1999, ILEA Editors 2000, Egziabher 2001, Franzel 2001, Barrios et al 2001, SciDev.net, August 2002, Critchley and Mutunga 2002).

On the other hand, there have been some challenges which should be considered as links are being established between farmers knowledge and science. These are:

- Those in-charge with improving local decision-making (R & D staff) are frequently unclear with farmer innovations or local priorities
- Much of the farmers' innovations are developed in response to new constraints and therefore are very location- and culture-specific. The same constraint is not necessarily resolved the same way across

cultures, even within the same ecological region therefore difficulties can arise when exchange and diffusion are attempted between cultures and locations (IFAD)

- Considerations on intellectual property rights, - who owns the innovation and who may use it?, who decides how to use it and for what purpose? And should the owner be compensated? (SciDev.net, August 2002)

Methodology

This study was conducted in Kwalei village in Lushoto district, Tanzania. Lushoto district is situated between latitude 4^0 24’ S and 5^0 00’ S and longitude 38^0 10’ E and 38^0 36’ E with an altitude ranging from 900 to 1200 m.a.s.l. The data used for this paper were obtained from three main sources namely, literature review, observations of the AHI-Lushoto research team on the farmers participating in the introduced technologies, and informal interview with the innovating and non-innovating farmers. Case studies are used to capture some few innovations in Lushoto.

Results

Farmers listed a number of innovations they have made to the introduced technologies. The innovations are both physical and social oriented. The physical ones include; use of Fanya Juu ditches for making compost (Box 1) and use of sugar cane for stabilizing soil conservation structure.

Box 1

Several technologies on soil and water conservation were disseminated to the farming communities and many of them were adopted. Among them were use of cut-off drains for rain-water harvesting and compost making techniques. Some of the adopters were found to have filled the cut-off drains with crop residues and weeds. When asked as to why they did that while they were trained that the drainage should be free of any trash they replied; “We are using the drainage for making compost. When the run-off comes it soaks and covers the trash with soil and in so doing we are making compost at the same time – killing two birds with one stone. When they get filled we follow the same procedures of unearthing them”.

Other farmers are using sugar cane to stabilize their soil conservation structures instead of the recommended napier, desmodium, trees etc. Lack of funds to buy the introduced materials is the main reason given by farmers thus looking for inexpensive alternative materials. The introduced Napier, Desmodium, and trees were not native of Kwalei therefore there were some costs farmers had to pay to get them.

Other innovations are use of indigenous trees and shrubs for soil fertility improvement eg *Vernonia subligera, Vernonia amyridiantha* as depicted in Plate 1 and also making different concoctions against pests and diseases (see Table 1 and Box 2). Some farmers reported to have increased their bean yields by more that 10 times by applying these concoctions on improved varieties (Minja et al 2003).

 

Plate 1: Farmers are knowledgeable of their soil fertility and remedial measures. Above (left) *Vernonia subligera* used by farmers to amend soil fertility from time immemorial; Right: A farmer learning how to use it more efficiently in Kwalei village.

Table 1: Different traditional materials and their different uses in Lushoto

Innovation	**Use of innovation**	
Vernionia spp (Tughutu and Mhasha)	- Soil fertility improvement,	
Sugarcane	- stabilizing soil conservation structures	
Concoctions	**Plant part and how used**	**Target pest**
Vernionia spp	- crude leaf extract + chilli + water	foliar/pod feeding pests
Euphorbia spp	- white sap in water	cutworm
Solanum incanum	Crushed fruit and water	cutworm
Datura spp	- crude leaf extract + chilli + water	Foliage feeding pests
Tithonia spp	- crude leaf extract + chilli + water + soap	Foliage/pod feeding pests
Ocimum suave	- crude leaf extract + chilli + water + soap	Foliage feeding pests
Cow urine	- fermented urine + water + soap	Foliage feeding pests
Fresh milk	- Fresh milk + ash + water	Potato and vegetable leaf diseases
Wood ash	- ash + Cyprus spp or Eucalyptus spp or Tagets spp	Bruchids and weevils in stored grains
Social	Elders who have ample land join with youth who have no land but ample labor to cultivate tomato. Youths also contribute FYM and all benefit from the cooperation.	

Box 2
Fruit sap-sucking insects, commonly known as fruit flies, are very destructive on fruits and vegetable production. An affected plant/fruit will get stunted, have scars and gets infected with other organisms. Farmers end up loosing tones of fruits and vegetables from these insects. Treatment against these fruit flies is through the use of commercial pesticides, which are in most cases expensive, not readily available in the rural areas and not environmentally friendly. Based on these difficulties, Mr. Shebughe, a fruit grower in Mombo Tanzania, designed a trap whereby a concentrate is made from a fruit (watermelon, mango or paw paw), mix it with spirit alcohol and half-fill a mineral-water plastic bottle (see insert below). This mixture produces good aroma that attracts the fruit flies. Several holes are made on the top-half of the bottle to allow the fruit flies to enter into the bottle as they go for the good smelling concentrate. The insects will feed on the concoction, get intoxicated, trapped and die in the bottle. “This trap is very effective and cheap, it has really helped in reducing the fruit damage in my garden” said Mr Shebughe

Social innovations include teaming up in groups so as to collectively accomplish some tasks which none could have accomplished alone. A good example is a case where elders with ample land join with youth who have no land but ample labor to cultivate tomato. The landowner lends the land to the youth under conditions that they will only use farmyard manure for growing tomato and not inorganic fertilizers. At the end of the season they all benefit from the cooperation – fertilized land for the landowner and more income for the youths. Other social innovations are the challenges farmers were putting on the scientists’ research protocols like opposing replication, controls and use of small plot sizes after the first year of experimentation.

Farmers mentioned that some factors that motivated them to innovate are: i) interest with the introduced technology, ii) local knowledge of simpler and easy to access alternatives to the problem, iii) desire for quick results (greater efficiency), iv) seeing and learning from their fellow farmers, and v) self esteem. Modifications are perceived as ‘short cuts’ to many of the recommended technologies and in so doing it saves their time, labor, land and other resources. “Sometimes the whole or parts of the technology, is/are too expensive for us – therefore we look for simple and easily available alternative. For instance instead of spending my meagre money in buying napier to stabilize my terraces as we were trained, I used sugarcane for the same and it is doing fine. With sugarcane I am getting an extra benefit from canes for human”. In Kwalei sugar canes have stable market for making juice and local brew. Other factors mentioned were enhancement of self esteem because they feel proud to have contributed something worthwhile and instils a sense of ownership and respect. Quick attainment of results was emphasised as one of the most important factors.

Conclusion

Farmers have valid reasons for modifying the introduced technologies. Farmers perceive modifications as shortcuts to the aimed results, saves cost and an opportunity to utilize their knowledge and resources more effectively. Despite the common reasons among the farmers, the types of modifications were different for each individual. The differences were largely dependent on an individual’s resource endowment and age. The wealthy farmers and youths were better innovators than the rest in the communities. Other differences in social and biophysical factors may also warrant some changes to the technology, bearing in mind that in most cases, where technologies are developed is different from where it is disseminated. Therefore farmers modifying the introduced new technologies is an inevitable situation and should be encouraged, as it is them who ‘live the problems’, gain the benefits and suffer the consequences. Allowing farmers to modify technologies empowers them through contributing to technology development, instilling the sense of ownership and increasing adoption. On the other hand, care should be taken when disseminating technologies to new farmers especially through farmer-to-farmer exchange visits as each farmer has different social and biophysical factors. It is therefore recommended that new farmers should be exposed to both original and the modified technologies so as to see the different options and let them modify based on their social and biophysical conditions. Integration of farmers' knowledge with the scientific knowledge has shown to increase productivity in Lushoto. Capturing local innovations and integrating them in research, extension and development activities, adoptable and sustainable solutions can be found and scaled up. However, the majority of R & D staff are yet to be convinced that farmers are fully conversant of their environment and have immense local knowledge which when tapped and complemented with the scientific knowledge, can revolutionize agriculture of the rural poor communities. As AHI tries to scale up to reach more farmers, from farm level to watershed level, capacity building of the R & D teams on how best to integrate the two knowledge bases, is of utmost importance.

This paper highlights some interesting innovative practices by farmers in Lushoto. It is very likely that farmers in other parts of Tanzania have developed other innovations but most of these may not have been documented. It is therefore suggested that efforts should be made to capture and document these innovations to assist in better understanding of farmers' capacity in natural resource management; and wisely integrating it with science so as to bring quick and positive impact on the rural communities.

References

Barrios, E., M. Bekunda, R. Delve, A. Esilaba, J. Mowo, 2001. Methods for Decision Making in natural resource management. Identifying and classifying local indicators of soil quality.

Chinkhuntha, G. 2004. How to Support Innovation and Entrepreneurship in African Farmers. www.ifpri.org/2020aficaconference

Critchley, W. D. Miiro, Ellis-Jones, J. Briggs, S and J. Tumihairwe, 1999. Traditions and innovations in land husbandry: Building on local knowledge in Kabale, Uganda. Technical report. www.relma.org/publication_reports.htm

Critchley, W. and K. Mutunga., 2002. The promises and perils of 'farmer innovation'

Egziabher 2001. Preface. IN. Chris Reij and Ann Waters-Bayer; 2001. Farmer innovation in Africa: A source of inspiration for Agricultural Development.

Franzel, S. 2001. Agroforestry practices for improving livelihoods in the African Highlands: Challenges for scaling up impact. Abstracts of International conference on contemporary development issues in Ethiopia.

Goldsmith, E. 2003. Learning to live with nature. The lessons of traditional irrigation. www.edwardgoldsmith.org/page 103.html

ILEIA 2000. Unleashing the Creativity of Farmers. ILEIA Newsletter, July, 2000. Centre for Research and Information on Low External Input and Sustainable Agriculture.

Kihupi, N., R. Kingamkono, H. Dihenga, M. Kingamkono and W. Rwamugira, 2003. Integrating Indigenous knowledge and Climate forecasts in Tanzania. IN; Coping with climate variability. The use of seasonal climate forecasts in Southern Africa. Karen O'Brien and Coleen Vogel eds.

Minja, E. M., E. Ulicky and H. A. Mziray, 2003. Farmer group activity reports for the DFID Crop Protection Programme (CPP) Bean IPM Promotion Project in eastern and southern Africa.

O'Neil, R., J. 1995. Farmer Innovation and Biological Control. Midwest Biological control Newsletter 2(3): 1-2.

Reij, C. and Ann Waters-Bayer, 2001. Farmer innovation in Africa: A source of inspiration for Agricultural Development.

Simpson, B.M. 1998. Investing in people: The support of farmers learning, creativity and local social networks in the Project Pisciculture Famiale, Zaire. J. Agr. Educ. Ext. 1998, 5,2, pp 99 110.

SciDev.net, 2002. Email article. Awareness of the value of indigenous knowledge, www.SciDev.net

Urasa, B. 2000. Personal communication. A written response as to why farmers did not attend the cabbage nurseries as per the agreement

Water-Bayers, A. 2001. Rural transformation and agricultural innovation processes. ETC Ecoculture, Netherlands.

Wickama, J. M and J. G. Mowo, 2001. Using local resources to improve soil fertility in Tanzania. iied. Managing Africa's soils No. 21.

Winkelerprins, A.M.G.A. 1999. Local Soil Knowledge: A Tool for Sustainable Land Management. Society and Natural Resources, Vol. 12, pp 151-161

Farmer Participatory Experimentation as a Strategy F Technology Transfer on Sweet Potato, Banana, Tomato and Cabbage in N. Highlands of Tanzania

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Abstract

This paper presents the results of farmer participatory experimentation (FPE) that was undertaken with farmers in Kwalei Catchments Area - a benchmark site of the African Highlands Initiative, in Lushoto district, Tanzania from 2000 to 2002. Farmer Participatory Experimentation in this context is defined as a process of bringing together the knowledge and research capacities of the local farming community with that of the scientific institutions in an interactive way. Crops subjected to on farm investigations were sweet potato, banana, cabbage and tomatoes. Farmer participatory experimentation was observed as an important strategy for technology transfer that can help improve the effectiveness of technology development, raise adoption rate and add value to the agricultural research output. Likewise, it creates democratic partnerships between farmers, researchers and extension agents and other stakeholders in the natural resources management. However, the challenges of farmer participatory experimentation found were the prejudice of basic research, incorporation of the farmers' criteria/indicators in the selection of the best varieties, design research/experiment rather than "demonstrations" that will be suitable not only to progressive farmers, incorporation of "control treatment" in the trial layout and to strengthen their ability to monitor and adopt experimental procedures, over dependency on inputs supply from researchers. The discussions have theoretical and practical implications for farmer participatory experimentation, which can be used to identify recommendation domains based on the farming system.

Introduction

Agricultural and the management of natural resources are central to the economies of the smallholder farmers in the northern highlands of Tanzania. However, yields obtained by smallholder farmers are relatively low, and the opportunities for increased agricultural productivity and economic growth are severely constrained by lack of appropriate technologies like improved varieties, management techniques and quality seeds.

The last twenty years have witnessed great investments in agricultural research and development of new technologies in Tanzania. However, there is a general feeling amongst the stakeholders in the agricultural sub-sector of the national economy that adoption rates of technologies developed at the research canters in the context of "top – down" approach are generally low, because in most cases goals were partially met (Lyimo, 2004; Personal communication). This has lead to question the validity of methodologies and approaches used in the transfer of technologies to end-users. As in the case with agriculture in general, Tanzania agricultural research has suffered a significant set back in the area of transferring research results to farmers and other end users due to "top-down" approach. Sandra et al. (1989) noted that the goal of agricultural research is the development of technologies that farmers will use to improve their welfare and that of their countries. Furthermore, this is generally because no matter how well new technologies on research stations is, or the science might be or how persistent the extension efforts, it has been found repeatedly that technological advances will not be adopted unless farmers accept and use them (Sandra et al. 1989). At this juncture, therefore, agricultural research system had to conceptualize an effective mechanism and capacity to implement the transfer of appropriate technologies and results to farmers. In this case, there a need to develop a new way of making these technologies acceptable to farmers so as to increase farmers' perceptions and invariably their adoption levels. In order to contain this problem, participatory approaches (PA) in agricultural research were introduced in Tanzania during the 1990's. They aimed at bringing an analytical approach and efficiency in the transfer of technology. Likewise, to make sure that research takes the needs of technology users, natural resources management, local resource constraints and risks into account. This was after it was recognized that development and transfer of technologies to end-users for their subsequent adoption is the prime goal of any research activity. Yet farmers especially smallholder ones in the northern highlands of Tanzania, have remained unaware and skeptical to taking full advantage of these technologies. Farmer participatory experimentation as a technology transfer approach was carried out in Kwalei catchments area - a benchmark site of the African Highland Initiative (AHI), in Lushoto district, Tanzania from 2000 to 2002. The objectives were to contribute towards increased crop productivity, enable farmers to understand better and carryout their responsibilities as investigators and innovators, and introduce on farm evaluation of technologies. There were three categories of technology evaluation schemes, which included improved crop varieties of sweet potato, banana, tomato and cabbage, crop husbandry practices and seed production schemes. The outcome of transferring technologies by Farmer Participatory Experimentation (FPE) has revealed that FPE can effectively fill the "missing linkage" between research and extension and make the programs of both research and extension institutions more efficient.

Background

This paper builds on the theoretical constructs of farmer participatory experimentation as a social learning process in the transfer of technology and natural resources management. It is well known that to improve agricultural productivity some form of appropriate technology is necessary as mentioned earlier. Central in the focus is the building of joint capacity among the various actors in technology generation and adoption, which is characterized by “face to face” interchanges of ideas between a researcher and a farmer (Bawden and Packham, 1992). In agriculture and natural resources management, transfer of technology process depends on the social and cultural context of people and their community. Therefore the design and adoption of agricultural technologies must be reflective to the local social, economic and agro ecological circumstances of farmers in order to make them adopt new technologies (Pretty and Uphoff, 2002). The value of participatory approach is that researchers and extension agents are enabled to learn on how to work with farmers in a participative rather than a “top-down” way and at the same time create the social network for facilitating exchange of knowledge between researchers and farmers (Pretty, 1995). In this regard, farmer involvement in the development of technologies, transfer, and decision-making process has generated a lot of models through several studies (Chambers & Jiggings, 1987), like the participatory approaches. Creating knowledge in this way is an integral part of sustaining agricultural production and increased output. Rather than exclusively focusing on convincing farmers to adopt introduced technologies generated outside their environment, a participatory approach provides an opportunity for farmers to tap their capacity to research and innovate according to the specific challenge of their farming system. The participatory approach provides a relevant conceptual context for exploring how farmers through farmer research groups (FRG's) in the Benchmark Site of AHI, is partnering with researchers and extension in learning together on how to disseminate new knowledge for technology introduced in natural resources management scenario.

Methodology

This study was carried out in the northern highlands of Tanzania in Lushoto District, Kwalei Village a benchmark site of AHI. It was chosen as the study area most importantly because its one of the district with higher population concentrations and extensive natural resource management problems. During the execution of the study, the farmer participatory experimentation followed a sequence of steps, including:

IDENTIFICATION OF FARMERS AND FORMATION OF FARMER RESEARCH GROUPS – FRG

Farmer research groups were formed on the basis of the crop. In this case each crop researched i.e. sweet potato, banana, cabbage and tomato had its own FRG, with a Chairperson and a Secretary. Each crop formed one group comprised of both men and women who were encouraged to participate, with special emphasis on up coming young generation. Participation was on voluntary basis based on the interests towards a particular crop and farmers were allowed to belong to various FRG's. Kwalei village farmers are not homogeneous as they differ in social status, wealth, access to and control over resources, and proclivity to conduct research. Research activities therefore focused mainly on the needs of low-resource farmers, particularly women and youth. Informally farmers were asked to mention their source of knowledge for each crop (Table 2).

Participatory problem analysis and site selection

The aim was to rapidly identify factors limiting production, and test potential solutions for their economic and social acceptability by way of on-farm experiments. Participatory problem analysis was conducted at the case study sites to help identify major constraints and their causes and effects, before trials were implemented. However, researchers had access to an earlier baseline diagnostic survey, which provided information on local socio-economic conditions. The job of the researcher at this point was to provide farmers with as broad a range as possible of technical solutions and technologies that may help solve the farmers' problems. The farmers identified problems that were of most concern to them for each crop by a pair wise ranking. Researcher moderated the exercise to make sure that farmers' feeling to this problem is important enough to want to work and solve it. They described what actions they have been taking in the past to minimize each problem, and decide which of the problems have the highest priority. They then discussed what action they would like to take to solve these problems in future. Site selection for the on farm experimentation was based on secondary information, history of the plot, ability and farmer enthusiasm.

Participatory research design

Farmers and researchers jointly designed the experiments. The aim was to strengthen the existing experimental capacity of farmers and to sustain the local management in the process of innovation. Research and extension staff organized village meetings through FRG's to consult with farmers. At these meetings researchers discussed trial plans and their implementation with farmers. Farmers themselves selected amongst themselves to provide plots for the trials.

On-farm trials / farmer experimentation

Categories of farmers who participated in experiments and technologies introduced are shown in Table 1. The approach followed in our projects was to allow farmers to test technology on their own farms under close supervision of the Village Extension Officer and Farmer Research Group's chairperson. The researcher was responsible for experimental layout, in order to generate statistical materials. Meanwhile participating farmers were responsible for the crop husbandry. Likewise farmers were required to provide the field history i.e. concerning the previous crop/s that occupied the land and whether the plot was fertilized or not. Planting density was 30cm between plants and 90cm between rows for sweet potato, cabbage and tomatoes. For sweet potato farmers were encouraged to plant on ridges. Each farmer was treated as a replicate. Although experiments were done in the fields of individual farmers, all decisions regarding what to try out, the evaluation of the technologies, were taken by a group. The trials were formal experiments designed and implemented by researchers on farmers' fields, using a traditional experimental design with randomized experiments and replicates. Farmers provided the land and, labor for plowing and weeding as laid out in the trial plan. Researchers provided some inputs mainly planting materials.

Table 1. Category, type of technology introduced and the number of farmers participated in experiment

Category	Type of technology	No. of farmer 1999	No. of farmers 2000
Sweet potato	Varieties CIP 440024, CIP 4400131 Tengeru Red, CIP 4400117 and CIP 440105, local var. "Katagi"	10	18
Banana	Varieties: Paz fupi, Pazi ndefu, Mbwailuma, Suu, desuckering, manuring, detrashing, spacing, standard tool keeping	10	14
Cabbage	Varieties: Amigo, Gloria F1, Field Force F1	12	18
Tomatoes	Varieties: Tengeru 97, Tanya	10	13

Participatory monitoring and eevaluation and sharing of results

The aim was to give farmers opportunity to participate in an active, rather than a passive way in a process in which their own powers of observation and analysis are clearly valued. At this stage, the goal is not only to determine acceptability but also to understand how farmers continue to adapt and modify the technology based on the experimental procedures. Researchers led discussions and answered farmers' questions. Field days that were organized by research and extension staff were meant to demonstrate the potential of the technology options to farmers in the area. During this stage, farmers described which of the technologies they like and why. They also explained which technologies they do not like, and why, and what characteristics of the preferred technologies could be improved. Farmers then assessed all varieties for field performance; yield ability, quality and biomass production. Farmers were allowed to choose their own indicators for each attribute. In order to determine indicators, pair wise ranking was conducted for each category.

Results

SOURCE OF KNOWLEDGE

Six learning processes were observed in the analysis as critical as to how farmers gained increased knowledge, understanding and skills in adoption of technologies introduced in the village. Table 2 shows the different learning processes through which farmers acquired knowledge. Through focus group discussions in the FRGs, participatory monitoring and evaluation, farmers described how their knowledge, skills and management techniques for producing crop were evolved. Overall it emerged that individual experimentation, visits by researchers/extension and community meetings were the most important learning processes. Meanwhile informal group forum was found to be the least method of acquiring technology.

Table 2. Farmers' source of knowledge learning processes before the on set of the project

	Sweet potato	Banana	Cabbage	Tomatoes
	N=28	N=24	N=30	N=23
Individual Experimentation	√	√	√	√
Visit to projects		√		√
Informal group forum				√
Visit by researcher Extension	√	√	√	√
Community meetings	√	√	√	√
Private sector			√	√

Farmer perception and awareness

Table 3 shows that farmers were less aware on sweet potato and banana technologies, but they were knowledgeable on cabbage and tomatoes in terms of varieties, production techniques, diseases especially tomato late blight and marketing. This is because tomatoes and cabbages are important cash crops to all people in Kwalei village. While farmers acknowledged their familiarity with some of the technologies, like improved tomatoes and cabbage varieties, however, they themselves acknowledged that they have limitations in certain domains of knowledge that are critical to good management like – disease identification, irrigation and water management, seed production techniques, cultivars and fertilizer in sweet potato.

Table 3: Farmers' awareness of the technologies

	Sweet potato	Banana	Cabbage	Tomato
	N=28	N=24	N=30	N=23
Varieties	√	√	√	√
Improved management				√
Production techniques			√	√
Diseases			√	√
Pests	√	√	√	
Seed production				
Post harvest				
Marketing			√	√

PROBLEM ANALYSIS

Table 4 shows the outcome of the problem analysis. The principal contributing factors that need be taken into account in the participatory experimentation are listed. Problems confronted by Kwalei's sweet potato, banana, cabbage and tomatoes farmers are many and differ in intensity from one farmer to another. The participatory problem analysis conducted revealed that they cover the spectrum of production to marketing continuum, which is an important part of the research for development. Individual farmers themselves raised all these problems. In short it was not possible to portray all problems facing peasant farmers. For our purpose here, an attempt was made to examine some selected problems inherent to the crops. They range from lack of improved varieties to inadequate extension services. The farmers decided to tackle their first most important problem as lack of improved varieties and lack of knowledge on pests/diseases/management that became the focus of the project.

Table 4: Participatory Problem analysis

Type of problem	Sweet potato	Banana	Cabbage	Tomato
	N=28	N=24	N=30	N=23
Lack of improved varieties	2	2	2	2
Lack of planting material	1	3	4	6
Lack of knowledge on pest/diseases/management	4	1	1	1
Drought	5	5	5	4
Fertility soil/fertilizer	3	4	6	5
Marketing	6	6	3	3
Extension services	7	7	7	7

Farmer assessments criteria – crop performance

The major crop performance criteria were – average yield, agronomic performance, origin and disease/pest reaction as shown in Table 5. However, some farmers who hosted trials expressed a desire to try out, on their own, some of the treatments that looked promising. Farmer assessment of the technologies was limited to participatory monitoring and evaluation visits and FRG meetings with researchers and extension. The criteria used by farmers to evaluate their own experiments differ from farmer to farmer and also for the same farmer, from crop to crop. The physical stand of the crop e.g. in sweet potato, and the way a crop bears say bunches in banana, head in cabbage and fruits size/number in tomatoes are some of the major criteria observed in Kwalei village. Ideally, farmers attending the assessments, provide ideas for experimentation based on their own criteria.

Table 5. Farmer's crop performance criteria

Criterion	Sweet potato	Banana	Cabbage	Tomato
Agronomic performance	**3*****	**2****	5	5
Average yield	1*	1*	4	**3*****
Early maturity	**2****	**3*****	**2****	4
Disease/pests	5	7	1*	**2****
Origin	4	4	6	6
Drought tolerance	6	5	7	7
Market	7	6	**3*****	1*
Good taste	8	8	8	8

Table 6. Farmer's perceptions and opinions about the varieties and technology

Technology	Perceptions	Challenges
Cabbage	Amigo F1 and Field force F1 were observed to have high tolerance to black rot disease. Gloria F1 displayed medium resistant to black rot disease. Farmers preferred Gloria F1 because of its ability to mature earlier than the other two varieties.	Availability of seeds. Study on the time of planting and spacing
Tomatoes	When questioned farmers said no other tomato variety could compete with var. Tanya and Tengeru 97 in yield and shelf life.	Train farmers on seed production techniques, Train farmers on pests/diseases identification
Banana	Banana planted with well-preserved manure established fast and are growing very, over the local variety "Ussu". Three successive plants per stools' format, had bigger girth, produced bigger bunches but also a bunch per stool annually.	Availability of quality planting materials Training on pests' diseases. Intercropping studies
Sweet potato	Farmers preferred varieties CIP 440024, Tengeru Red, CIP 4400117 and CIP 440105 over he local variety "Katagi"	Management of sweet potato weevils Availability of quality planting material

Table 7. Farmer perception and comments on experimentation

Procedure	Recommendation
Experimental layout	Include few treatments
	Omit control treatments
	Farmer management to be the control
Site selection	Early planting
Data collection	Practical ones like yield, crop stand number of fruits/roots
	Training on data collection
	Data collection should be limited to the needs of the project
Data analysis/reporting	1. Summations and average yield/number of roots/fruits

Yield data-Average economic yield (Tones/ha)

Table 8: Average economic crop yield. (in bracket is farmer actual yield)

Crop	Season 1999	Season 2000
Sweet potato	17 (6)	12
Banana	22 (7)	27
Cabbage	19 (9)	25
Tomatoes	15 (10)	18

Merits of the farmer participatory experimentation at Kwalei

- Farmer Participatory Experimentation (FPE) is an important strategy in the technology transfer that can help improve the effectiveness of technology development in the research for development continuum scenario.
- Raises adoption rate and adds value to the agricultural research output
- Creates democratic and equitable partnerships between farmers, researchers and extension agents and other stakeholders, like religious organizations in the natural resources management. The project collaborated with the church in seed schemes
- Creates equitable partnership between research and farmers in technology transfer and agricultural innovation
- Farmers were equal partners in the projects as they are involved directly in the planning, implementation and evaluation of research activities in a collaborative manner
- Focus group sessions within the FRG’s facilitated in-depth analyses and understanding of farmer perceptions of their partnerships with research and extension institutions, as well as motivations underlying their participation

The study also illuminates the potential inherent in a broader role of research extension linkage, by highlighting on how institutional innovations in research and extension can transform farmer learning and strengthen their capacities where traditional constructs of technology generation and adoption has failed.
It also contributes to increasing the knowledge base of agricultural professionals on emerging concepts and approaches for working with small farmers in research and extension
Farmers discovered the potential of optimizing land use by introducing and adopting improved varieties and good management practices and were inspired to solve problems by themselves

Demerits of farmer participatory experimentation

- An important problem for on-farm research is that the client is - in most cases - not (directly) paying for the services
- Agricultural research was considered as a public good and farmers were not ready to contribute financially even in input purchase
- Over dependency of inputs from donors that heavily influences the research agenda
- Expensive in terms of travel to over 500 km from SARI and HORTI
- Difficultly in generation of statistical data
- Design of experiment as “demonstration” impeded statistical analysis
- Over emphasis of “applied research” to solve practical problem
- Prejudice of “basic research” which is very important in increasing researcher knowledge

Discussion

It is well known that people’s livelihood security can be improved by enhancing sustainable natural resources management. However, this depends on the type of approaches that encourage personal and social learning as it was observed in the benchmark site. Through observations, it was found that Kwalei farmers have knowledge, social capital, and entrepreneurial skills to invest in such an approach of participatory experimentation. Thus while farmers acknowledged their familiarity with some aspects of experimentation like spacing, linear planting, there were clear appreciation of the opportunity to validate their local knowledge through sustained observation and experimentation, complemented by learning through interaction with researchers. As reflected in the quote from one farmer, Mr. Hozza, that *“we farmers value interactions with researchers from SARI and HORTI who have been frequently visiting us, as we never expected to be interacting with scientists in collaborative and participative manner in terms of ideas, both formal and informal way”*.

It was observed that awareness depended mostly on the level of education and the importance of the crop to the particular farmer; whether a particular crop is grown for cash generation or for food or both. It was very difficult to work with the illiterate ones in the experiments despite their enthusiasm. It is also observed that, the more education one has, the better his/her perception of the relevance of the experimental procedures and technologies. On the other hand, wealth profiles, gender, age, and marital status were not important determinants of farmers’ perception on experimentation and technologies introduced in the village. This means that these characteristics did not influence the perception of the farmers to the relevance of the experimental procedures and the particular technology.

While farmers acknowledged their familiarity with some of the technologies, like improved tomatoes and cabbage varieties, they acknowledged that they have limitations in certain domains of knowledge that are critical to good management such as: on farm pest/disease identification, spraying regimes, irrigation and water management, seed production techniques, cultivars and fertilizer in sweet potato. For sweet potato it was found that in Kwalei village, it is regarded as a women crop and treated as a “rustic crop”. This coincides with the observation by Kapinga et al. (1995). Women were found to be more knowledgeable in terms of names of local varieties, seasons, time to maturity, and production practices. Sweet potato was found to receive very little attention in terms of management compared to other crops like tomatoes and cabbages, especially in terms of land allocation and input. The same was observed with low perceptions among farmers on banana production technologies. Banana was found to be poorly managed and sometimes the crop stand was left on large stools of over 10 plants per stool popularly known as *“mighunda”*. Banana fields in Kwalei catchments have been reduced to the now infamous `mighunda’, which produce as few as 25 miniaturized (pocket size) bunches per hectare (Mbwana, 2000. Personal Communication). Men especially the youth dominated tomatoes and cabbage production. This is because these two crops are important source of cash income once sold, besides being capital intensive in terms of inputs.

During the problem analysis exercise, two categories of problems were short-listed. They included crop production and experimentation problems. The synthesis and summary of the problem analysis indicated that the major ones included lack of improved varieties, unavailability of quality planting materials close to the planting season and inadequate knowledge on pests/diseases/crop husbandry. The first problem was found to affects all crops, and was addressed by the introduction of improved varieties. Nevertheless, lack of quality planting materials was observed primarily on sweet potato and banana. This could be explained as due to the vegetative nature of its propagation and pest/disease especially in banana. It is sometimes very difficult to keep good quality vegetative planting in Tanzania. To counteract the problem, rapid multiplication technique on sweet potato was introduced, and good husbandry techniques like desuckering were introduced in banana. Lack of adequate knowledge on pest/diseases/crop husbandry was addressed by training farmers on all aspects like good management involving desuckering, manuring, detrashing, spacing and standard stool keeping. For tomatoes and cabbages, farmers were found to depend entirely on pesticides. The problems in the experimentation scenario, which were mentioned by farmers, were: site selection, incorporation of "control treatment", layout, data collection and analysis and presentation.

Despite the fact that traditional researches encourage control treatment, farmer suggested that it should be omitted in the layout. This is because it benefits researchers only, it occupies land without any economic benefit, costly to maintain and is often a source of pests/disease. Farmers frequently mixed up treatments, location of experiments on "bad plot" like on shade, water logging, harvesting before data could be taken. This could probably be due to the education levels, the role of the crop to the particular farmer and the over-dependency of inputs from researchers or the project. Kwalei farmers place tomato and cabbage experiments on their best plots, and sweet potato on the marginal ones because farmers got inputs like fertilizers, pesticides and fungicides for these experiments and therefore saved on costs of production. Despite these draw backs in experimentation, early harvesting before data was taken, an indication that these varieties are well adapted to the Kwalei farming systems and accepted. The peace meal harvest nature of sweet potato and banana despite affecting data collection indicated the role of these two crops in family food and nutritional security. Likewise, it indicates continued potential yield as observed by Kuoko (2004).

The challenges of farmer participatory research were: the incorporation of the farmers' criteria/indicators in the selection of the best varieties, design research/experiment that will be suitable not only to progressive farmers, in the trial layout and to strengthen their ability to monitor and adopt experimental procedures, over dependency on inputs supply from researchers. It was observed that some research data i.e. basic research data, which are very important to improve knowledge, could not be taken. These include data like percentage dry matter, plant height, and internodes longitude, number of flowers per trust, and biomass. In the choice of good cultivars, farmers consider more than one parameter.

Kwalei farmers like their counterparts in the other highlands prefer varieties that have good agronomic performance which could be readily adaptable to their farming system, with average yield, early maturity in order to capture the market and contain food insecurity and have pest/disease tolerance and aspects that will reduce cost of production especially in vegetables and maximize profitability of the enterprise. The technologies introduced were readily accepted and some of them adopted. Sweet potato varieties Tengeru red, CIP 4400123, 4400117 and CIP 4200024 were selected on taste, agronomic performance and yield basis at average of 15 tones/ha. They out yielded the local variety "Katagi" by over 60% of the actual economic yield. Farmer accepted both tomato varieties – Tengeru 97 and Tanya as they showed to have long shelf life of more than 14 days after harvest because of being very firm and hard. These tomato varieties have captured good market in Dar es Salaam and Tanga. Taste was found to be complex, incorporating sweetness, texture, and suitability for cooking and eating fresh, cooking time, flesh color, floury, lack of fiber and flatulence.

Several lessons can be drawn from Kwalei experiments. First, that it takes time to clarify objectives with farmers, and to design a methodology that meets these objectives. Second, it is important that all members of the research team (researchers and farmers) understand the methodological and technical concepts behind trials and training should be given if necessary. Experience showed that data collection should be limited to the needs of the project and that participatory research requires the same rigor and discipline as conventional research. There is a potential contradiction between the collection of on farm research results and providing farmers with an opportunity to adapt technologies. Sustainability was the central issue in the Kwalei trials and on farm research by participatory experimentation proved that it increases opportunity for newly introduced crops, increase yield and productivity; diversify activities and income generating opportunities, and initiates sustainable research efforts based on participatory principles.

Conclusion

This study shows how farmers and researchers are learning through a participatory approach that supports adoption and natural resources management. The case study identified key elements in terms of source of knowledge, merits, demerits and challenges facing the farmer participatory experimentation. Small community based groups based on farmer research groups were constituted on the basis of the interests towards a particular crop; individual experimentation, monitoring and evaluation visit by researchers. Community FRG meetings emerged as significant factors in sustaining FPE, technology transfer and adoption. The study highlights an example of how FPE as an approach of technology transfer based on "bottom-up" can transform farmer perceptions and strengthen their capacities and increase adoption rate where traditional constructs of technology transfer i.e. " top-down approach" and adoption have not been very successful. The study illuminates the role of improved varieties and management techniques in agricultural productivity and natural resources management. Finally it contributes to increasing the knowledge base of agricultural professionals on emerging participatory concepts and approaches for working with smallholder farmers.

References

Bawden, R., and R.G. Packham, 1995. Systemic praxis in the education of the agricultural systems practitioner. Systems Practice. 6:7-20.

Biggs, S. 1990. A multiple source of innovation model of agricultural research and technology promotion, *World Development* 18(11): 1481-1499

Carey, E.E., Gichuki S.T., Ndolo P.J., Turyamureeba, G. and J.M. Teri, 1997. In: *Collaborative sweet potato breeding in Eastern, Central and Southern Africa.* CIP Program Report 1995-1996.

Chambers, R. 1983. Rural development: Putting the last first. Burnt Mill, Hallow, Essex: Longman, Scientific and Technical.

Chambers, R., A. Pacey and L.A. Thrupp (eds.), 1989. Farmer First: Farmer Innovation and Agricultural Research. IT Publications, London.

Chambers, R. and J. Jiggings, 1987. Agricultural for Resources – Poor Farmers: Transfer of Technology and Farming Research. Agricultural Administration. No. 20. p. 98.

FAO 1996. Food for all Report of the World Food Summit 13-17 November 1996. Pp. 32-39.

Kapinga, R., Ewell, P., Jeremia, S.C and R. Kileo, 1995. Sweet potato in the farming and food systems of Tanzania. Implications for Research. Ministry of Agriculture and Livestock Development and International Potato Centre (CIP), Nairobi, Kenya.

Kaimowitz, D. K. and C.M. Merril-Sands, 1989. The technology triangle. The Hague. International Service for National Agricultural Research. Pp 1-25

Lyamchai C.J, S.D. Lyimo, R.V. Ndondi, M.Z. Owenya, P.A. Ndakidemi and N.F. Massawe, 1998. Participatory Rural Appraisal for Kwalei Catchment's, Lushoto District. The African Highlands Ecoregional Programme (AHI), Selian ARI Arusha, Tanzania

Lyimo, S.D. 2004. Personal Communication, Selian Agriculture Research Institute SARI.

Pretty J., and N. Uphoff., 2002. Human dimensions of agroecological development. Chapter 20, in, N. Uphoff, Ed. Pp. 243 –250. Agroecological Innovations: Increasing food production with participatory development. London: Earthscan Publications.

Roy, S. 1990. Agriculture and Technology in Developing countries, India and Nigeria. Sage Publications Ltd. London. Pp 2-4.

Sandra, R., Bremer, Fox, J. Poats, S. and L. Graig, 1989. Gender Variable in Agricultural Research. A report prepared for Women in Development Office US pp. 3-4.

The Effectiveness of Decentralized Channels for Wider Dissemination of Crop Technologies: Lessons from AHI Areka sites

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Abstract

Improved crop varieties are commonly used as entry points in addressing complex, knowledge-intensive natural resource management constraints. However, dissemination of new varieties has been constrained by many factors, including lack of continual supply mechanisms. In Areka, shortage and untimely delivery of improved seeds were among the priority problems of farmers. Decentralized seed multiplication and dissemination was initiated to disseminate available improved seeds and identify effective seed dissemination channels. Major seed dissemination channels were identified, including individual farmers, churches and schools. A total of 15 farmers, four churches, and two schools were involved in the seed production and dissemination process using different varieties of four major crops (wheat, haricot bean tef and maize). Subsequently, they received training on seed system and seed production. The total area cultivated, amount of seed produced, sold, exchanged and gifted were recorded in the course of each activity together with informal monitoring of seed system processes. At the end of the activity, an adoption study and technology diffusion mapping were carried out. Quantitative and qualitative data were analyzed using descriptive statistics summarization, categorization and systematization. Findings suggest that seed multiplication and dissemination through churches was most effective as compared to other dissemination channels in reaching more number of farmers principally because they produced a lot of seed, used diverse promotional and dissemination methods, was better accessed by farmers since they sold in the market, their members passed through some of the adoption process when they were involved in the seed production process and continued contact and the confidence farmers have in the delivering agents. The advantages and disadvantages of the various schemes will be discussed.

Introduction

Different agricultural technologies have been generated in Ethiopia for the last few decades by national and international research institutes. However, most of these technologies have neither reached nor been adopted by the majority of the farmers due to various technical and policy constraints. For example, the formal seed agency in the country is not in position to satisfy the growing demand for improved seeds and emphasizes few major cereals while there is no responsible institution to handle self pollinated crops. In few cases, where improved seed is available, untimely delivery of seeds and poor packaging is also a bottleneck to farmers who are seeking these inputs. Because of the weak institutional capacity of the formal system, about 90% seed supply in the country is done through the informal seed system (Sebil, 2001).

African Highlands Initiative, an eco-regional program which is aiming at improving natural resource management in the highlands of central and eastern Africa has been working in Areka benchmark site since 1999 so as to achieve improved livelihoods through integrated research and development. Among the priority problems listed by the farmers in the project area includes shortage of improved crop varieties and untimely provision of improved seeds (diagnostic survey, 1999). Decentralized seed multiplication and dissemination schemes were developed to address these problems. Improved seeds of major crops were multiplied and disseminated through three different channels; i.e. individual farmers, churches and schools at the same time to evaluate the effectiveness of each channel for technology multiplication and dissemination. This paper reports the activities of decentralized seed multiplication and dissemination experiences at Areka Benchmark Site, south Ethiopia.

Methodology

SITE OVERVIEW

Gununo is situated on an undulating slope that is divided by steep V-shaped valleys with intermittent seasonal streams. It is characterized by very high population density which is about 450 peoples per sq. km. The altitude is between 1880 and 1960 meters above sea level. This area has mean annual rainfall of about 1300 mm, and an average temperature of 19.5 degrees centigrade. Average land holding is estimated to be around 0.25ha per household which is also fragmented and degraded. The soil is poor in fertility due to soil loss through runoff and continuous cropping. There is low production potential of existing crop varieties and livestock breeds in the area. The area has poor infrastructure and poor access to markets for farm products.

METHODS

PRA and diagnostic surveys were conducted in Gununo to identify farmers' priority problems. Consecutive discussions with the community revealed that shortage and untimely delivery of improved seeds were among the community's priority problems. The solution proposed for these problems was to multiply improved varieties of major crops in the area. It was possible to find out that some institutions were involved in production of grains and these were subsequently contacted for their willingness to participate in seed production. Negotiations were made on the process of seed production and dissemination and trainings were then organized for representatives of churches, schools and individual farmers on topics of seed production, processing, storage and marketing. There was follow-up on these groups so as to help them in technical aspects of seed production. Aggressive seed production and dissemination of the varieties selected by farmers was carried out. Data on farmers criteria for variety evaluation, amount of seed produced, sold, gifted, exchanged, area covered and process documentation was done. Overall, 5 varieties of haricot bean, 3 varieties of tef, 3 varieties of wheat and 1 variety of maize were produced and disseminated for 3 years through 2 schools 4 churches and about 15 farmers. At the end of the TDM exercise, evaluation was done to know how much and how far the varieties diffused.

Results

SEED PRODUCTION

The dissemination channels from 1999-2001 produced a total of 52.8 quintal of improved seed (wheat, tef, maize and beans). The greatest proportion was produced by churches (59%) followed by schools (23%). This is partly because churches allotted relatively large amount of land (73.4%). Individual farmers took the lowest share from the total seed produced (9.6%). The reason was that farmers in the area have very small and fragmented land and give priority for food production rather than seed production. In addition to this they fear risks for allotting their lands for seed production. A large amount of land was allotted for wheat seed production, followed by tef and maize (Tables 1 & 2).

Table 1. Dissemination channel and area allocated to seed production

Dissemination Channel	Crop	Seed produced (Qt)	Area cultivated (Ha)
Church	Beans	7.17	0.6
	Tef	8.42	0.72
	Wheat	15.73	2.49
	Individual beans	1.35	0.11
School	Tef	4.48	0.52
	Wheat	3.15	0.17
	Maize	12.5	0.5

Maize seed production on individual farmers' farms was not recommended since there may be a probability of segregation as their land was fragmented and very close together. Therefore, schools and churches were found to be alternatives since they have larger landholdings than individual farmers; as a result, all the maize was produced by schools.

Table 2. Total area cultivated and seed produced by crop

Crop	Amt of seed produced (Qt)	Area cultivated		Mean yield	
		%	ha	%	/ ha
Beans	8.52	21.14	0.72	15.55	10.86
Tef	12.90	32	1.24	26.78	9.02
Wheat	18.88	46.84	2.67	57.66	14.46
Maize	12.5		0.5		25
Total	52.8				

Effectiveness of diverse dissemination channels

Effectiveness of a channel can be evaluated from different angles with different indicators and methodologies. David et al. (2002) found that limited access to seed and a failure to promote a variety had considerable effect for low adoption rate of a bean variety. In addition to these two factors the success of each channel in disseminating the varieties and their weaknesses and strengths were evaluated.

DISSEMINATION OF THE VARIETIES

Seed production and dissemination through individual farmers

Four individual farmers multiplied improved bean varieties but none distributed the seed to other farmers. Only one of the farmers retained the seeds for future planting. The rest consumed all the seed due to lack of market. The new varieties did not meet the important criterion of the red color although some of them had higher yields. The local variety (red Wolaita) with a red color changes the color of maize to red when boiled together. This is the important and decisive criterion for the bean market in the area.

About six farmers were involved in tef seed production. Of the six, only one (16.6%) distributed the seed to his relatives and neighbors through free gift, exchange and selling. The remaining 83.4% did not distribute the seeds because of the shortage and very low productivity of land; they were unable to produce enough food for household consumption plus for distribution. Despite variations, 66.6% of the farmers retained the improved tef seeds for planting while 33.3% of them consumed or sold all the seeds without retaining for themselves. Similar observations were made in Uganda, Burundi, Rwanda and DRC, that the poor farmers are more seed insecure than the rich (David et al., 1999), because they eat or sell all of their grain during acute food shortage or when attracted by better price. For example, as Wortman et al. quoted by David et al., (1999), in a post trial survey in Uganda, a quarter of farmers who stopped sowing K132, a preferred, highly marketable seed type, had sold all their seed , while 17% had consumed it.

The area is food insecure and most of the farmers are poor. According to Bush (2002), 75-80% of the household population in bolos sore Woreda (where the research area is located) was poor in a wealth ranking done in the year 2002. In addition, Tilahun et al. (2001) stated that about 90% of households in the area experience food shortages for at least two out of every twelve months, even in years with a relatively good harvest.

The advantage of multiplication and dissemination through individual farmers is that if the farmer is popular with wider social ties there is better dissemination. The drawback of this channel is there is small amount of land to be allotted for seed production due to shortage of land and fear of risks. In addition the farmers consume and sell all the seeds whenever there is food shortage. Mostly, individual farmers disseminated the improved seed to their relatives and those who they have social ties with. This limited the dissemination of the new varieties to few farmers who have strong relation with the source farmers.

Table 3. Type of crop, numbers of individual farmers produced seed and percentage of farmers distributed, retained, sold and consumed the seeds

Crop	Total number of seed producing? farmers	% percent of farmers who distributed the seeds	% percent of farmers who did not distribute the seeds	% percent of farmers who retained seeds for next planting	% percent of farmers who sold or consumed the seeds
Beans	4	-	100	25	75
Wheat	6	16.6	83.4	66.6	33.3
Tef	5	40	60	80	20

From the five farmers who multiplied wheat seeds two of them (40%) disseminated the varieties to their neighbors, relatives, mahebertegna* and share croppers. This was done through selling, free gifts, exchange and debts. The other three farmers did not distribute the new wheat varieties to other farmers. However, all of them, except one had seeds for planting.

Case study- individual farmers seed diffusion network; Example: Ato Meskele Eligo

Ato meskele was one of individual farmers who were involved in seed production and dissemination process. He produced two quintals of wheat seed (Kubsa variety) in 2002. He distributed the seeds to four farmers among which three were his neighbors and one was his mahebertegna* whose name is Toma. Toma lives in a village six kilometers far from Meskele. Toma heard about the new variety in one Maheber gathering from Meskele. He bought and planted the seed. From his words "I heard from Meskele about the improved variety in one Maheber meeting. He told me that it is productive and has good color. I asked him to sell me 25 kg. He was happy and I planted the new variety with my share croppe". After harvesting Toma sold and gave the new variety to about four farmers who are his neighbors, relatives and share croppers (See figure 1). Meskele said that kubsa is a good variety. It has good color and has good market. He sold the seed for a 10% increase in price than the local variety.

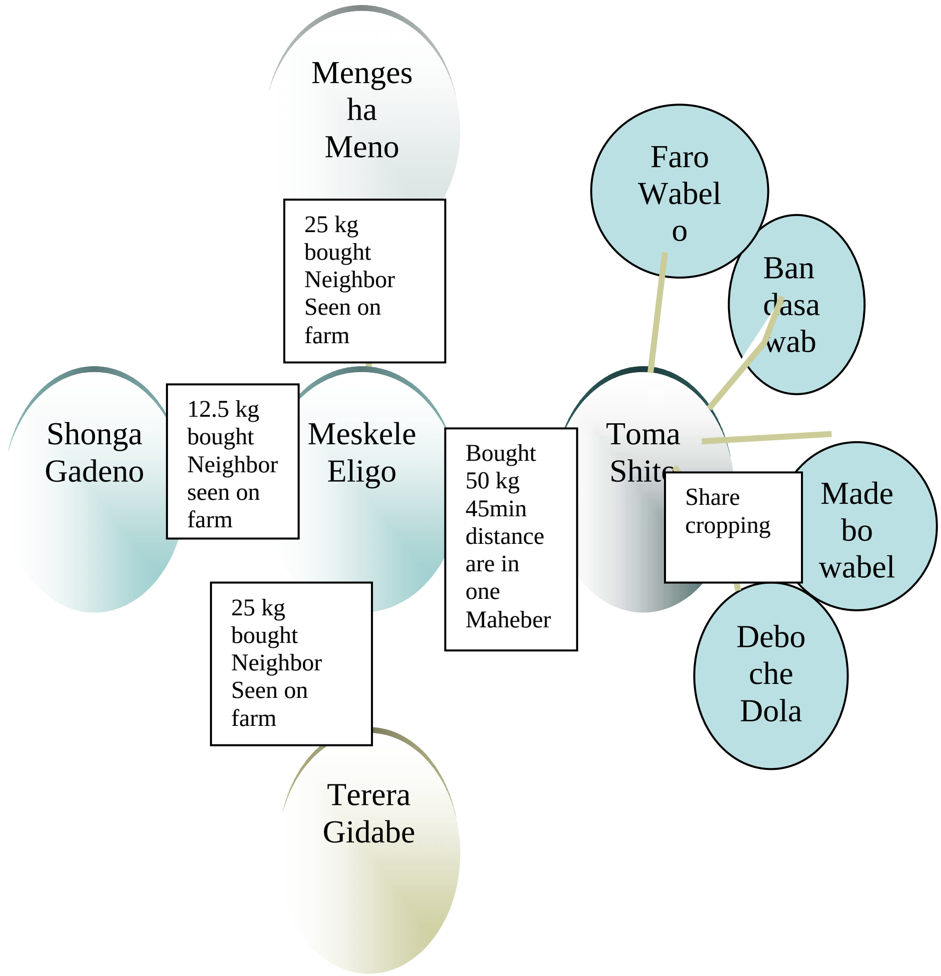

Figure 1. An individual farmer's seed diffusion network

Seed production and dissemination through Churches

Four churches were involved in the seed production and dissemination process. These were Dubo Kalehiwot church, Gununo Orthodox church, Dubo Catholic church and Gununo Hawariat church. About 50% of them were effective in production and dissemination of the seeds while the same percentage mixed the seeds and sold as grains. This was partly due to the weakness of the committees coordinating the seed production and dissemination activities. The commitment and devotion of committees in churches had significant effect for effective seed production and dissemination.

Table 4. Name of churches, crops produced and their effectiveness

Name of the church	Crop	Effectiveness	Reasons
Dubo catholic	Beans	***	
Gununo orthodox	Beans Tef	* *	Mixed and consumed Mixed and sold
Gununo kalehiwot	Wheat Tef	*** ***	
Gununo hawariat	Wheat	*	Mixed and sold

Dubo Catholic Church has been involved in seed production and dissemination process widely after getting starter seed from the project. Additional diffusion research is required to know how much the new bean varieties were diffused in the system. Gununo Kalehiwot church produced and disseminated wheat and tef varieties. The church disseminated the varieties through selling in the market and in the church to a large number of farmers. Both church members and non members had access to the new varieties, though the former were greater in number (). Since the church allotted larger plots of land and produced a lot, they disseminated to the highest number of farmers. For example the church distributed a total of 657 kilograms of improved wheat seed to 20 farmers with an average of 32 kg.

Case study-2: Seed diffusion network of Gununo Kalehiwot Church

The church disseminated the seeds to seed retailers who are church members and leaders. In addition, they sold in the market. The church sold 2 quintals of seed to Abraham Alango (seed retailer and church member), 2 quintals to Wodalo Doda (seed retailer and church member), two quintals for Bekele (church committee member and seed retailer) and one quintal each to Alemayehu Anjulo and Goa Bete who are church members and farmers. The church (in 2000) also sold to 20 church members an average of 32 kg to each. Abraham Alango sold to three people, two of whom are his relatives and the rest in the market. Wadalo Doda is a seed retailer without land. He sold to five farmers who are church members and in the market. Ato Bekele sold to about 15 farmers among which 3 were his neighbors and the rest are church members. He also sold in the market to other farmers. Goa Bete and Alemayehu also sold the seeds to church members and non church members in the market.

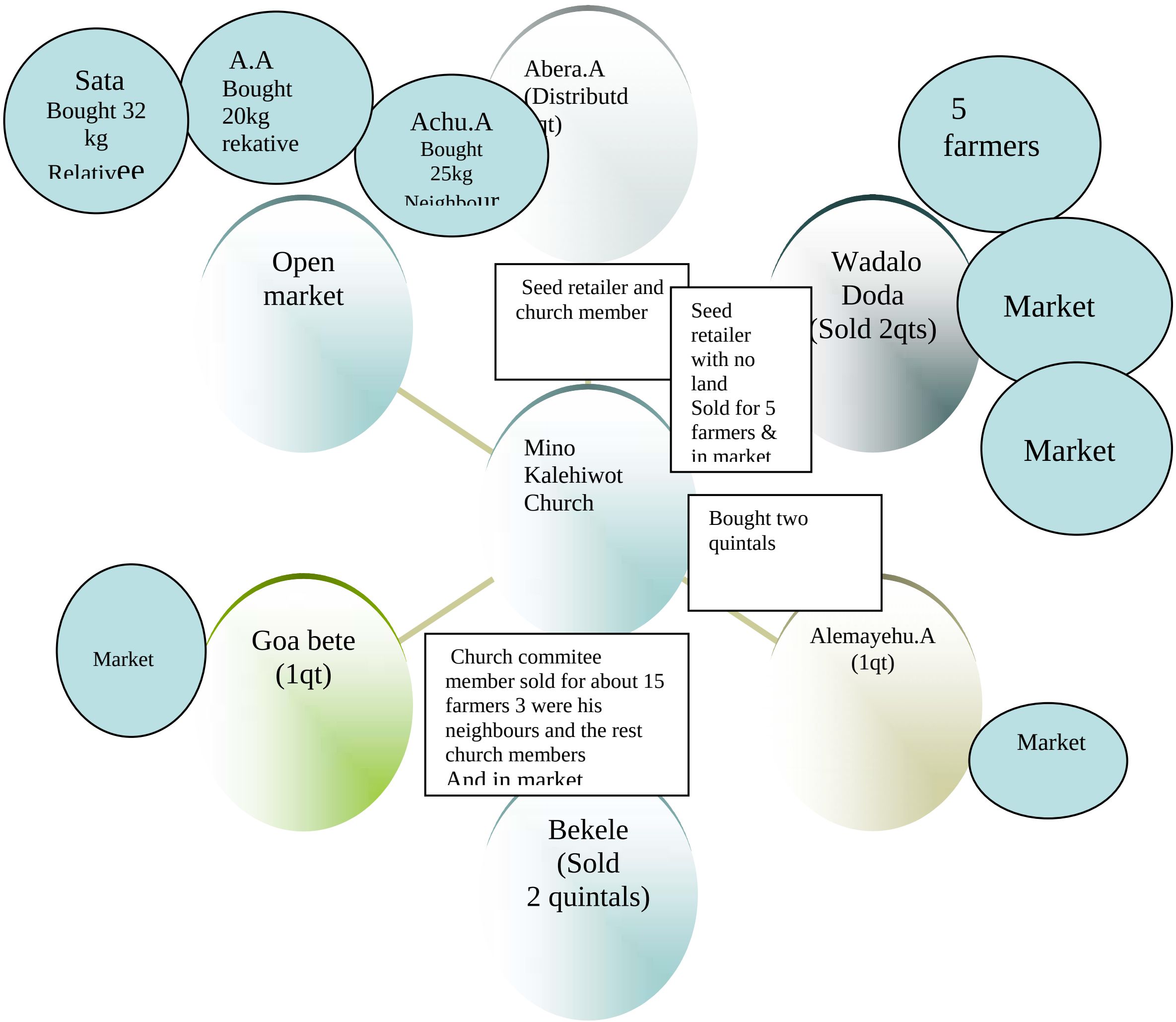

Figure 2: Seed diffusion network through churches

Farmers' preference to different sizes of seed packaging was studied. It was agreed with the church to sell the seed without fixing the amount of seed. Then data including name of farmer and amount of seed purchased was recorded. It was possible to identify that most farmers in the area preferred 25 or less kilograms packaging size. Sixty percent of the farmers bought 25 kg and less amounts of seeds. This was due to their small amount of land and low purchasing power. The two farmers who bought 100kg of seeds were seed retailers.

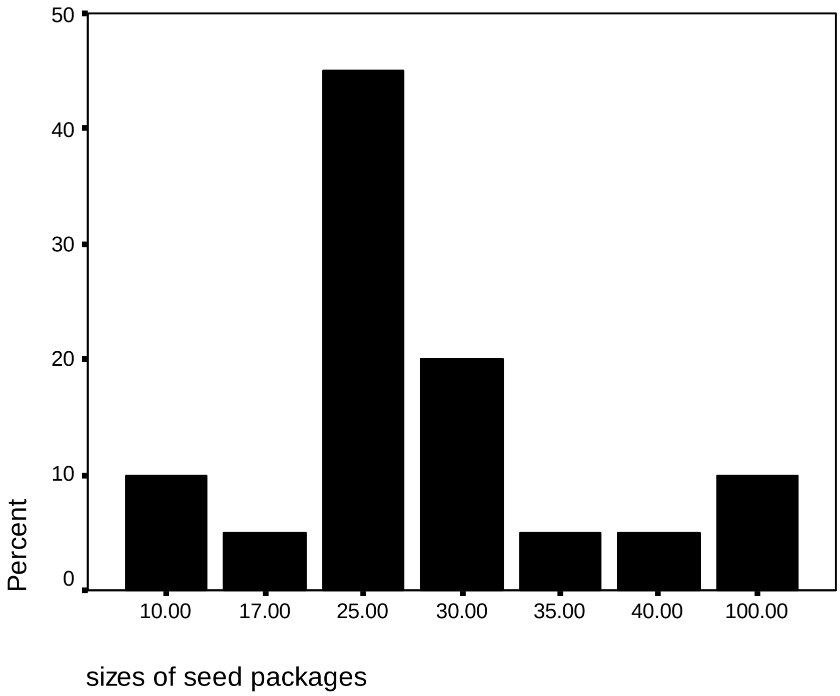

Figure 3 farmers preference to different size of wheat seed packages (Sold by gununo kalehiwot church for about 20 farmers in 2000)

One of the strengths of churches as seed multiplication and diffusion channels was that they were able to reach a greater number of farmers. This was due to the fact that they had allotted a large amount of land and consequently could produce plenty of seed. They used different promotional ways to disseminate information about the new improved varieties especially for their members. The other strength is that a lot of farmers had been involved in seed production process at the same time they were passing through the adoption process. Churches retained the seeds till planting time and sold it for planting seed. This is because they had savings for immediate purposes and they sold to seed retailers who sold it at planting time to farmers. They also had better educated coordinators. The weakness of these channels was the problem of committees. Its effectiveness was highly dependent on the strength and commitment of committee members. Because of the weak committees, many non church members did not get the improved seeds.

Seed production and dissemination through schools

Two schools participated in the seed multiplication and dissemination scheme. They were Gununo Elementary and Areka Junior schools. Gununo Elementary school produced 12.5 quintals of synthetic maize variety A511. Due to fear of weevil attack and more interest in the money they sold the seed in the market as grain for consumption. Areka Junior school was also unable to manage the seed production activities. The schools were more interested in grains which could give good returns without intensive management activities. However, seeds require frequent follow up and management for which the schools did not have time since they were engaged in routine educational activities.

Accessibility of channels

According to David et al. (1997), two issues are important in considering farmers' access to seed. These were how frequently the seed is made available to buyers and whether access is easier or more difficult for certain categories of buyers. In addition to this, the amount of seed produced (available) determines the accessibility of the scheme. Individual farmers were better accessed by their relatives and neighbors. There was limited access for those farmers who did not have social relations with the individual farmers. However, churches were accessed by members and non members since they sold the seed in open market.

Promotional efforts made by channels

Adoption of technologies is highly dependent on awareness of available technologies. In an investigation to study the relationship between individual farmer adoption and his or her social characteristics, 76% of the studies showed positive relationship between adoption index and knowledge of innovations (A.W.Vanden ban & Hawkins, 1996). Information about the new varieties from the channels reached farmers in different ways. Individual farmers used social networks to disseminate information about the new varieties. Most of the individual farmers distributed the seeds to their brothers, fathers, wife's family, neighbors, and those who were in the same Maheber. Churches introduced the new varieties to their members while in religious gatherings. In addition, they sold the seeds in open market. The other important promotional method used in churches was the involvement of a lot of member farmers in the seed production activities. They were passing through some of the stages of the adoption process when they were involved in the seed production process.

According to Lionberger quoted by Burton et al. (1997), the adoption process consists of five distinct stages: awareness, interest, evaluation, trial and adoption. The individual in the process goes through each stage within a defined time period. Other work by Lionberger and others has shown that these stages are not as distinct as he first proposed and that some of the stages may become condensed with in the individual cognitive process, thus making them unrecognizable as a behavior which can be measured over time. In Gununo Kalehiwot church for example, about 250 members of the churches were participating in the plowing, planting, weeding, harvesting, threshing and weighing stages of the seed production process. This gave them the opportunity to get awareness about the improved seeds which in turn created interest towards the varieties. They also got the chance to evaluate the performance of the varieties on the church's field. In the end, most of them bought the seed to try on their own land. In schools however, the students who were participating in the seed production processes were not decision makers to try a new technology. Individual farmers with their families were responsible for the seed production.

Table 5. The seed production process and number of farmers involved at each stage in Gununo Kalehiwot church.

The seed production process	Plowing	Planting	Weeding	Harvesting	Threshing
Number of member farmers involved	30	60	40	100	150

Conclusion

Churches had better chances to promote & disseminate the varieties to many farmers. This is because they produced greater amount of seed, used diverse and a combination of promotional and seed distribution methods which were capable of reaching more farmers. A considerable number of church members were passing through the adoption process when they were involved in the seed production process. This gave them the opportunity to know about the varieties which raised their interest and they evaluated the varieties performance on the church's field. Finally most of them were interested to try the new varieties on their own field. Churches had better financial, material and human capacity.

Individual farmers produced small amount of seed due to fear of risk, shortage of land and their priority to food crops due to large family size. Individual farmers ate or sold the seeds when they faced food shortage. Individual farmers disseminated the improved seeds to their relatives, neighbors and mahebertegna and used their social networks for information dissemination about the new varieties. The individual farmers were accessed by limited number of farmers due to small amount of seed produced, and because they disseminated to only those farmers they had social ties with.

Schools were not effective in the seed production and dissemination because they were highly involved in their daily activities and gave less emphasis for it.

RECOMMENDATIONS

- Seed multiplication and dissemination activities should include churches as an alternative channel.
- Deeper investigations in schools and other alternative channels should be done so as to use them for seed multiplication and dissemination purposes.
- Because of their numerous advantages, it is very crucial to integrate these decentralized channels with formal seed system. In addition, networking of the channels among themselves will help them to disseminate varieties (and also other technologies) amongst each other.
- Linking churches and other local seed multiplication and dissemination channels with potential seed buyers and seed sources is very important to make the system sustainable. There are some farmers who are specialized seed retailers in the local areas. Therefore, they should be assessed for their potential to use them for seed disseminations and to help other farmers who are interested in engaging in such activities.

References

Van den Ban, A.W. and Hawkins, 1996. Agricultural extension (second edition). Blackwell Science Ltd.

Burton E etal (Eds), 1997. Improving agricultural extension. A reference manual. Food and Agriculture Organization of the United Nations.

Diagnostic survey, 1999. Unpublished.

Frew Mekbib, 2001. Local bean (P.vulgaries L.) Seed Systems Study in EasternEthiopia: Implication for Establishment of Sustainable Seed System: In Crop science society of Ethiopia (CSSE).2001. Sebil. Vol.9. Proceedings of the Ninth Biannual Conference, 22-23 June 1999, Addis Ababa, Ethiopia.

Sperling L. 1994. Analysis of bean seed channels in the great lakes region: South kiuv, Zaire, southern Rwanda, and select bean growing areas zones of Burundi. Network on Bean research in Africa, occasional publication series, no. 13, CIAT/ RESAPAC, BUTARE, Rwanda.

Sonia David and Louise Sperling, 1999. Improving Technology Delivery Mechanisms: Lesson from bean seed systems research in eastern and central Africa. CIAT Africa reprint series, No. 21.

Tilahun Amede, Takele Belachew and Endrias Geta, 2001. Reversing the degradation of arable land in the Ethiopian highlands. Managing Africa's Soils No.23. IIED, London.

Traditional Dances for Technology Dissemination

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Abstract

The effectiveness of traditional dances in disseminating integrated natural resource management technologies to farmers was studied in Lushoto, northeast Tanzania. One drama show of the popular Mdumange, the traditional dance of the Wasambaa who are the dominant tribe in Lushoto, was successfully performed. The aim was to expose farmers in Kwalei Village, the African Highland Initiative Benchmark Site in Tanzania, to technologies for soil conservation, soil fertility management, improvement of food and cash crop production, and agroforestry. Farmers appreciated the show and were very positive on drama as one of the best ways to disseminate technologies. Interviews conducted in 2001, one year after the show, revealed that 88%, 86% and 73% of women, men, and youth groups, respectively, reported to have changed their agricultural practices after the show. The 2002 survey results revealed that Mdumange was among the best methods for technology dissemination as it scored a third position in absolute ranking and fourth in pair-wise comparison. Likewise, the 2004 survey results also showed that Mdumange was still the method accepted by the community due to its ability to disseminate technologies to a large number of people. It ranked fourth in both matrix ranking as well as pair-wise comparison. Seventy two percent of interviewed farmers suggested formation of their own traditional / drama groups in the village for the purpose of sensitizing and creating awareness among community members on available technologies to enhance their uptake. The paper concludes with a discussion of how traditional dance might be integrated with other dissemination methods to enhance awareness and adoption of proven technologies.

Introduction

The poor performance of the agricultural sector in developing countries has been blamed on the failure of farmers to adopt "proven" agricultural technologies (Bollinger et al. 1994; Limbu 1999). However, close interaction with rural communities revealed that most farmers are not even aware of these technologies. Lack of effective strategies for conveying information has played an important role in the failure of agricultural technologies to reach most farming communities.

Different extension programs have experimented with participatory extension strategies, but limited efforts has been directed towards the use of the time-tested indigenous communication mechanisms (Ndakidemi and Lyimo 1999) such as traditional dances. This communication tool was commonly used in the past to convey messages locally, but nowadays it is mainly confined to the entertainment of dignitaries and tourists and in political rallies. Studies conducted by Rwangyezi and Woomer (1995) suggest that in almost all tribes, local dances and drama have proved to be a successful way of disseminating technological messages and other information. For example, local dances have been successfully used in AIDS control in Mbeya Region, Tanzania (Harder, et al. 2000). In this paper, Mdumange, a popular traditional dance of the Wasambaa, a dominant tribe in Lushoto northeast Tanzania, was studied to establish its effectiveness in the dissemination of proven INRM technologies (Lyamchai et al. 1998) in the pilot AHI village of Kwalei. The specific objectives were (i) to create farmers' awareness on the available technologies in INRM using traditional approaches to communication and (ii) to popularize the traditional information dissemination techniques existing in Tanzania. The research question was whether traditional dances were effective and efficient means in disseminating technologies? Following a brief description of the Methodology, findings are presented. The paper concludes with a discussion of the strength and limitations of traditional dances in technology dissemination, and some recommendations on how best to exploit this traditional mechanism for passing on information in our farming communities.

Methodology

An inventory of the technologies brought to and adopted by Kwalei farmers was done through focus group discussions involving farmers from all age groups including men, women and youths as well as other stakeholders like policy makers, researchers, extension workers and village leaders. This was followed by the identification of a popular traditional dance troupe in the area in collaboration with farmers. The identified troupe (Mzee Shauri Cultural Troupe) was contacted and a contract signed, after which the troupe was given some orientation on the technologies that were earmarked for dissemination. Technologies identified for inclusion in the drama were on soil and water conservation, soil fertility improvement using indigenous nutrient resources, improved livestock structures, improved crop and livestock husbandry, improved seeds and tree planting for environmental conservation. Sensitization of the community to establish a saving and credit society (SACCOS) to enable them access some of the farm inputs such as improved seeds was also included. The troupe was asked to perform several times each time with a different theme. They were also asked to do it in Kisambaa the local language in the area, and in Kiswahili which is the national language. The village community was then invited to attend the performance on a day decided upon by the farmers themselves. Invitation was done using posters displayed in key areas such as shops and places of worship as well as through verbal communication. The dancing troupe composed several entertainment activities through music, dancing, and stories and the first show was performed in Kwalei village on 7th April 2000. The scene was videotaped and some photographs taken.

To measure the impact of the drama three formal and informal surveys were conducted in 2000, 2001 and 2004. The surveys were done within a period of 4 months, one year and four years after the show. During the first interview a total of 29 farmers of different gender categories were selected randomly and interviewed. The second and third surveys involved 23 and 25 farmers, respectively. In the third survey, 80% of the interviewees' were present during the performance in 2000, while 20% were not present but got the message from other farmers. A formal questionnaire was administered to each of the interviewees. Some of the questions were designed order to get information on advantages, disadvantages and criteria considered when selecting an effective information method. Other questions were set to get information on different ways used by farmers in the past to disseminate information and on farmers' preference of dissemination methods.

Results

More than 500 people of different age, gender and wealth categories attended the Mdumange performance. Of these, 380 were women, 80 were men and 40 were youth. As a result of this show, farmers purchased bean seed, which was sold just after the show.

Results show that 88%; 86% and 73% of women, men, and youth groups respectively, reported to have changed their agricultural practices after the show. When absolute ranking was done to compare drama with demonstrations, leaflets, TV/Video and tour within and outside the country, the 2001 survey results indicate that drama ranked third after farmer to farmer visits and learning through video or other visual aids (). Pairwise comparison showed that drama ranked fourth after tours in and out of the country, demonstrations and leaflets. Ninety-two percent of farmers indicated that drama is a good method of sensitizing farmers to adopt technologies because it reaches a large number of farmers at once and it is an easy tool of communicating with those who can not read.

All farmers who were interviewed during the third survey indicated that they know Mdumange and are aware of its advantages. 92% of the interviewed farmers were present during the first performance of Mdumange so it was easy for them to remember what messages were disseminated during the show. 88% of the farmers reported that together with drama there are other methods, which were used in the past to deliver information or create awareness to villagers. These include (with percent respondents in brackets) village meetings (72%), awareness songs (20%), newspapers (8%), radio 12%, farmer to farmer visit (40%), *gunda (a call for collective action)* (32%), sharing of seeds (24%), announcement during funerals, Sunday / Friday prayers (24%) and through extension workers (8%). In addition watching messages on television, out of country visits and researchers are among the new sources of information. These approaches are either used alone or in combination.

Knowing the important role-played by traditional dance in information dissemination for social or political issues; farmers commented that it could also be used to disseminate technological information very efficiently (See Box 1). They suggested performance period to be either at the beginning of the year (60%), during harvesting time (20%), any time of the year (4%) and middle of the year (16%). However for wider adoption the majority of the farmers suggested the show to be conducted at the beginning of the season. For sustainability of the approach, 72% of the farmers suggested establishment of their own drama groups in the villages for the purpose of sensitizing, awareness creation and / or dissemination of technological information. 28% of the farmers reported that collaboration between farmers, extension workers and researchers in planning and implementation of drama for technology dissemination would ensure sustainability of the approach.

Farmers mentioned the advantages and disadvantages of different technological dissemination methods currently being used in Kwalei village. The methods discussed include drama/songs, training seminars, visits (in and out of the country) and farmer groups. Others were leaflets/posters, radio/TV and demonstration plots. Results of their analysis are shown in Table 1.

Table 1: Advantages and disadvantages of different technology dissemination methods as assessed by Kwalei farmers

No	Method of technology transfer	Advantages	Disadvantages
1	Drama/songs	Attracts many people therefore disseminate information to many people and fast. Entertain Creates awareness Easy to remember the message due to repetition of the same words many times.	Takes time to prepare. Relatively high cost
2	Training/Seminar	Facilitates exchanges of ideas and experience Enable farmers to meet with different people (learn from others)	Relatively high cost. Need time to prepare Need well knowledgeable personnel Only few would benefit
3	Visits within and out of the country	Increase confidence of farmers by seeing Increase farmers morale to change	High cost especially for out of country visits Need time to prepare. Involves few farmers at a time
4	Farmer Groups	Easy to transfer technologies Other farmers can copy technologies from farmer groups Encourage practical work Increase confidence of farmers	Sometimes one member may cause mis-understanding in the group, which may affect performance of the group. Lack of credibility among group members may lead to the failure of the group. Needs commitment and self-motivation.
5	Leaflets and posters	Can be stored Easy reference Easily transferred to other places	Can be destroyed easily Difficult for those who can not read
6	Radio/TV	Reach many people Seen by reasonable number of people	Many in the villages do not have Television and radio sets Initial cost to purchase a TV or a radio is high.
7	Demonstration Plots	Encourage practical work Seeing the technology at work	Spreads out slowly High cost of inputs needed to conduct the demonstration

Advantages of the different methods are based on the extent of coverage (number of people reached at a time), easiness to remember messages, promotion of farmer to farmer interaction, seeing the technology at work and storage of the information for reference. Disadvantages are mainly based on cost incurred in the application of the method, limitation in coverage, time involved and difficulty in reading where literacy levels are low.

Farmers were also asked to mention criteria that they normally use to select a particular method of technology dissemination. The different dissemination methods considered were drama, training/seminar, visits (out and In-country), farmer groups, leaflets, radio/TV, songs and demonstration plots. The criteria mentioned include efficiency, entertainment, long life storage, exchange of experience, low cost and facilitation of easy adoption. Using matrix ranking long life storage was highly scored followed by efficiency in delivering information and facilitating ease adoption. Exchange of information and entertainment ranked fourth and the last scored criteria was low cost.

Discussion

The large number of people who attended the Mdumange show points to its popularity in bringing people together. Some could have come for the entertainment while others for both entertainment and learning. With such high numbers, technological messages spread to many people fast and at a minimum cost compared to visiting individual or small groups of farmers. Further, since drama attracts many people it could be exploited for the displaying and / or selling of different improved materials such as improved seeds.

In this study the number of women who participated was significantly higher compared to that of men and youth underlying the importance of women in agriculture. The smaller number of youth might imply that the younger generation might not be so enthusiastic about traditional dances and drama like the elders and therefore there is need to look into parallel approaches like using new generation music and drama that will attract young farmers. The impact of the show was better reflected in adult farmers whose response was relatively higher with respect to changes in their agricultural practices after the show.

When traditional dances / drama was compared to other methods of dissemination it ranked lower than demonstration plots, leaflets, TV, farmer visits (within and out of the country). Experience has shown that when farmers see the technology at work or learn from fellow farmers there is a greater likelihood that they will adopt since seeing is believing (Kingamkono and Lyamchai, 2000) and “if a fellow farmer can do it I can also do it”. Preference to a particular method of dissemination will depend on many factors including cost and other requirements associated with that particular method. Compatibility with other dissemination methods is also an important factor and in this context drama can well complement other dissemination methods such as farmer to farmer visits and tours in and out of the country. During such visits, drama can be included to remind visiting farmers of the technologies they saw. Adopting a mixed menu of technology dissemination methods enables coverage of a wider audience since those who can not be reached by one method will be reached by the other, while pulling upon the relative strengths and weaknesses of different methods. For example if in the audience there are farmers who can not read they can benefit when traditional dances is one of the methods adopted. In such shows there should be at least one scientist who knows the local language to make sure that the messages given to the dancing troupe are not altered**.** It is very difficult to isolate the effect of traditional dances / drama from other dissemination methods.

Conclusion

The results from this study show that traditional dance / drama ensures delivery of technological information to a large number of people at the same time. The older generation still considers this method of communication important while younger farmers might prefer innovative approaches such as new generation music. This is reflected in the numbers of young farmers attending and the relatively lower percentage of young farmers who changed their agricultural practices after the show. Women were more attracted to the traditional dances than men, an aspect that might reflect on the importance of women in agriculture and hence on the type of messages that should dominate such shows. To exploit the potential of traditional dances in dissemination of technologies, farmers should be encouraged to form and sustain their own groups instead of hiring services from other villages. Researchers should also find from young farmers what kind of extension approach most appeals to them. Finally, traditional dances should be conducted from time to time to remind and create awareness to farmers on available technologies in order to speed up adoption.

References

Ngendello, A., Mgenzi, S.R.B. and T. Schrader, 2003. Dissemination of agricultural technology: Narrowing the gap between research extension and farmers. Proceedings of the National Workshop on Client Oriented Research 27-28 May 2003, Moshi, Tanzania.

Bolliger, E., Reinhardt, P. and T. Zwellweger, 1994. Agricultural extension: Guidelines for extensionworkers in rural areas. SKAT, Swiss Centre for Development Co-operation in Technology and Management, Switzerland.

Harder, J.B., Koshuma, Y.A., Pervilhac, C. and U. Vogel, 2000. Hope for Tanzania; Lessons learned from a decade of comprehensive AIDS control oin Mbeya Region; Part II; avide for HIV/AIDS/STD Interventions in a District of Sub-saharan Africa ,Example from Mbeya Region; Published by GTZ in cooperation with the Ministry of Health Tanzania.

Kirway, T.N., Lema, N.M., Lyimo, S.D., Kileo, R.O., Kapange, B.W., Schouten, C. and T. Schrader, 2003. Participatory technology dissemination, networking and collaboration, model 6; Farming Systems Approaches Training Manual Vol.1.

Limbu, F. 1999. Agricultural technology, economic viability and poverty alleviation in Tanzania.Paper presented at the structural Transformation Policy Workshop, 27-30 June 1999, Nairobi, Kenya. ECAPAPA, Tegemeo Institute and Michigan State University.

Lyamchai, C. J., Lyimo, S. D., Ndondi, R.V., Owenya, M. Z., Ndakidemi, P. A. and N.F. Massawe, 1998. Participatory Rural Appraisal for Kwalei Catchment, Lushoto District. The African Highlands Ecoregional Programme (AHI), Selian A.R.I Arusha, Tanzania.

Kingamkono, M.N. and C.J. Lyamchai, 2000. Seeing is believing. A Report on Kilimanjaro farmers visit to Embu and Maseno in Kenya, 2000. Selian Agricultural research Institute, Unpublished.

Ndakidemi P. 1999. The use of traditional dances in dissemination of agricultural technologies in Kwalei. ‘’In C. J. Lyamchai and J. G. Mowo. (eds). Progress report for the Lushoto benchmark site Ministry of Agriculture 1999. Selian Agricultural Research Institute, Arusha, Tanzania.

Ndakidemi, P., Lyimo, S.D. and M.Z. Owenya, 1999. Promoting farmers’ awareness about problems and potential solution of agricultural production in Kwalei village through local mdumange dancing troupe.

Rees, D. 2000. Agricultural knowledge and Information System in Kenya: Implications for technology dissemination and development, ODI: Agricultural Research and Extension Networks. Paper No, 107.

Rwengyezi, S. and P.L. Woomer, 1995. Promoting environmental awareness through performance education Nature and resources 31(4): 34-39.

Farmer Innovations and Participation in Agricultural Research and Development: A Case for the Lake Albert Crescent Zone (LAC) in Uganda.

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Background

More than 1.4 billion people worldwide live in poverty with a malnutrition rate higher than 31% and over 340 million people live on less than US $1 per day. There is a high mortality rate of about 140 people per 1000. This is further aggravated by the increasing HIV/Aids status. Moreover, there is increased pressure on natural resources especially soils, leading to their depletion and degradation. In the LAC virtually most of the people depend on agriculture for their livelihoods and there is little room for horizontal expansion in agricultural productivity. Increased incomes and improved livelihoods of smallholder communities in this area, therefore, will depend on increased use of improved agricultural technologies and rational use and sustainability of the natural resource base.

Introduction

Conventionally research has had little participation of stakeholders in research planning, implementation and evaluation processes. Local community dynamics, constraints, opportunities and interactions are not well understood. Formal research systems have lacked the capacity to develop site-specific solutions and Farmer Indigenous Technical Knowledge (ITK) has not been incorporated in the research agenda. It is only recently that gender issues have started being considered while designing research projects.

Some of the approaches that have been previously used include **Transfer of technology (TOT)** (Farrington and Martin, 1987). This approach assumes that there are ready technologies on shelf for transfer to farmers. These technologies are scientist designed and are just passed over to farmers to adopt or reject. This is a 'learning from above and teaching from below" approach and there is no wonder that it has not produced the desired results (Chambers and Jiggins, 1987). In t**he on-farm trial approach**, the scientist tests technologies at the station and later on-farm. The farmer's role is restricted to providing land and labour and the scientist is interested in the performance of the technology across environments. In the **Farming Systems Research (FSR)** approach, the agriculturall interventions are based on different agoecological zones. This approach recognizes the need for addressing area specific problems and the farmers to be part of the process. However in some cases the FSR approach is used as a variant and adaptation of the TOT approach (Chambers and Jiggins 1987). The key decision on what to apply remains with the scientist. The list of these approaches is long including; **On-farm Client Oriented Research**, **Farmer first and last approach** (Chambers and Childay, 1985), **Farmer back to Farmer approach** and **Farmer Participatory Research (FPR).**

Agricultural research and technology development is a core role of Agricultural Research and Development Centers (ARDCs) and FPR approaches are used in this process. Research conducted with partner organizations like International Institute for Tropical Agriculture (CIAT) in selected rural communities, has promoted technology adoption and improved food security by identifying suitable agroenterprises, and managing natural resources. Over 30 Farmer Research Groups (FRGs) have been formed and are actively involved in technology testing, evaluating and dissemination. Lessons learnt have been used to scale-out these technologies to communities in the Lake Abert Crescent Zone. Based on this experience, Uganda and Kenyan scientists are now making farmer research groups and other participatory approaches a prominent feature of work done by their country's regional agricultural research centers.

The pioneering efforts of PRIAM have continued under a new alliance of the PRGA program with AHI in cooperation with national institutions and NGOs. From this work important lessons have been learnt about the selection, performance, and monitoring of farmer research groups-lessons that provide a basis for rapid spread of participatory methods in Africa.

Participatory research has value in many areas. CIAT and its partners in Africa have developed methods for application in participatory plant breeding, seed systems, integrated pest management, the improvement of soil fertility and natural resource management, and the dissemination or scaling out of technology. CIAT with the national programme in Uganda and other countries is also undertaking another project called "Enhancing Rural Innovation," (ERI) which promotes rural agroenterprise development, farmer experimentation, and natural resource management with various partner organizations, such as Africare in Uganda so that farmers gain, not just easier access to research products, but a stronger voice in their development.

The renewed interest and emphasis on poverty alleviation makes FPR an effective vehicle for empowering resource poor farmers and scientists to generate appropriate technologies that will instill among farmers a sense of ownership leading to higher adoption and sustainability while enriching the research process by having wider participation of stakeholders and incorporating ITK in research and development. A recent survey on ITK in the Lake Albert crescent zone has revealed a lot of farmer indigenous knowledge that has neither been documented nor incorporated in the conventional research agenda (Kanzikwera and Aliguma, 2003).

Use of Farmer Participatory approaches in NARO

The deliberate decentralisation of research by government has led to creation of Zonal Research Centers (ARDCs) based on agro-ecological zones. These act as conduits for technology development and dissemination by conducting zonal specific research based on farmer priorities, opportunities and constraints. The ARDCs conducts research activities with the communities. Community participatory diagnosis (PD) as shown below, visioning and development of joint action plans are done jointly with the farmers.

Plate 1. Farmers, researchers and other stakeholders of the Lake Albert Crescent Zone developing joint action plans

Use of Farmer Research Groups (FRGs)

The ARDC has been using FRGs identified by its partners as entry points to communities. In recent years, there has been increasing interest in farmer research groups (FRG) to catalyse farmer participation in research, and to widen the impact of participatory research. The number of FRGs in the Lake Albert Crescent Zone increased from 8 in 2003 to 20 in 2004 consisting of 187 active members. Over 67% of these farmers are women and this is in agreement with findings of Sanginga *et al.,* 2001 who found out that the probability of participating in FRGs was higher for women compared to men, and that there were no significant differences in wealth circumstances between FRGs members and the rest of the community. The authors argue that FRGs as an approach has a great potential for catalysing the participation of farmers as partners in research and development activities. However, this requires significant support and personal commitment of researchers to broaden the scope of FRGs from a functional consultative type to a more collegial empowering type and from variety evaluation to broader natural resources management research and other developmental issues. However, there is a lack of systematic empirical studies that evaluate the quality of participation in FRGs. Using empirical data from a sample one should be able to find out what types of participatory research occurs at the different stages of the research process, how farmer participation occurrs, who participates in FRGs, what are the factors that determined farmers' participation in FRGs, and what criteria should be used in monitoring and evaluating the performance of FRGs (Sanginga *et. al.,* 2001).

Linking farmers to the market

One of the criteria for selection of an enterprise is the availability of market for the produce. Farmers should be guided to produce what they can sell rather than sell what the y produce. Through technical backstopping by CIAT, Bulindi ARDC was able to conduct Participatory Market Research workshops for stakeholders and to physically link farmers to the markets through market surveys, market chain analysis and provision of market information. This process helped farmers to identify profitable enterprises. Farmers' capacity was then increased through training of farmers on the selected enterprises and development of joint action plans.

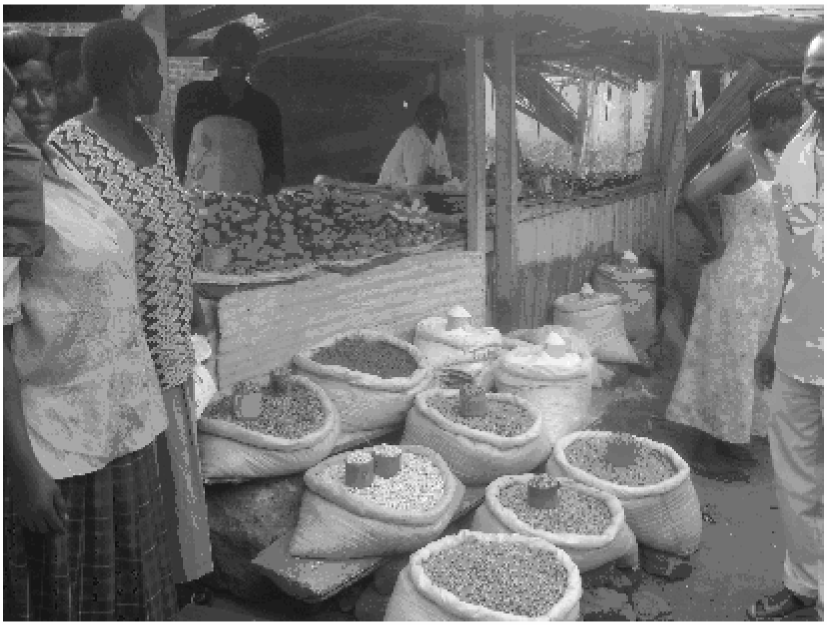

Plate 2. Linking Producers to Market

Outcomes from FPR

The approach enabled researchers and other stakeholders to understand the farming systems and livelihoods of the communities, their constraints, opportunities and system component interactions. Research agenda was enriched by incorporating farmers' indigenous knowledge and innovations. This instilled the spirit of ownership and led to increased adoption of technologies among FRGs thereby ensuring the sustainability of research projects. There was increased scaling out of research technologies as the number of FRGs increased from 8 to 33. More relevant technologies will be generated as a result of feedback from farmers to researchers. Stakeholders were able to identify priority research areas and suggest possible interventions through a participatory prioritization exercise. Farmers were linked to markets and this has increased demand for research technologies and forced researchers to have a market focus in agricultural research and development

Challenges of FPR

One major challenge for the success FPR is that the approach needs patience and takes a long time while farmers want results in a short time and see no need for replication or repeating trials. Wider participation and scaling out requires a range of committed partners and this is not so easy to achieve. Another challenge is on how to strengthen farmer groups and keeping them cohesive. Sanginga *et al*., 2001 reported that the dynamics of farmer groups is a U shape. Many farmers join in the beginning, then some pull out and later the number gradually increases. Farmers have high expectations in terms of free inputs and funds. Mainstreaming gender into research activities requires attitudinal changes which occur slowly. Marketing is affected by many factors and is therefore dynamic. Linking farmers to markets is still a big challenge.

Acknowledgement

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References

Chambers, R. and B.P. Gyldyal, 1985. Agricultural Research for resource-poor farmers. The Farmer First and Last Model. Agricultural Administration. (20): 1-30.

Chambers, R. and J.L.S., Jiggins, 1987. Agricultural Research for Resource-poor farmers. Part I: Transfer of technology and systems research. Agricultural Administration and extension 27: 35-52.

Farrington, J. and A. Martin, 1987. Farmer Participatory Research: a review of concepts and practices. Agricultural Administration. Research and Extention Network discussion paper 19. London Overseas Development Institute.

Kanzikwera, R.C and L. Aliguma, 2003. Report on Farmer Indigenous Knowledge in The Lake Albert Crescent zone in Uganda.

Sanginga, P., Martin, A. and F. Place, 2001. Strengthening social Capital for NTRM in SW Uganda. NRSP Participation Workshop.

Up, Out and About: Success Factors an Challenges in Dissemination and Scaling Up of INRM Options for Sustainable Livelihoods

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Abstract

There are many success stories of participatory research and development projects, but most of them are confined to localized sites. This is partially due to the low adoption of options resulting in less impact and little long term effect on livelihoods especially in the rural communities.There is an urgency for scaling up the benefits of research and development work, bringing more quality benefits to more people over a wider geographical area, more quickly, more equitably and more lastingly. A variety of approaches are used for scaling up of technologies, but there are few that incorporate the processes implemented. Various approaches include, farmer to farmer dissemination, farmer field schools, common interest groups, farmer research committees/groups, umbrella groups, watershed management committees, village committees etc. Some factors to consider in adoption are: farmer – centred research and extension, market and enterprise development/credit, private sector involvement and the balance between income generation and household nutritional needs/food security. There are many challenges for effective scaling up activities that need to be addressed in the future, and the various gaps identified need to be filled in order to improve the overall livelihoods of people researchers and scientists are working with.

Spillover of Farm-level Innovations and Implications for Scaling Out in Baga Watershed, Lushoto Tanzania

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Abstract

A spillover study was conducted to trace out the extent to which innovations had gone, the pathways, farmer innovativeness and impacts. Two types of spillovers were identified, a spontaneous spillover where technologies spread unmediated by researchers or extension staff and the mediated spillover due to facilitation by the research team to facilitate a broader adoption. It was also found that technologies that had quick results spread more quickly, created faster and impacts, than the long term technologies. This paper reviews the spillover process using the fast moving technologies and highlights on key challenges, lessons and impacts, and provides an overview of how it could guide strategic scaling out.

Chapter 6:

Participatory Integrated Watershed Management

Participatory Integrated Watershed Management: Evolution of Concepts and Methods

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Abstract

This paper focuses on the conceptual evolution of watershed management within the African Highlands Initiative, as informed by both theory and practice. After situating the AHI watershed program within the global context, the paper explores the conceptual underpinnings of watershed management within AHI. The paper summarizes progress made thus far in conceptualizing "watershed issues" (NRM problems at landscape or watershed scale and related incentives) and "stakeholders", and how such clarifications have helped to operationalize "integration" and "participation" in watershed management. By discussing these concepts one by one in the context of an implementation process, the influence of practice (approaches and lessons) on the program's conceptual development are brought to light. The paper concludes with a discussion of implications for agricultural R&D in the eastern African region.

Introduction

Fresh water is expected to become the most limiting resource in many parts of the world in the near future (Gleick, 2000; Postel, 1997; Postel et al., 1996). This has led to a surge in funding for watershed management programs (Shah, 1998; UNCED, 1992). Given this new funding climate, there has been a surge in actors involved in watershed management programs. Yet as often occurs as interests soar in response to funding levels rather than endogenous developments, an imbalance emerges between development aims and outcomes (Hinchcliffe et al., 1995; Rhoades, 2000; Shah, 1998). Therefore, there is an urgent need to take a critical look at the motives for watershed management, the beneficiaries, and methods used to reach specified objectives.

This paper highlights some of the different forms of watershed management emerging in the global arena, focusing on a participatory integrated watershed management program being implemented under the African Highlands Initiative (AHI), an ecoregional program operating in the highlands of eastern Africa. The bulk of the paper highlights recent progress made in operationalizing some of the key concepts underpinning PIWM on-site through approach development and testing. The paper fills an important gap in the watershed management literature by illustrating how the states objectives and beneficiaries influence approach development, and by contributing to the body of literature on methods and approaches for participatory watershed management.

Background

WATERSHED MANAGEMENT

The Political Ecology of Watershed Management

The recent surge in funding and interest in watershed management must be looked at closely in terms of its political foundations. Political ecology helps to shed light on how the agendas of different actors in the global system shape how ideas (science) are formulated and leveraged toward particular ends (Agrawal and Gibson, 1999; Leftwich, 1994). It is no different within the watershed domain (see Shah, 1998), where multiple actors see in the approach a means to accomplish disparate objectives. This has resulted in multiple visions of the "watershed approach". Among agronomists, it is seen as a means of scaling out technologies, primarily those for soil and water conservation or environmental protection more generally (see analysis by Hinchcliffe et al., 1995). For the water resource sector and policy-makers, it is seen as a means for enhancing environmental services and public goods emanating from upper catchments for the society at large (FAO, 2000; IIED, 2004). Among conservationists, it is viewed as a framework for enabling trans-boundary natural resource management (Wilkie et al., 2001), in which livelihood concerns are often addressed only to the extent that they help to further conservation goals. Yet among social scientists and others, watershed management is seen as a framework for enhancing collective action and equity in natural resource access and governance, or livelihood problems that cannot be solved at the level of the farm or household (Meinzen-Dick et al., 2002).

A critical question that we must ask ourselves to unravel the political ecological foundations of watershed management aims and methods (in terms of who benefits and whose agendas are furthered by the approach) is, "watershed management for whom?" A clarification of the intended beneficiaries, whether local users, society at large or diverse external stakeholders (i.e. agricultural, conservation or health organizations), is needed to define everything from watershed objectives to watershed boundaries, stakeholders and methods. If implemented for the benefit of local users, for example, boundaries can be defined by the issue at hand – whether inscribed within a set of contiguous farms, the micro-catchment at other spatial scales. If the aim is water provision for society at large, then boundaries become the basin. If for scaling out technologies or reforming policies, administrative units may be equally useful units. Any attempt to operationalize watershed management must therefore be grounded in a preliminary statement of aims, beneficiaries and the nature of problems to be addressed.

PARTICIPATORY, INTEGRATED WATERSHED MANAGEMENT (PIWM)

In participatory integrated watershed management, the approach can be qualified through two aims. First, the process must be participatory in terms of the particular issues to be worked on, and how related activities are carried out (Hinchcliffe et al., 1995; Rhoades, 2000; Turton and Farrington, 1998). A critical question to ask when formulating a participatory watershed management agenda is, "Why would a farmer want to think beyond the farm level?". Only by gaining clear answers to this question can a participatory watershed approach be developed. Participatory problem definition also implies that the relevant boundaries for interventions are not necessarily the "watershed," but perhaps units defined by non-biophysical parameters (administrative or cultural units) or at other scales (for example, a set of neighbouring farms or a particular landscape niche). It must therefore be treated as a hypothetical unit of analysis until participatory diagnosis confirms that problems conform to hydrological boundaries.

Second, the process must be integrated. While different people may define integration differently, a common approach is to emphasize the integration of disciplines (technical, social and institutional dimensions) (Bellamy et al., 1998; Eren, 1977; Reddy, 2000) or objectives (conservation, food security, income generation) (Shah, 1998). While it is increasingly clear that the success of watershed management programs rests on the integration of conservation with livelihood goals, technical with institutional interventions (Reddy, 2000; Shah, 1998), few programs have effectively achieved such integration in practice (Rhoades, 2000; Shah, 1998). It is therefore essential that any approach at integration integrate an understanding of the principles operating within natural and social systems (Meinzen-Dick et al., 2002; Reddy, 2000).

THE AFRICAN HIGHLANDS INITIATIVE

The African Highlands Initiative (AHI) is an ecoregional program of the Future Harvest Centers (CGIAR)[1] and the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). The program operates in benchmark sites of the eastern African Highlands that share similar characteristics: high population density, declining agricultural productivity, and limited economic opportunities. Since 1995, AHI has worked in partnership with NARS of Ethiopia, Kenya, Madagascar, Tanzania and Uganda to develop new working approaches that enable improved farm- and landscape-level natural resource management (NRM) among rural communities. Research and funding during Phases 1 and 2 of AHI emphasized farm-level natural

[1] CGIAR stands for the Consultative Group for International Agricultural Research.

resource management, primarily through technological innovation. In recognition of the strong interactions among users and components (trees, cropland, water, and livestock) at landscape level, Phase 3 aims to address broader dimensions of NRM beyond the farm level. This has catalyzed funding for what has become a full-fledged emphasis on participatory, integrated watershed management and the development of methods to operationalize this approach. While still in early stages of implementation, important lessons are emerging for agricultural research and development (R&D) in the eastern African region.

It is important to take a look at the foundations of watershed management within AHI, given the variability of objectives and approaches falling under the "watershed management" umbrella. AHI's aim is to operationalize a participatory, integrated watershed management approach to address problems of immediate relevance to highland communities. This means that it is a largely endogenous approach in terms of the motives for change (i.e. NRM problems identified by watershed residents themselves) and the ultimate beneficiaries (upper catchment residents). Principles guiding watershed approach development include equity, sustainability and local empowerment. While higher-level actions in the near future will be restricted to district-level institutional and policy interventions in support of watershed-level actions, it is possible that such 'working catchments' will be integrated into higher-level watershed or basin management initiatives.

Methodology

APPROACH DEVELOPMENT: ACTION RESEARCH

Action research and social learning approaches are central to the evolution of concepts and methods within AHI. Concepts and methods are developed through an iterative process of reflection and implementation at site and regional levels, where practice informs concepts and vice-versa. While a central office or regional research team assists in the coordination of strategic research and interventions and to synthesize findings at regional level, national scientists in each benchmark site develop methodology on-site and carry out the bulk of the work on the ground. As the process unfolds, site teams work with one or more regional research fellows to develop "best bet" approaches, test them in the field, and improve upon them before implementing more broadly. Thus, while most ideas are generated through a "constructivist" (Chambers et al., 1992; Rodwell and Woody, 1994) approach to knowledge generation and social learning on-site, regional staff enhance cross-fertilization of ideas between sites. The latter enables a more robust approach through cross-site comparison, and greater regional integration (Figure 1). While this cross-fertilization helps to strengthen the approach followed as well as the regional research dimension, site-level scrutiny of approaches under development ensures sufficient variation so as to enhance comparative learning between sites.

Through this iterative approach to site application and regional synthesis, concepts are formulated and approaches formulated and tested with watershed communities. This has led to an improved conceptualization of a number of important concepts in watershed management (watershed issue, stakeholder, integration, participation). Without having a fixed idea about the nature of issues to be addressed within the watershed management umbrella, understanding of what constitutes a "watershed issue" remains illusive. Following the diagnostic phase, a typology of watershed issues facing highland communities in eastern Africa was formulated. These include common property resource (CPR) management problems, negative trans-boundary interactions (among neighboring farms and villages), problems of resource access and distribution, and areas for which limited collective action hinders agricultural productivity and livelihoods more generally (German, 2003). Given the nature of then AHI watershed approach and the issues facing local communities, "stakeholder" then becomes defined in more specific terms – often local actors with different interests or "stakes" as defined with respect to the particular issue at hand (trans-boundary, CPR or other). Non-local stakeholders are only involved if the issue involves them directly, including the management of public lands, governance issues or public services (water, etc.).

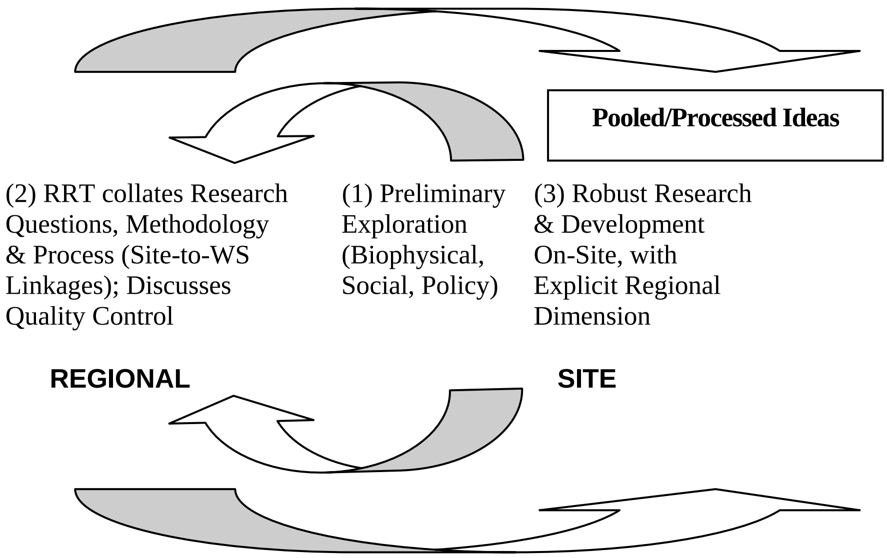

Figure 1. Site- Regional Linkages in AHI

The nature of issues identified in AHI benchmark sites has also enabled a more explicit understanding of watershed "integration" and "participation." While several forms of integration can be identified, the most prominent include: a) managing interactions between and benefits to diverse watershed-level components (trees, water, livestock, crops, soil); and b) a multi-disciplinary (multi-sectoral) approach to integrate biophysical, social, market and policy interventions. Operationalizing "participation" around specific issues allows it to becomes less associated with a particular methodology (i.e. PRA), and more linked to underlying values of equity and empowerment. It therefore assumes multiple meanings, from *local ownership* of the process (from problem identification to planning and implementation) to *collective action* (in terms of widespread motivation and participation, and more negotiation of processes and outcomes) and more *equitable benefits* to diverse user groups.

Results

ENHANCING PARTICIPATION AND INTEGRATION IN WATERSHEDS

Participation" in Watershed Management

"Participation" means different things to different people. All too often, however, it is taken to mean mere turn-out at community fora, undermining true participation in decision-making and benefits. Throughout the diverse stages of watershed management, we have experimented with diverse forms of participation, from equity to representation to negotiation.

Participation in Problem Definition

The political ecology of watershed management suggests that those involved in defining the watershed management approach will have important influence on the definition of objectives and methods. It is therefore important to look at how the questions asked, and the methodologies utilized, influence the outcomes of problem definition in watershed management. In Lushoto benchmark site, Tanzania, the correlation between questions asked and elicited responses was closely tracked (Table 1). The results enable a better understanding of how the formulation of questions influences the definition of problems. They also demonstrate the importance of triangulating research questions for a robust diagnosis of watershed problems.

After seeing the contribution of different types of research questions, all of the questions were integrated into a single interview checklist.

Table 1. Correlation between Questions and Elicited Responses in Lushoto Benchmark Site

Question	Elicited Responses
1. What activities could benefit from collective action?	- SWC, FYM application, banana planting - Maintaining community bull - Community mill construction & operation - Maintenance of roads / community buildings - Managing water sources / irrigation infrastructure
2. How do activities of neighboring farms and villages influence your livelihood?	- Eucalyptus on neighboring plots / boundaries - Neighboring fields harboring rodents/pests/weeds - Stray fire - Failure of neighbors to conserve their plots, drainage - Lack of respect for farm boundaries
3. Are there any natural resource management conflicts?	- Land shortage / boundary encroachment - Free grazing - Theft of crops and village trees - Traditional vs. modern beliefs on NRM - Limited drinking / irrigation water
4. Are there any problems associated with the management of communal property?	- Water shortage (drinking, irrigation) - Water pollution - Fires and theft in village forest - Impact of crops / eucalyptus on water availability

More open-ended interviews conducted during the more formal watershed diagnosis enabled the identification of additional issues affecting the livelihood of some groups. In Ginchi, for example, women mentioned the decline in fuel wood access as a key problem. In recognizing the existing research questions did not effectively elicit this problem, it was decided that an additional question was required, namely, "How have land use and landscape changes over time influenced livelihood?"

Another critical issue are the methods used to identify watershed problems. The community forum is the most popular approach to problem definition due to widespread experience with Participatory Rural Appraisal techniques. However, in recognition of the influence of more outspoken individuals on effective participation, approaches aimed at greater social disaggregation were tested within AHI. Individual interviews and focus group discussions were both utilized. While individual interviews are more advantageous for understanding how perceptions differ within different groups, focus group discussions were found to foster greater rapport and debate over elicited responses. To identify the key watershed problems from the standpoint of diverse social groups, focus group discussions by gender, age and wealth were utilized in several benchmark sites. In other sites where there is a clear patterning of households according to landscape position, landscape location (upslope vs. downslope) was an additional basis for focus group formation. Once the issues were identified, they were compiled into single lists and ranked. For the ranking procedure, individual interviews were utilized to capture inter-group variation in responses. Ranks were compiled into watershed averages, as well as group averages (by gender, wealth, age and landscape position). Results demonstrate the critical importance of socially-disaggregated problem diagnosis (Table 2). Issues reflecting female domains of activity such as domestic water supply receive a much higher rating by women than by men, while issues affecting male rights (i.e. rights to land and irrigation water) and responsibilities (road maintenance) are prioritized more highly by men. Similarly, wealth influences how issues requiring significant resource inputs (labor, capital) are ranked. Finally, landscape position influences the relative access to drinking and irrigation water, and the corresponding ranks for these issues.

Table 2. Socially-Disaggregated Ranks of Selected Watershed Issues

Watershed Issue	**Socially-Disaggregated Ranks**							
	Men	Women	Elder	Youth	High Wealth	Low Wealth	Up Slope	Down-Slope
Water Issues								
Limited access to potable water	15	**2**[a]	-	-	-	-	**1**	15
Insufficient irrigation water in the dry season	**8**	18	-	-	-	-	**8**	13
Individual ownership of springs	16	**6**	-	-	-	-	-	-
Trans-Boundary Issues								
Insufficient respect for farm boundaries	**13**	27	-	-	-	-	-	-
Other Land Management								
Need for group tree nurseries	13	**2**	**<5**	**<5**	**<5**	**<5**	14	**8**
Lack of improved seed	**5.5**	**<5**	**<5**	**<5**	12	**<5**	**<5**	**6.5**
Infrastructure								
Need for cooperation in road maintenance	**3.5**	16	-	-	14.5	**3**	-	-

[a] Lower numbers (in bold font) refer to issues that received high ranks, and are of greater importance.

Participation in problem definition can also be operationalized through the identification of strategic leverage points or 'turn keys' from a social perspective. One way to do this is to identify issues of high importance to most social groups. This can be done by contrasting the ranks given by different social groups to watershed issues falling within each category (as in Table 2) or overall. An example from Lushoto illustrates how trans-boundary issues are ranked by different groups (Table 3). Here, out of all 11 trans-boundary issues identified in the watershed, only 3 or 4 are considered highly by most groups.

Table 3. Top Three Trans-Boundary Issues by Social Group, Lushoto Benchmark Site

	Gender	**Age**		**Location**		
	F	M	Elder	Youth	Up	Down
Theft of others' property	2				3	
Trans-boundary pest & disease effects		**1**[a]	**2**	**2**		**1**
Lack of respect for farm boundaries						3
Stray fire crossing farm boundaries						
Run-off from upslope cultivation	**1**		**1**	**1**	**2**	
Non-respect for communal land boundaries	**3**	**3**				**2**
Shade from boundary trees						
Run-off from upslope Black Wattle trees						
Drying of land from boundary trees (Eucalyptus)		**2**	**3**	**3**	**1**	
Rodents from fallowed land						
Free grazing across boundaries						

[a] Figures in bold font indicate trans-boundary issues of high priority to most groups.

Participation in Planning

Farm-level interventions, while often carried out through group work, are generally negotiated up to the level of the household only and applied to private property. Watershed-level interventions have the potential of enabling technological interventions to work better from both technical and social standpoints, given the strong interactions between neighboring landscape units (farms, individual and private property). The question then becomes how to ensure equity in such negotiated outcomes, in terms of moving from potentially interest-based to more equitable decision-making. Watershed action plans must be negotiated among diverse users with different priorities and levels of influence. When attempting to ensure effective participation in watershed planning, several issues should be taking into consideration: a) the level at which planning is carried out, b) whether to plan for multiple issues simultaneously or around specific issues, and c) how to address social trade-offs in decision-making.

Regarding the level at which planning is carried out, practitioners have a tendency to take the watershed as the appropriate level of diagnosis and planning – compelled both to conform to watershed boundaries and to simplify the "community-project interface" for practical purposes. Yet there are important implications of watershed-level planning and implementation in which representatives of each village come together to take key decisions for the entire area. The first of these is that levels of participation are compromised. Geographical and demographic barriers hinder participation by influencing the effort that must be expended in attending planning sessions and influencing the number of voices that may be heard during group discussions. Equally critical are psychological barriers to participation within larger, less familiar groups, which hinder the participation of less empowered and outspoken groups. One possible solution, watershed planning with community representatives, poses new problems. First, representation in name does not imply representation in practice, as those involved in planning will more often than not plan according to their own priorities and benefits than for those they are supposed to represent. This poses a problem in terms of elite capture of program benefits. Furthermore, unless high-quality feedback mechanisms are put into place, the broader watershed community will have little understanding of decisions taken and therefore little incentive to participate. Several strategies for addressing these constraints are currently under development within AHI.

The first involves decision-making at the watershed level only after watershed units (village or other) elect representatives and establish a plan for more widespread feedback and validation once preliminary decisions have been taken. Yet for this to be effective, performance criteria for elected representatives should be established prior to the identification of individuals due to the tendency for elected representatives to reflect existing power dynamics rather than robust leadership criteria. The second strategy involves greater devolution of decision-making and management within the watershed, moving to higher levels of negotiation only for those issues that demand it.

The second consideration when seeking effective participation in watershed management is whether to develop general watershed action plans, or plan around specific issues. While the former enables an integrated approach to planning, the latter is more suited to an emphasis on stakeholder equity. This involves the identification of stakeholders specific to each issue, followed by multi-stakeholder negotiations at village or watershed level. A stakeholder approach minimizes involvement to only those who have a direct 'stake' in the issue at hand, and lends itself more easily to effective representation – since for any given issue the individuals directly involved in negotiation will hold views that approximate those of their constituents. It is also preferable in terms of the depth of planning, given that a single issue is addressed at a time and the nuances of different perspectives made central to analysis and planning. Stakeholders can be defined in a number of ways – according to the issue at hand (Table 4), or specific sub-components of these issues that define more specific stakes (see tree niche example, Table 5).

Table 4. Stakeholders of Specific Issues

Issue	Stakeholders
Input quality	Stockists, farmers (by wealth[a]), suppliers
Water	Those implicated (owners of springs, tree lots), those most affected (irrigating farmers, women)
Poor governance	Local leaders, diverse local constituents (relatives of local leaders vs. others), district

[a] Farmers with different resource endowments will rely on different types of inputs, requiring that these divergent 'stakes' be made explicit.

Table 5. Niche-Specific Stakeholders, Lushoto District, TZ

Niche	Stakeholders
Farm boundaries	Owners of boundary trees, neighboring farmers, missions, churches
Forest buffer zone	Farmers in buffer zone, Ministry of Natural Resources and Tourism
Watering points	Individual landowners, water users
Within farmland	Individual household members (by gender, age)

A final consideration for enabling effective participation is how to anticipate and manage the benefits and costs of interventions to diverse groups. Only by acknowledging such social trade-offs during the planning phase can solutions – and the benefits derived from them – be negotiated by different user groups. Without explicit acknowledgement of such differential impacts and the development of strategies to manage processes and benefits more equitably, collective action will occur at the expense of equity rather than as a means to further it (Ramírez and Berdegué, 2003). An example from Ethiopia helps to illustrate this better. During the watershed exploration exercise, researchers identified conflict among neighboring villages due to limited water resources. Villages with more water were being visited by farmers and livestock from neighboring villages. Paths through the farms and villages were being blocked as a manifestation of resistance to water sharing. As we work to develop watering points in the watershed and water quantity and quality are positively affected, neighboring villages are likely to want access to these water resources. A solution may, therefore, be the source of a future problem (in this case, water resource conflicts), a problem that can be anticipated from what is known about the current situation. We are currently developing strategies for facilitating communities to consider such potentialities up front, and to develop an approach for managing watering points once "developed". This might include negotiation with neighboring communities to develop structures and rules of governance for the resource given anticipated demands on the resource in the near and distant future, and strategies for periodic re-negotiation of these strategies under changing circumstances.

To better target such efforts at negotiated planning, it is important to consider the conditions under which collective action, negotiation and/or formal by-laws (as opposed to a more individualized approach) are needed to enable improved NRM and equity. Thus far within AHI, three conditions have been encountered thus far which would require negotiation in planning to ensure effective participation:

- Negotiation of any program benefits,
- Negotiation of solutions where interventions may have an overly negative impact on certain groups, and
- Negotiation of rights and responsibilities where the intervention is likely to cause conflict through increased demand over the resource.

Participation in Implementation

Fostering effective participation during implementation can be seen in terms of greater numbers of participants, or in terms of negotiation of rights and responsibilities among diverse groups. For the first of these, collective action is seen as a vehicle for greater access to program benefits due to higher numbers of participants. Yet as mentioned above, collective action can be achieved through both voluntary and authoritarian means and either further or reduce existing inequities (Ramírez and Berdegué, 2003). It is therefore critical that collective action be seen as a conceptual framework for enabling equitable stakeholder involvement in implementation processes. For this, a system for ensuring that rules of governance established during the planning stage are implemented in practice. It is also important to consider that rules established at the outset are 'best bet' approaches, and not yet tested in practice. As such, overly rigid adherence to established rules can be as detrimental to program success and effective participation as non-adherence to rules (Kloppenburg, 1983; Nemarundwe and Kozanayi, 2003). A flexible yet accountable system of governance can be best achieved through an iterative social learning process. This, in turn, requires a participatory monitoring and evaluation system that encourages active reflection on the implementation process (action learning).

In recognition that not all ramifications of watershed interventions will be anticipated, an effective monitoring and evaluation (M&E) strategy is needed to capture trends in benefits capture and other social impacts as they emerge. Without such monitoring systems in place that make the distribution of benefits and social impacts explicit, it is likely that current interventions will become problems for certain social groups and further existing inequities. Continuous monitoring also enables continuous (re-)planning, a prerequisite to adaptive management in that realities encountered during implementation do not always reflect 'best approaches' as prescribed early on in the planning process and therefore require continuous adaptation of approaches (Chevalier, 2004; Holling and Meffe, 1996). This enables the learning from participatory monitoring (performance of key indicators, unexpected challenges encountered) to be integrated into improved actions.

Figure 1. M&E with non-participating farmers

While an optimal strategy for monitoring the impacts of interventions on diverse system components and social or stakeholder groups has yet to be determined in the context of AHI, it isclear that both rigor (in the sense of capturing diverse views) and efficiency must be considered. The trade-offs of external and participatory monitoring should be weighed in terms of the ability of each to capture nuances and political dynamics within a community, and the need to minimize time investments of farmers and outside actors. While socially-disaggregated monitoring could be taxing for facilitators and other participants, it may prove to be the only means to ensure effective "participation" (i.e. capturing negative impacts on less outspoken or more vulnerable groups) in societies governed by hierarchical decision-making processes (Figure 1). Ultimately, such outside control over who has a voice and who benefits should give way to a more vibrant civil society in which more marginalized groups can voice their own concerns.

M&E with non-participating farmers is necessary to capture local dynamics which influence the distribution of benefits. During informal M&E, these women noted that they are not participating in a project income generating activity 'because they were not invited.'

Integration in Watershed Management

Similar to participation, "integration" means different things to different people. Within AHI alone, several forms of integration are required. First, integration means managing benefits to diverse watershed-level components, including tree, water, livestock, crop and soil components. This is required so that gains to one particular component (i.e. timber yield) do not have an overly negative impact on other components (i.e. water resources) – or on users depending on the viability of this other component for their livelihood. Integration also means integrating diverse solutions through a multi-disciplinary or multi-sectoral approach. This form of integration is required not only given the "systems" thinking in a biophysical sense, but to support technical solutions with social, policy and market interventions (Figure 2). A third form of integration can be seen in the need to manage interactions among diverse tenure systems, so that investment in individual and private "goods" can be balanced with investment in common and public goods. This last form of integration can be aided by collective action theory, which seeks a better understanding of the conditions required to enable greater investment in common property resources and public goods (Meinzen-Dick et al., 2002; Ostrom, 1990; Pandey and Yadama, 1990; Wittapayak and Dearden, 1999). Since this last form of integration can be treated in unison with the first, given that system "components" can be defined in biophysical or legal (tenure) terms.

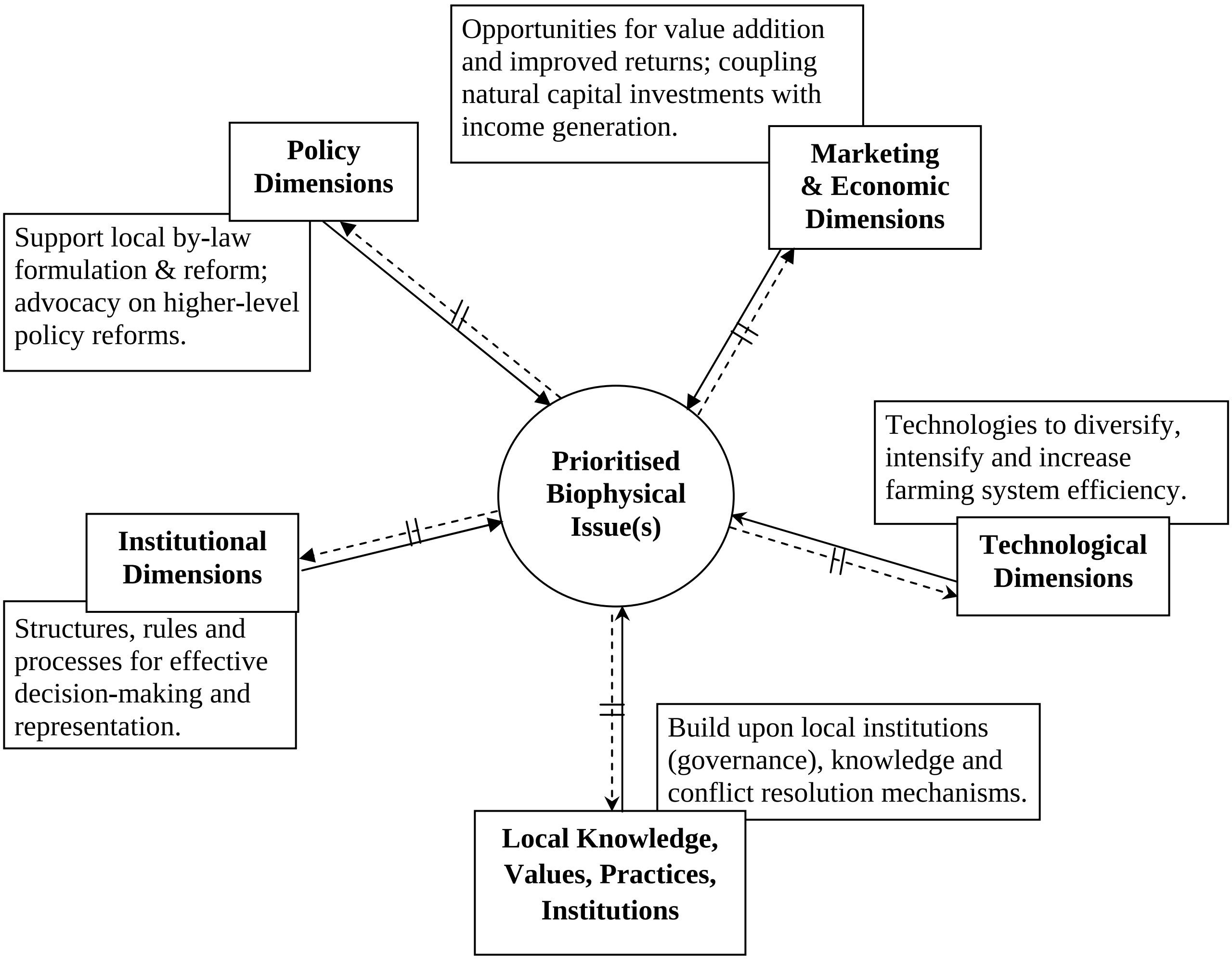

Figure 2. Multi-Disciplinary and Multi-Sectoral Integration in Watershed Management

Key:
- -|⊢> = Bottleneck
- ⟶ = Opportunity

Integration in Problem Definition

During problem definition, integration can be achieved through a fully interdisciplinary exploration of watershed problems (including biophysical, social, policy and market dimensions) and through a systems analysis of component linkages. Research questions guiding problem and opportunity identification in AHI benchmark sites are illustrated in Table 6. These questions are not meant as a template for watershed exploration in other sites, given that biophysical dimensions are given more systematic treatment than other areas. It nevertheless illustrates a certain degree of interdisciplinarity in problem identification.

The second step, systems analysis of component linkages, can be carried out once key watershed problems have been identified and prioritized. In each AHI benchmark site, a list of biophysical issues was generated from the above research questions through socially-disaggregated problem diagnosis, grouping of like issues, and socially-disaggregated ranking of issues as described above. In addition to identifying issues of high importance to most social groups, discrete issues were grouped according to the presence of strong functional interactions among them (German et al., 2003a). The idea behind this was to identify clusters of issues that could be addressed simultaneously, so as to foster positive synergies among them and multiple returns (i.e. water, food, fodder and fuel) (Ibid).

Table 6. Regional Research Questions for Watershed Exploration in AHI (German et al., 2003b)

Primary Research Questions	Secondary Research Questions
Primary Biophysical Research Question: What are the key NRM problems, from the community's perspective, requiring a watershed approach or collective action?	• How have changes in the landscape and land use over time influenced livelihood? • Do on-farm management practices of your neighbors' have any influence on your livelihood? How about the management of resources by neighboring communities? • Are there any NRM problems that could benefit from collective action? • Are there any problems associated with the management of communal resources? • Are there any conflicts associated land or NR management (within or between villages)? • How do different groups (by gender, age, wealth or landscape position) prioritize these issues?
Primary Social/Policy/Market Question: What are the key opportunities (social capital, policy mechanisms) and constraints (social & policy barriers) for enabling collective action in the watershed?	• What local social units (internal) and institutions (external) exist in the watershed? What are their characteristics (history, objectives, strengths & weaknesses, tendency to cooperate with other groups, decision-making processes and importance to diverse social actors)? • Are there traditional practices or beliefs influencing NRM? • Are there any NRM conflicts? Are there any traditional mechanisms for conflict resolution & decision-making? • Who are the influential individuals in the communities? How effective are they in community mobilization? • What brings people together for cooperation? Is there anything that keeps people from cooperating? • How do local, district or national policies influence land management & use of communal resources? Do any of these policies influence collective action? • What strengths & limitations exist for by-law enforcement? • Are there any coping strategies for finding a better outlet for agricultural produce?

Integration in Planning

Integration in planning can be addressed from the standpoint of both component integration and disciplinary or sectoral integration. For the first of these, higher-level system goals should be specified for each cluster in order to avoid disintegration during planning. An example from Ginchi Benchmark Site in Western Shewa Zone, Ethiopia, can help to illustrate the point (Getachew et al., 2004). In Ginchi, two system clusters were identified by identifying strong functional linkages among discrete watershed problems:

Soil and Water Conservation and Utilization (SWCU) Cluster

- Poor water quality
- Water shortage for livestock and humans
- Loss of seed, soil and fertilizer from excess run-off
- Crop failure due to drought
- Loss of indigenous tree species

Integrated Production and Nutrient Management (IPNM) Cluster

- Feed shortage
- Wood shortage
- Soil fertility decline
- Loss of indigenous tree species
- Lack of income-generating opportunities

System-level objectives were then established not for discrete problems, but for the cluster as a whole:

Overall SWCU Cluster Objective: To enhance the positive synergies between water, soil and tree management in micro-catchments.

Overall IPNM Cluster Objective: To improve farmer incomes and system productivity (crops, livestock, trees) while ensuring sustainable nutrient management in the system.

Finally, when the watershed management program integrates research and development, higher-order research questions can be established toward which each component contribution is ultimately linked:

Primary Research Question, SWCU Cluster: How can NRM practices (SWC structures, tree planting, drainage systems, etc.) enhance agricultural production / productivity through decreased erosion while also enhancing spring recharge long-term?

Primary Research Question, IPNM Cluster: How can income be improved through increased agricultural production / productivity (crop, livestock, tree and nutrient management) and marketing while also enhancing system nutrient stocks?

Following the identification of higher-level system goals, component contributions to this integrated objective should be clearly identified. This is because conventional practice is to enhance the performance of a single component rather than the system at large (Table 7).

Table 7. Re-Defining Research and Development Objectives for Greater Component Integration

Component	Conventional Objective	Integrated Objective
Soil	Soil fertility and stabilization	To optimize soil quality, soil stability, water quality, and the production of food, feed & timber
Agroforestry	Maximize the production of tree products	To optimize the yield of tree products, crop yield, soil quality and water discharge
Crop	Maximize the yield of edible plant parts	To maximize the yield of edible plant parts and crop residues (for soil fertility and feed) without compromising soil fertility
Livestock	To maximize the production of edible and marketable livestock products (milk, meat, eggs, hides).	To optimize the production of livestock products (including dung) while maintaining or increasing soil fertility

Component contributions to system objectives for the Soil and Water Conservation and Utilization Cluster at Ginchi are illustrated graphically in Figure 3 (Getachew et al., 2004). It is clear from this diagram that in addition to contributing to their own component-specific objectives, activities falling within each cluster must aim to achieve system-wide benefits where possible.

While not immediately obvious, such strategies acknowledge the component interactions and trade-offs characterizing watersheds. The aim of such integration would be to avoid negative interactions (where maximizing one system objective hinders another) and to foster positive synergies among system components. An example of such component trade-offs is illustrated in a tree niche analysis conducted in two of AHI's benchmark sites (BMS). Key informants knowledgeable about the properties of indigenous and exotic tree species were asked to identify key species and species characteristics making them compatible with different landscape niches. Negative impacts of trees identified in each of the two sites are compiled in Table 8, where trade-offs between gains to forest and other components (soil, crops, water) are clear.

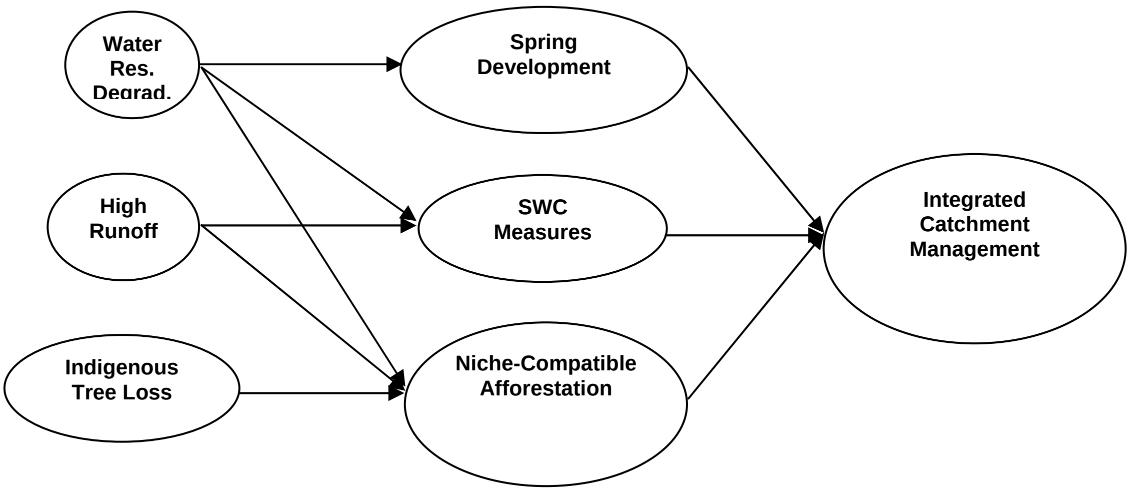

Figure 3. Articulating Component Interactions in Galessa Watershed, Ethiopia

Table 8. Perceived Negative Impacts of Trees in Two AHI Benchmark Sites

Lushoto BMS, Tanzania	**Lushoto BMS, Tanzania**
Arrests undergrowth	Is bad for crops
Creates large shady area	Dries springs
Has aggressive root system	Is bad for soil
Leaves bad for crops, soil	
Heavy feeder on groundwater	
Out-competes other tree species	
Dries valley bottoms	

Similar to efforts at achieving effective participation in watershed management, it is useful to consider the conditions under which system interactions and trade-offs should be addressed during the planning stages to enable optimal (system-wide) benefits. Thus far within AHI, two such conditions have been encountered:

- Where the intervention in any given component is likely to have a negative impact on other system components (water, livestock, crop yield, soil fertility), or
- Where integrated planning is likely to enhance positive synergies among components (multiple system benefits).

In terms of achieving sectoral or disciplinary integration during planning, two considerations have come to light within AHI. First, unless 'other' dimensions of the problem are made explicit during planning, biophysical interventions will take precedence. For each major intervention, it is therefore critical to cross-check identified solutions by considering whether diverse dimensions (technical, social, policy, market) have been considered. An example from Ginchi and Lushoto benchmark sites (Table 9) illustrates how doing so ensures that complementary dimensions of watershed management are brought on board.

Table 9. Integration of Technological, Social and Policy Dimensions of Niche-Compatible Afforestation

Technological Dimensions Dimensions	Social and Policy Dimensions	Economic
Niche adaptation trials	Rules on nursery management (benefits, responsibilities, sanctions)	Identification of alternative high value trees to aid in trees to aid in negotiations
Tree nurseries	Negotiation of niche-compatible afforestation (regulations on species' location or density)	

Ensuring that strategies falling within each dimension are considered will help to address the second consideration, which is how to identify and enable positive synergies among diverse types of solutions. Three types of such synergies have been identified thus far within AHI. These are illustrated in Table 10, along with examples of each.

Table 10. Types of Synergies among Diverse Types of Interventions

Nature of the Synergy	Examples
Disciplinary / sectoral synergies (social, policy, technological)	Niche-compatible afforestation, as in Table 9
Income-natural resource management synergies	Introducing high-value crops with soil fertility management practices and conservation structures
Short- and long-term solutions	Spring rehabilitation with an integrated catchment management approach

Integration in Implementation

While a number of strategies have been developed and are undergoing implementation in AHI benchmark sites, lessons on the relative success of different approaches – or of similar approaches sequenced differently – have yet to emerge. Nevertheless, it is possible to identify strategies being targeted to ensure biophysical and multidisciplinary integration during early stages of implementation.

To achieve integration of landscape-level components, there are several implementation options for any given problems. While the diagram in Figure 3 would appear to suggest an implementation pathway, there are two clear possibilities for operationalizing this form of integration. First, teams of scientists and practitioners can work on individual components (spring development, SWC practices and niche-compatible afforestation) independently, yet ensure the work addresses system goals, as defined in the overall cluster objective. The pitfall of taking this option is that existing interdisciplinary biases will tend to disintegrate the approach into component-specific approaches unless mechanisms are taken to ensure accountability to the system goal. This can include the integration of relevant disciplinary expertise on teams working on each component, so that hydrologists, soil scientists and foresters (in addition to social scientists and community facilitators) jointly work on niche-compatible afforestation for example. Other mechanisms include assigning a Cluster Leader to oversee implementation and adherence of each component to the higher-level system objective, and detailed interdisciplinary planning in which the actions to be taken in the name of integration are made clear to and debated by all team members.

The second option to ensure component integration is to implement each of the component activities through a single set of activities, for example by focusing activities on “Integrated Catchment Management” rather than individual components as in Figure 3. Within AHI, this approach has been planned in two ways that differ in terms of sequencing of activities. The first entails spring development to enhance enthusiasm about project activities, followed by integrated afforestation and soil and water conservation activities in different landscape units (Ginchi Site Team, 2004). One assumption inherent in this approach is that if spring development – as the most immediate solution to a highly-prioritized issue – is used as an entry point, outcomes of future R&D investments will be greater due to increased community trust and enthusiasm (Ibid). The second approach, planned for implementation in Lushoto Benchmark Site, does not assume this and rather ensures that the high-priority entry point is used as a stimulus for more integrated and long-term catchment planning among watershed residents (Mowo, personal communication) (Box 1). The difference between these two approaches lies in the sequencing of activities, and in the expected impact this will have on community willingness to invest not only in short-term solutions (spring development) but in long-term natural resource management investments (niche-compatible afforestation, SWC structures, etc.).

BOX 1. Facilitation Plan for Integrated Catchment Management – Lushoto BMS

a) Awareness creation through feedback of watershed findings, in particular the complex linkages between hillside erosion and valley bottom fertility, hillside management (physical structures & vegetation) and spring discharge, and existing problems (increased erosion due to iron sheet roofing) and possible solutions (water capture to enhance availability to domestic water).
b) Establish an integrated catchment management competition by offering integrated services (technical assistance and materials for water reservoirs, technical assistance on soil and water conservation and niche-compatible afforestation; organizational and by-law support) in exchange for high-quality negotiated action plans and social mobilization at micro-catchment level.
c) Micro-catchment interventions in select catchments (up to 3) to further develop and implement action plans. Findings and lessons from prior and current working groups (linked technologies, tree niche analysis, spring management) will be fed into the integrated catchment management approach to enhance impact.
d) Impact studies to document the impacts of the above methodology in relation to other approaches being utilized (including technology dissemination approaches targeting individual farmers and isolated approaches to spring management).

In addition to considering the level at which integration is operationalized (at the level of objectives and research questions, as in the first example, or of activities as in the second), it is important to include a monitoring and evaluation system that seeks to ensure integration through periodic re-assessment. For the purposes of component integration, monitoring must assess the impacts of activities on diverse system components. Therefore, whether monitoring is carried out by component (niche-compatible afforestation, SWC structures or spring development) or by system (integrated catchment management), monitoring must address the impact of *activities* on *diverse components* (water, livestock, crop yield, soil fertility). To operationalize this, it is important to: a) consider all *potential* interactions between the activity conducted and different components, and b) to identify priority indicators from scientific and/or local perspectives that will be monitored for each. Examples of potential effects and indicators for afforestation activities have been developed with farmers from Lushoto and Ginchi benchmark sites, and are presented in combined form in Table 11.

In terms of multidisciplinary integration, it became clear during early stages of implementation that monitoring and evaluation of all program activities will benefit from interdisciplinary dialogue. In a recent case, it was found that quality control was being determined in purely technological terms due to the strong biophysical basis of site team expertise, in effect marginalizing social and policy dimensions despite joint planning on these issues. Two lessons can be derived from this experience. First, it is important that interdisciplinary planning be done *in detail,* down to the level of activities and the approach to be used to carry them out. Second, interdisciplinary planning should specify the sequencing of activities, so that principles specific to each discipline or sector are well integrated into the sequencing of technological and other interventions. In social terms, how to motivate and mobilize the community in terms of balancing short- with long-term benefits, and farmer investments with project inputs (as in the spring development example), becomes critical.

Table 11. System Interactions and Indicators for Niche-Compatible Afforestation in Lushoto, Tanzania and Galessa, Ethiopia (adapted from German et al., 2004)

Potential Interactions	Indicators
Crops – competition or compatibility (nutrients, water, sunlight, allelopathy)	Does not arrest undergrowth; leaves have neutral or positive effect on crop growth; can be pruned to reduce shade; canopy holds onto rain and releases it slowly; does not extract too much water from soil
Soil – nutrient interactions; erosivity	Does not hinder infiltration or enhance run-off; has a neutral or beneficial effect on soil fertility; leaves decompose easily
Springs – water quantity; taste	Tree does not change the taste of water; has a neutral or positive effect on spring discharge; has a shallow root system
Livestock – provision of feed; effect on grazing land	Makes good feed for livestock; has neutral or positive effect on crop growth (crop residues used as feed); serves as shade for livestock; seedlings survive browsing after 2 years (for grazing areas)
Trees – competition or compatibility (nutrients, water, sunlight, allelopathy)	Does not inhibit the growth of other trees.

In economic terms, market opportunities should be identified prior to the selection of the agro-enterprises or crop varieties to be field-tested to counter the supply-driven emphasis of smallholder farming systems (Ostertag Gálvez, 1999). Finally, and most important during the implementation phase, both intermediate planning (required to adjust action plans to field realities) and monitoring and evaluation (of all activities, independent of their disciplinary or component focus) should be done by multidisciplinary teams at project level and by multiple local stakeholders. This “constructivist” form of planning and evaluation, in which multiple views are consulted and negotiated, is one of the fundamental principles of social learning and adaptive management (Chevalier, 2004).

Finally, several insights may be drawn from the challenges faced in staying integrated during the implementation stage. First, integration is a continual challenge, given the role of disciplinary biases in favoring certain viewpoints and approaches, and the institutionalization of disintegration (in university training, the division of departments and programs, peer review, etc.). AHI is testing a number of approaches for ensuring ongoing integration: a) mutual capacity-building to reach a common understanding of the goal; b) team and cluster management to ensure that each component keeps the primary objective and research question in mind during the implementation phase; and c) regularly scheduled meetings at program and community levels to share experiences, evaluate and re-plan.

Conclusion

Participatory, integrated watershed management presents many challenges to research and development actors. The first is the need to manage a complex, ambitious agenda in which diverse types of trade-offs and synergies must be identified and managed. The second lies in the gap between current institutional arrangements, which foster disciplinary planning and action and isolate research from development (Hammersley, 2004), and those required to operationalize integrated planning and action, research and development. A third challenge lies in the bias of research toward more formalized, empirical methods over action research approaches. A fourth challenge lies in staying integrated when moving from systems thinking to systems action.

This paper fills an important gap in the watershed management literature by illustrating how key principles (participation, integration) can be operationalized in practice. By taking a step-by-step look at diverse stages of watershed planning and implementation, the paper illustrates key challenges faced and principles to be applied when trying to enable widespread participation and landscape-level integration. Approaches developed thus far for integrated and participatory diagnosis, planning and implementation are outlined, citing specific examples that will enable other R&D actors to learn from AHI's experience.

While significant progress has been made in operationalizing a particular form of watershed management (integrated, small-scale, and driven by endogenous motives for change), much remains to be done for scaling up the approach and seeing it translate into concrete benefits for watershed residents. One of the key challenges lies in the formulation of appropriate institutional arrangements for more widespread application, given the isolation of different disciplines – and of research from development – within existing institutions. To move forward here, it is important to take a systematic look at the tasks and skill base required to operationalize PIWM, and the degree to which existing institutions can be mobilized to fill the gap. Funding for action research and social learning approaches to test new types of institutional arrangements and linkages (partnerships) can be a starting point from which broader experiences are drawn and strategies formulated. Another key challenge lies in forging stronger linkages between research and development, so that development (community or organizational facilitation) is linked to and given at least equal status as research, and action research given equal weighting as more conventional empirical research. For this, the nature of university training, institutional mandates and incentive systems, and opportunities for social learning at local and institutional levels must be given close consideration with respect to the integrated mandate embodied in PIWM.

References

Agarwal, A. and C.C. Gibson, 1999. Enchantment and Disenchantment: The Role of Community in Natural Resource Conservation. *World Development* 27(4):629-649.

Bellamy, J.A., G.T. McDonald and G.J. Syme, 1998. Evaluating Integrated Resource Management. *Society & Natural Resources* 12:337-353.

Chambers, D.E., K.R. Wedel and M.K. Rodwell, 1992. Qualitative Research Methods and the Constructivist Paradigm in the Evaluation of Social Programs and Policies. In D.E. Chambers et.al. (eds.), *Evaluating Social Programs*, pp. 288-332. Boston: Allyn & Bacon.

Chevalier, J.M. 2004. The Social Analysis System. Url: www.sas-pm.com/.

Eren, T. 1977. The Integrated Watershed Approach for Development Project Formulation. In *Guidelines for Watershed Management*, FAO, pp. 9-14.

FAO, 2000. Land-Water Linkages in Rural Watersheds: Introductory Note for the FAO e-Workshop. Land-Water Linkages in Rural Watersheds Electronic Workshop, 18-27 October, 2000. Rome: FAO.

German, L. 2003. Beyond the Farm: A New Look at Livelihood Constraints in the Highlands of Eastern Africa. *AHI Brief* A2.

German, L., Berhane K. and R. Shemdoe, 2004. Social and Environmental Trade-Offs in Agroforestry: Integrating Knowledge Domains to Enhance 'Win-Win' Scenarios in the Highlands of Eastern Africa. Paper presented at *Ethnobiology, Social Change and Displacement*, The 9th International Congress of Ethnobiology, Kent, UK, 13-17 June, 2004.

German, L. and A. Stroud, 2003a. Creating an Integrated Research Agenda from Prioritized Watershed Issues. *AHI Technical Notes Series* B5.

German, L., A. Stroud, T. Amede, C. Opondo and J. Mowo, 2003b. A Framework for Strengthening Site-Regional Research Linkages. *AHI Technical Notes Series* A1.

Getachew A., Yohannes G., Berhanu B., Berhane K., L. German, Dagnachew B., Gebremedhin W., Mesfin H., Tesema T., Agajie T. and A. Stroud, 2004. Methods being Used to Move from Identified Watershed Problems to Action at Galessa Watershed: The Research Perspective. Poster presented at the conference, "Integrated Natural Resource Management in Practice," 12-15 October, 2004, ICRAF Headquarters, Nairobi.

Ginchi Site Team, 2004. *Site Team Watershed Action Plan 2004-2005*. Technical Report, Holetta Agricultural Research Centre, May 2004.

Hammersley, M. 2004. Action Research: A Contradiction in Terms? *Oxford Review of Education* 30(2):165-181.

Hinchcliffe, F., I. Guijt, J.N. Pretty and P. Shah, 1995. New Horizons: The Economic, Social and Environmental Impacts of Participatory Watershed Development. *IIED Gatekeeper Series* 50:3-20.

Holling, C.S. and G.K. Meffe, 1996. Command-and-Control and the Pathology of Natural Resource Management. *Conservation Biology* 10(2):328-337.

International Institute for Environment and Development (IIED), 2004. Developing Markets for Watershed Protection Services and Improved Livelihoods. Report of the Implementation Phase Planning Workshop, January 28-30, 2004. London: IIED.

Kloppenburg, J.R. 1983. Group Development in Botswana: The Principles of Collective Farmer Action. *Research in Economic Anthropology* 5:311-333.

Leftwich, A. 1994. Governance, the State and the Politics of Development. *Development and Change* 25:363-386.

Meinzen-Dick, R., A. Knox, F. Place and B. Swallow, 2002. *Innovation in Natural Resource Management: The Role of Property Rights and Collective Action in Developing Countries*. Washington, D.C.: IFPRI.

Nemarundwe, N. and W. Kozanayi, 2003. Institutional Arrangements for Water Resource Use: A Case Study from Southern Zimbabwe. *Journal of Southern African Studies* 29(1):193-206.

Ostertag Gálvez, C. F. 1999. Identifying and Assessing Market Opportunities for Small Rural Producers. *Tools for Decision-Making in Natural Resource Management* No. 7. Cali, Colombia: CIAT, 173 pp.

Ostrom, E. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action*. Cambridge, UK: Cambridge University Press.

Pandey, S. and G.N. Yadama, 1990. Conditions for Local Level Community Forestry Action: A Theoretical Explanation. *Mountain Research and Development* 10(1):88-95.

Postel, S. 1997. *Last Oasis: Facing Water Scarcity.* New York, N.Y.: W. W. Norton and Company.

Postel, S.L., G.C. Daily and P.R. Ehrlich, 1996. Human Appropriation of Renewable Fresh Water. *Science* 271:785.

Gleick, P. H. 2000. *The World's Water: 2000-2001*. Washington, D.C.: Island Press.

Ramírez, E. and J. Berdegué, 2003. Collective Action to Improve Rural Living Conditions. Santiago, Chile: Fondo Mink'a de Chorlaví.

Reddy, V.R. 2000. Sustainable Watershed Management Institutional Approach. *Economic and Political Weekly* (September, 2000):3435-3444.

Rhoades, R. 2000. The Participatory Multipurpose Watershed Project: Nature's Salvation or Schumacher's Nightmare? In *Integrated Watershed Management in the Global Ecosystem*, Rattan Lal (ed.). London: CRC Press, pp. 327-343.

Rodwell, M. K. and D. Woody III, 1994. Constructivist evaluation: The policy/practice context. In Sherman, E. and W. Reid (eds.), *Qualitative Research in Social Work*. New York: Columbia University Press, pp. 315-327.

Shah, A. 1998. Watershed Development Programmes in India: Emerging Issues for Environment-Development Perspectives. *Economic and Political Weekly* (June, 1998):A-66-A-79.

Turton, C. and J. Farrington, 1998. Enhancing Rural Livelihoods through Participatory Watershed Development in India. *ODI Natural Resource Perspectives* 34:1-4.

United Nations Commission on Environment and Development (UNCED), 1992. *Agenda 21: Programme of Action for Sustainable Development.* New York: The United Nations.

Wilkie, D.S., E. Hakizumwami, N. Gami and B. Difara, 2001. Beyond Boundaries: Regional Overview of Trans-Boundary Natural Resource Management in Central Africa. In Biodiversity Support Program, *Beyond Boundaries: Trans-Boundary Natural Resource Management in Central Africa*. Washington, DC: Biodiversity Support Program.

Wittayapak, C. and P. Dearden, 1999. Decision-Making Arrangements in Community-Based Watershed Management in Northern Thailand. *Society & Natural Resources* 12:673-691.

The Baga Watershed Characterization: A Step for Scaling Out Technologies

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Abstract

This study aimed at recording social and biophysical characteristics of a watershed in the East Usambara Mountains of Tanzania, which would be used in a participatory mode to identify relevant options for natural resources management. The methodology was developed to gather the data necessary to target options relevant for degradation hot spots and different wealth groups. Semi-structured interviews, community meetings and informal discussions were used to collect data from farmers. A total of 300 farmers randomly selected were interviewed using standardized questionnaires which mostly contained closed questions. In addition, key informant interviews and physical mapping using geographical information system were done to delineate physical boundaries of different villages and map physical features such as rivers and environmental hot spots. Data from standardized questionnaires were analyzed using descriptive statistics. Results show that lack of capital, small landholdings, limited enforcement and effectiveness of by-laws, and market instability are key socio-economic problems. Biophysical bottlenecks include low yields per unit area due to low soil fertility, pests and diseases, and the drying of water sources. It is concluded that for successful natural resources management in the watershed, a holistic approach where social and biophysical consideration take equal proportions is the prerequisite.

Introduction

Inadequate natural resources management in Lushoto district, Tanzania, is threatening the productivity of crops and livestock, hence affecting tremendously peoples' livelihoods. The rate of natural resources exploitation is by far surpassing supply potential. The consequences have been soil degradation (Reinhard, W. 1987; Kaswamila and Mkavidanda, 1997), rampant clearing of natural forest and shrub cover (Kaoneka, 1993; Kaoneka *et al.,* 2000), degradation of water sources and inadequate water availability for both domestic and irrigation use. Low soil productivity is evident whereby yields for the staple food, maize, stands at 0.5 t/ha, while milk production from the diary cows is between 0.5 and 1.5 litres per milking time per animal (Shelukindo, 1992). Degradation of soils is evident in different forms such as sheet, rills and gullies (NEMC, 1995). Wickama and Mowo (2001) and Meliyo *et al.* (2001) reported nutrient deficiencies for macronutrients such as phosphorus and nitrogen. The ultimate end has been frequent food shortages and deepening poverty among residents of the area.

Background

SITE DESCRIPTION

The Usambara Mountains are located in the northeastern part of Tanzania and extend over three districts (Lushoto, Korogwe and Muheza) in Tanga region. They form part of the East African "Eastern Arc" series of mountains that are rich in biodiversity of a tropical afro-montane forest (Griffiths, 1993; Lovett 1996). The Usambara mountains derive their name from being rich in bananas. They are famous worldwide because they are among the world's tropical rain forests with a rich biodiversity, and unique plant species (Masayanika, 1995). These mountains are the watershed for five rivers, which are Pangani, Rwegera and Umba in the West Usambaras and Sigi and Mkulumuzi in the East Usambaras. These rivers provide water for domestic use and hydroelectric power. The Usambara mountains are composed of the ancient crystalline rocks, part of the Precambrian Mozambique belt composed of highly metamorphosed sediments and minor intrusive igneous bodies (Griffiths, 1993; Lovett 1996) which originated by block faulting over a long period of time resulting in metamorphic rocks of gneiss type. Most of the West Usambaras contain highly weathered tropical soils mostly red soils such as Acrisols, Ferralsols and Luvisols (Meliyo *et al.,* 2001).

Climate, geology and soils

The climate in the watershed resembles the West Usambara Mountains' wetter side characterized as oceanic with a bimodal rainfall pattern greatly influenced by proximity to the Indian Ocean's closeness to the equator, less than 5^o south (Hamilton, 1989; Poc's, 1976). Rainfall peak is in November and April with mean annual rainfall more 1200. Temperatures are cool. The geology in the watershed also resembles Usambara Mountains which are composed of the late Pre-Cambrian rocks of the Usagaran System; metamorphic rocks of gneiss type. Distribution of soils in the watershed follows the catenary's concept whereby the soils' physical and chemical properties relate to the position on respective landscape. The major soil type in hilltops is *Humic Acrisols with rudic phase* (FAO-UNESCO 1998). The soils are mostly covered by natural forests and woodlots of exotic tree species. The constraints are steep slopes, shallow and rocky/gravely soils, poor water holding capacity and poor fertility (Meliyo *et al*., 2001). Soils classified as *Acrisols, Lixisols and Luvisols* are major soils found in the multifaceted slope land units of the watershed. The soils are deep to very deep, well-drained, reddish sandy clays and gravely at deeper horizons. They have a pH of <5.5. *Fluvisols* and *Gleysols* are major soils found in the valley bottoms. The soils are very deep, slightly well drained, stratified, sometimes poorly drained, dark reddish brown, to greenish grey, silt to sandy loam and a massive structure.

Agriculture is the main economic activity in the Usambaras, Baga watershed inclusive. The mountains are the source of food stuffs such as vegetables (cabbage, tomato, sweet pepper) different fruits, cereals and legumes crops for markets such as Dar es Salaam, Tanga and district towns in Mombo, Korogwe and Muheza. The Usambaras and the Baga Watershed are also famous for cash crops such as coffee and tea which are not only cash earners in the district but also to the country as whole. Other economic activities include utilization of forest resources such as logging and lumbering, trading on consumer goods and a bit of cultural and eco-tourism.

Due to the nature of the topography and population pressure, the West Usambara mountains and Baga Watershed are experiencing tremendous degradation of the natural resource base (Kaswamila and Mkavidanda, 1997, Kaoneka, 1993; Lyamchai *at al.,* 1998; Wickama and Mowo, 2001). There is evidence of soil erosion, reduced river flows and even drying out of rivers, reduced soil productivity (NEMC, 1995) and increasing tendencies of warm weather and unreliable rainfall. The consequences of natural resources degradation have been declined agricultural production for example staple food maize yields stands at 0.5 t/ha (Shelukindo,1992), shortage of water and forest products. There have been trends of increased food insecurity and poverty which threaten not only the residents of the Usambaras but also people from nearby towns who utilize water, food and forest resources from the Usambara watersheds. Despite the ecological destruction, there is little quantitative and even reliable qualitative information available on natural resources degradation and its impact on social and biophysical environment (NEMC, 1995). The perception of communities living in different landscapes of the mountains is still unknown.

AHI started with a pilot site at the Kwalei village catchments where together with farmers and other stakeholders, factors constraining production were identified and options to tackle them tested. After 3 years farmers had selected the best bets and the network has now expanded to 5 more villages bordering Kwalei in the Baga Watershed. The Baga watershed defined in both geographical and social terms forms a true representation of the West Usambara in topography and ecological setting.

This study was designed to collect baseline data on social and biophysical characteristics in the Baga Watershed that will enable formulation of successful strategies that will make effective stakeholders' involvement, and enable impact assessment of the AHI interventions in future.

Methodology

DESCRIPTION OF THE STUDY AREA

Baga watershed is located between two small towns of Soni to the West and Bumbuli to the East. The study area is presented in Figure 1. The area encompasses six villages, of which four are Kwalei, Mbelei, Kwekitui and Kwadoe in Mamba ward, Soni division and two villages Dule and Kwehangala in Bumbuli ward, Bumbuli division. The watershed provides a typical topographic representation of the West Usambara Mountains. The altitude varies between 800 to 1500 m a.s.l while the annual rainfall ranges from 800 to 1700 mm. Temperatures are mostly cool but there are tendencies that during dry seasons, temperatures become very hot.

METHODS

A participatory watershed characterization and diagnosis was undertaken at village level involving all necessary stakeholders. Structured questionnaires, meetings and informal discussions were used to collect data from farmers. A total of 300 farmers randomly selected were interviewed using standardized questionnaires which mostly contained closed questions. Data from standardized questionnaires were analyzed using descriptive statistics. Land use and assessment of natural resources in conjunction with major crop and livestock enterprises, markets and marketing information, and social institutions and groups that exist were researched. Global Positioning System (GPS) equipment was used in transect walks and along village boundaries to map them and establish aerial extents. The equipment was also used to georeference hotspots identified through farmer interviews such as water sources, degraded areas, woodlots and forest resources. Key informants knowledgeable about the watershed features guided the research team. The data collected gave a detailed picture of the Baga watershed socially and biophysically.

Results

SOCIO-ECONOMIC CHARACTERIZATION

Population

The Baga Watershed has a total population of 13,183 people, comprising 6,763 men and 7,375 women (Census, 2002). Population data show that 51% of the total population is under 18 years of age, 4% above 65 years and 45% constituted by persons between 18 and 65 years of age.

Household (hh) size

Most of the hhs have a range of 6 to 14 persons. Similar household size was observed by Kaswamila and Mkavidanda (1997) in other parts of west Usambara Mountains. The medium wealth category has consistently many household members across the watershed, although the wealth group had the highest number in Kwadoe which is 14 members. The explanation to this could be traditional and religious beliefs that allow members to get married to more than one wife and most of the wealthier men get married to more than one wife. Age distribution in the many household is skewed whereby the age below 18 years of age has more family members, which simply signifies more dependants than producers.

Education level

The available information on the status of education in Baga watershed showed that many farmers in the watershed have not completed primary school education. The pilot village in the watershed has the highest number of primary and secondary school leavers (38% and 8%, respectively) at a household level. The remaining villages have many primary school drop outs before standard seven. This scenario implies that most of the primary school entrants drop out of school before completing, probably to migrate to urban areas in search of jobs. Out of six members in the household, only one or two persons at most complete primary school education. Of recent, there has been a strong campaign and pressure from the government for all school-age children to be registered in schools with the hope of having high school enrolment in future.

The major part of the population belongs to three ethnic groups: Wasambaa (70%), Wapare (10%) and Wanguu (10%). Other immigrants make up the remaining 10% of the population. According to interviewees, these ethnic groups live in harmony and wrongdoers are judged not because of their ethnicity but according to individual behavior.

Household characteristics

Farmers in the Baga watershed were first categorized into groups according to criteria put forth by farmers themselves. The criteria are presented in Table 1 below. There are three wealth endowment groups. Household characteristics are discussed on the basis of wealth groups.

Average farm sizes

Results indicated that the average farm size ranges between 1.4 and 4.9 ha per household and on average, one household has about 8 to 14 people. This suggests that land available per person in the watershed ranges from 0.3 to 0.6 ha, quite a small area for meaningful food production. For instance, taking the average yield of maize (staple food) which stands at 500 kg of maize/ha in the district (Shelukindo,1992), the food available per person from these farms is only 40 kg of maize/year which is not sufficient to feed the people and make them concentrate on other agricultural activities.

Livelihoods

Livelihood has been defined by Chambers (1988) to be adequate stocks and flows of food and cash to meet basic needs. It includes security, which refers to ownership or access to resources and income earning activities including reserves and assets to offset risk, ease shocks and meet contingencies. Livelihood also encompasses sustainable livelihood, which refers to maintenance of resource productivity on a long term basis. Livelihood analysis in Baga watershed was carried out while trying to link the villagers' livelihood and natural resource management.

Grouping of farmers

The livelihood in the watershed is less diverse and also had weak links to farmers' wealth categories. The farmers identified three wealth categories based on resource endowments which grouped as low, medium and high (Table 1).

Table 1. Wealth ranking criteria in the Baga Watershed

Indicator	Resource endowment classes		
	High	Medium	Low
Land size	> 5 acres	1-3 acres	0-1 acre
Land management	Well managed	Slightly well managed	Not well managed
Cattle possession	> 5 cattle	1-3 cattle	0-1 cattle
House type	Block iron roofed	Wooden iron roofed	Mud grass thatched

According to the criteria put forward, the village population had 19% persons belonging to the high class while the medium and low wealth categories covered 42 and 39% of the population, respectively. It was also found that 25% of the households are women headed for both high and medium categories, while 36% of low wealth category are women headed. This means that the women headed households are more prone to poverty than male headed households. Therefore, technologies that improve livelihoods should purposely be targeted to the vulnerable groups of women and youth.

Sources of income

Like many rural areas, agriculture is the main source of income. Variations exist between individuals as well as lasses whose causes are mostly based on the perennial crops grown or inherited. Data illustrate differences among classes (wealth groups) on the basis of cash or food crop endowments. For example, most low wealth households do not own tea fields and therefore lack income from tea sales. There are cases in which low category groups obtain more money from crops such as Irish potato, which fetches good income in times of high demand. However, there are some inconsistencies in many avenues of production. Major differences in wealth could be due to the size of landholdings, as well as land tenure. The high wealth category tends to own more land than the low category groups.

It is important to note that yield levels are very low due to many reasons. The major cause is soil fertility, indicated by studies on soils carried out in Kwalei (Lymchai *et al*., 1998; Wickma and Mowo, 2001, Meliyo *et al*., 2001). Systematic cross-section observation in the watershed indicated that there are severe deficiencies of macronutrients phosphorus, nitrogen and potassium. The implication of low yields is low income, and therefore increased hunger and poverty.

There are households with family members with permanent employment in civil service like teachers, nurses and community development staffs who reside in the villages. There are also casual laborers who are employed in tea estates. However, their number is negligible compared to the total population in the watershed. In general, government employers, though very few, earn the most, followed by self-employment activities such as masonry and carpentry. Other sources of income include livestock keeping and self-employment. It is important to note that since farmers do not have enough food year round, they cannot put total effort in their respective fields and farms. They normally sell their labor to comparatively richer farmers in order to get food or money to buy food. This persistent food insecurity therefore has become an unbearable burden in some households. There is also a less accepted form of employment where young girls between the ages of 15 and 30 move to towns to work as house girls and barmaids. Boys also seek off-farm employment selling consumables to remote buyers and grazing livestock. The income contribution of these forms of employment is rather limited, but it has been one way in which villages are increasingly integrating into the urban economy. The consequences of such out migration have been both positive and negative. Some youth go back home with husbands and wives, some with unwanted? pregnancies, and some infected with HIV / AIDS. Some return home with money to build corrugated iron sheet houses, which are considered to be an indication of high wealth.

In general regardless of diversified sources of income in the watershed, livelihood is still a very challenging struggle because these income sources give meager funds that do not adequately meet all household needs. Income in the watershed ranges from Tsh 100 to 980/person/day, which is below 1 US$ regardless of which wealth group a person belongs.

USES OF INCOME

Results indicated that most of the money (75-100%) was used for food at household level. The proportion of income (10%) used for other purposes was very small across groups and sites. Other household requirements such as clothing, medical treatment, schooling (in some households), leisure (drinking, smoking), giving to co-wives and concubines (nyumba ndogo) and buying expensive items such as bicycles, watches, corrugated iron sheets and building houses are prioritized/invested in differently by different individuals. Some individuals invest money in petty trade (shops, local teashops). Accurate estimates on the proportion of money invested in such activities could not be established as this type of investment was on an ad hoc basis, done only when money is available. Data suggest that as income increases, children are sent to school, people hired for labor and agricultural input use increases.

PUBLIC INSTITUTIONS

There are diverse institutions in the watershed. The government institutions are similar to other institutions elsewhere in the country. There are also local or traditional institutions. The latter have inconsistent strengths and weaknesses which, according to farmers, depends on the cohesiveness among members. The weaknesses have been increasing with time mostly because youth are no longer interested in most of the traditional customs. In addition, new religions such as Islam and Christianity were mentioned to influence the present lifestyles among youth away from traditional beliefs that were a strong foundation for the local institutions. Other institutions oriented toward agricultural production, sports, midwifery, and funeral support exist without proper governance systems, and are therefore weak and vulnerable to grabbing by individuals for their personal benefit.

Public services

There are permanent roads from Lushoto via Soni to Bumbuli traversing the six villages in the watershed. There are daily buses from Dar es Salaam to Bumbuli and several trips a day of commuter buses from Soni to Bumbuli carrying people in and out of Baga Watershed. There are also feeder roads in every village and hamlets. Telephone communication is through TTCL call box at Mbelei, the Mamba ward headquarters and there are two mobile phone towers in the watershed at Mbelei and Kwehangala.

There are reasonably good consumables shops in Mbelei, Kwalei, Kwekitui, and Kwehangala. They sell sugar, soft drinks, maize flour, rice and different types of sweets. Mbelei is more advanced where there are even clothes like kangas. There are also small teashops. The headquarters also serves as a marketing centre for coffee and sometimes as a collecting centre for vegetables to intermediaries who come to buy produce at farm gate prices.

Markets and marketing outlets

There are different types of markets: local markets and distant markets. The local markets include those for tea, coffee and vegetables which are mostly sold in the villages to individuals or companies. Tea is sold in Hrekulu Tea Company at Tsh 65 per kg of fresh leaves. Coffee is sold in the village to buyers who are licensed. These look for the people who would buy and collect coffee beans for them at Tshs 500/kg dry coffee beans. Vegetables are either sold in the village or carried to markets in Dar es Salaam, Morogoro, Korogwe, Muheza and Tanga. The prices for vegetables are never static and may change on daily basis depending on the availability of vegetables in major markets of Dar es Salaam.

Traditional laws and bylaws and their formulation

The study examined traditional laws and bylaws that are in force in the watershed. Results indicated that there were traditions and beliefs that helped people live in harmony and order in the community and with the environment. For example, wrongdoers were punished and sometimes killed harshly as a lesson to others. Collecting water using dirty pots from streams or rivers; cultivating close to water sources, cutting trees close to watering points, and cutting some types of trees were all prohibited. All water sources were communally owned and protected and the bylaws which were formulated by the community, chiefs and the chiefs' aids were respected.

The bylaws on water sources were intended to maintain the buffer zone needed to protect water resources. This state of affairs was maintained until recently when young generations became developmental, and less caring. In the past, although the bylaws were few, they were respected. Many of the bylaws today are not respected due to fear of upsetting family relationships as well as fear of people with high status in the village. Fear of witchcraft was also mentioned as a constraint to implementing the bylaws.

With the onset of colonialism, laws were enforced through penalties of heavy fines, caning and detention. Independence left local rulers in place who maintained the system. The traditional beliefs were rendered weak and hence the traditional governance system was irretrievably weakened.

BIOPHYSICAL CHARACTERIZATION

Watershed coverage

Figure 1 shows the Baga Watershed and the water resources. The land coverage of the study area is 6,006 ha, with Kwalei covering an area of 1,098 ha, Mbelei village 838 ha, Kwadoe village 1,217 ha and Kwekitui village 877 ha. Others are Kwehangala 2,277 ha and Dule 301 ha.

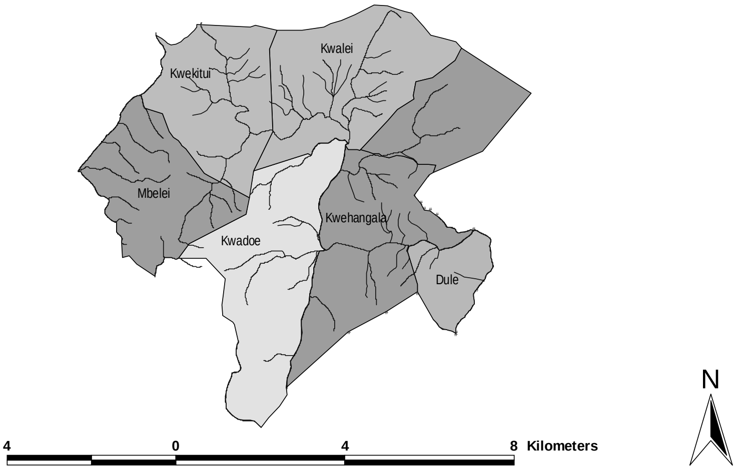

Figure 1. Baga watershed showing six village and (rivers) water sources

Forest resources in the Watershed

Local tree species, (Mpamba), *Szygium guineense* (Mshihwi) were found coppicing from the last harvest, and few old stands. There was also a rarely seen *Fagaropsis angolensis* (Mkunguni) which informers reported to have extra beautiful timber that glitters and is as soft as glass. The forests also have extensive distribution of *Albizia gummifera* (Mshai), *A. schimperiana* (Mshai mawe), *Ficus sycomorus* (Mkuyu) and *Ficus thonningii* (Mvumo). Other tree species in the forests are *Croton macrostachyus* (Mshunduzi), *Cassia abbreaviata* (Msangazi), *Rauvolfia coffra* (Ng'weeti), *Carissa edulis* (Mfufu) and *Dracaena usambarensis* (Ng'weng'we). Native forests diminished significantly to a small acreage in the 1980s. The reasons were expansion of cropland and commercial logging, particularly in the 1970s. The present portion is still being encroached upon by neighboring villages. The participatory management approach, where respective village governments are involved in governing the forest, remains the major means of sustaining the present forest remnants.

Water resources in the watershed

The number of springs and streams, and their water levels, has been declining with time parallel to environmental degradation, which reached significant levels in the 1980s. According to farmers' historical assessment and informal discussions, water levels in streams declined by almost 50% between 1950 and 1980s and further declined to 25% of their original volume by 2003. Scientific quantification may be necessary to better estimate the level of decline.

Farmers mentioned factors such as planting of exotic trees (*Eucalyptus spp and Acrocarpus spp*), cuttingof indigenous trees (e.g.*Albizia thonningii, Albizia gummifera, etc),* and grazing and cultivation around water sources as causes for increased evaporation of water from the sources and reduced recharge of water sources. Figure 3 shows the magnitude of water source encroachment whereby farmers grow vegetables very close to water sources (spring (left); stream (right)).

Figure 3: Cultivation of vegetables close to water

Production bottlenecks

Summaries of socio-economic bottlenecks by watershed residents suggest that important differences exist between wealth groups across villages. Fifty to 75% of interviewees cited lack of capital as one of the socio-economic bottlenecks. Agricultural inputs also scored comparatively high across wealth groups and villages. Other bottlenecks include pests, parasites and diseases affecting both crops and animals.

Crop Production

Agriculture, the major economic activity in the watershed, is characterized by smallholder cultivation of food and cash crops, agroforestry and livestock production. Major food crops include maize, beans, wheat, root and tuber crops (cocoyam, taro, cassava, sweet and round potatoes), banana and vegetables. Major cash crops are coffee, tea, cardamom, sugarcane, beans, peas, soyabean, vegetables and fruits. Cropping patterns include intercropping of food crops (i.e. maize and beans) with cash crops (i.e. coffee and banana). Maize is normally intercropped with beans, and sometimes coffee and banana, to make optimal use of limited landholdings. Tea and some horticultural crops such as tomatoes, cabbage and potato are monocropped. Most farmers use locally available varieties; in some cases, they recycle improved varieties after harvest by sorting seeds with good appearance and big size.

Crop production constrains

There are several biophysical problems encountered by farmers in the watershed which are also common throughout Sub-Saharan Africa (Gichuru *et al.,* 2003). These include: use of low yielding cultivars, depleted soil fertility due to continuous cultivation without use of fertilizers (soil mining), and soil erosion accelerated by poor agronomic practices, steep slopes and lack of soil conservation measures (Tenge, 1995; Juma and Mowo, 2001; Meliyo *et al.,* 2001). The poorly established crops are also affected by pests and diseases (whiteflies, aphids, bean-stem maggot, bean flies, fungal and nematoded in vegetable crops). The consequence of such constraints have been low yields, food insecurity, malnutrition and poverty. Farmers indicated that between the 1950s and 1980s, yields were up to 1800 kg of maize per acre compared to between 40 and 80 kg of maize per acre at present. Lyamchai *et* al. (1998) reported similar low yields for maize of 750 kg/ha in Kwalei village. The present figures for maize yield indicate a spiral decline through time.

Livestock production

Zero grazing and tethering around homes characterizes livestock keeping in the Baga Watershed. Despite by-laws making free grazing illegal, there are incidences of free grazing by farmers near forest reserves and within villages. This is an ongoing source of conflict among farmers and other stakeholders.Livestock kept in the six villages include cattle (indigenous and improved), goats and sheep, poultry and other domestic birds.

The total number of cattle is 1,983, of which 1,071 were indigenous and 912 were improved. There were 700 goats and 452 sheep. The birds, chicken and ducks were 2,835.

Constraints affecting livestock production

Results indicate that bottlenecks affecting animal productivity in the area include:

- Periodic fodder shortage;
- Poor management practices, including poorly built sheds, inadequate feed and unhygienic feeding environments (Figure 4);
- Unproductive animal breeds; and
- Parasites and diseases due to the high expense of veterinary services.

Description of major land use patterns

The aerial extent of the Baga Watershed is 6006 ha. Table 2 presents a number of delineated land use patterns in Baga watershed. These land polygons planted with crops are indicated with respective coverage. In general, every unit faces challenges depending on the use. However, the challenges on soil erosion were common to all cultivated units due to lack of conservation measures. Forest reserves were facing different challenges including encroachment/deforestation, whereas cultivated lands (90%) were found to be facing challenges of nutrient mining and soil erosion.

Table 2. Summary of land use patterns in the watershed

Land Use	Area ha	% of WS
Annual crops	382.3	6.4
Annual crops intercropped with trees	1052.1	17.5
Multi-storey cropland	1663.3	27.7
Grazing	37.5	0.6
Settlements	48.5	0.8
Smallholder tea cultivation	551.5	9.2
Large commercial tea growing	235.9	3.9
Black wattle woodlots	524.6	8.7
Other woodlots	283.0	4.7
Afromontane forests (natural forests)	1226.5	20.4
Grand total area	6005.2	99.9

Trans-boundary problems

Household survey results also highlighted trans-boundary problems among neighboring farmers or land units. These problems cut across fields and villages regardless of borders. They include cultivation of undesirable tree species such as *Eucalyptus, black wattle* and *Acrocarpus* along common borders; pests and disease infestations; soil erosion and farm boundary encroachment. Transboundary issues were affecting 100% of residents in the Baga watershed. They have been a source of conflict among community members, and require collective action involving all stakeholders and perhaps policy reforms.

Relationship between land use and environmental hot spots

There were several natural resources degradation “hot spots” in the watershed. There is a direct relationship between land use types and identified hot spots (Figure 2). The notable hotspots are soil erosion (gullies/rills), affecting over 80 % of the watershed and accelerated by steep slopes; destruction/encroachment of water sources, affecting mostly Kwekitui and Mbelei villages; and cultivation of undesirable trees (common to all villages). Opinions on these problems differ by village. In Kwehangala, where eucalyptus trees are sold to tea factories and represent an important source of income, they received less blame compared to Kwekitui and Kwalei. Deforestation is also threatening some endangered plant species.

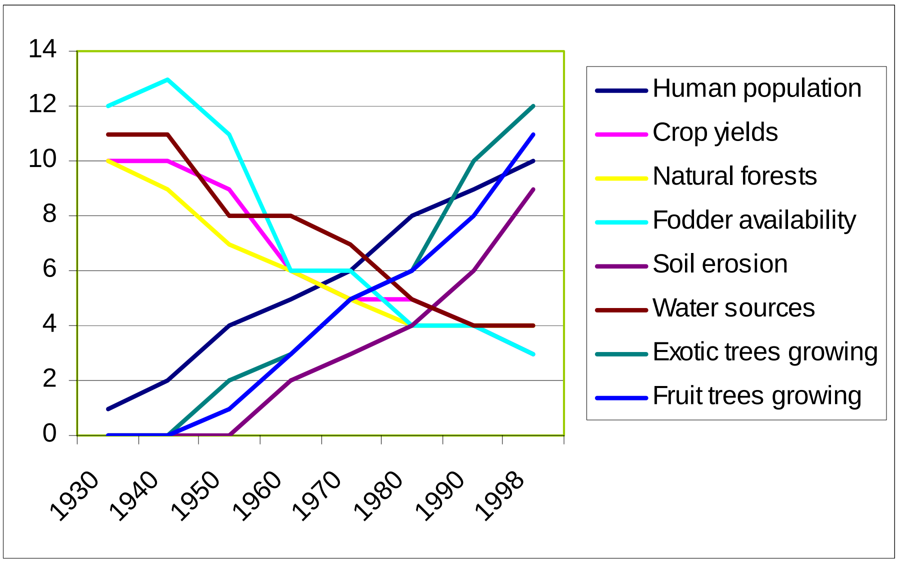

Figure 2. Relationships of natural resources in the watershed

Conclusion

Population growth has negatively affected natural resource management in the watershed. As the population increases, shrinking of forest resources, degradation of water resources and acceleration of soil erosion have occurred. Per capita food production has also declined over time. Land and soil productivity is very low. Without efforts to reverse these trends, food insecurity and poverty will persist. Women-headed households are the most affected.

Given the above, the following recommendations are made for the watershed approach:

- Strongly advocate holistic and participatory approaches to NRM bearing in mind the hard-work involved in opening up conservation structures, every best bet should be carried together soil conservation measures.
- Collective action will make farmers be closer and solve most of their problems as one.
- Management of water sources needs collective action and a lot of awareness creation in order to balance livelihood needs with the conservation of this basic resource.

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References

Census 2002. The national population census, Tanzania.

Gichuru, M.P., A. Bationo, M.A. Bekunda, H.C. Goma, P.L. Mafongonya, D.N. Mgendi, H.M. Murwira, S.M. Nandwa, P. Nyathi and M.J. Swift, 2003. Soil Fertility Management in Africa: A regional perspective, Academy Science Publisher. Pp 306.

Griffiths, C. J. 1993. The geological evolution of East Africa. Pg. 9-21 in Lovett, J.C. & Wasser, S.K. (eds) Biogeography and Ecology of the Rain Forests of Eastern Africa. Cambridge University Press. Cambridge pp 341.

Hamilton, A., C.K. Ruffo, I.V. Mwasha, C. Mmari, J.C. Lovett, 1989. A survey of Forest types on the East Usambara using variable area tree plot method. Pg. 213-225 in Hamilton A.C. & Bensted-Smith, R. (eds.) Forest Conservation in the East Usambara Mountains, Tanzania. IUCN Gland Switzerland pp 392.

Kaoneka, A.R.S. 1993. Land use planning and quantitative modelling in Tanzania with particular reference to Agriculture and Deforestation, some theoretical Aspect and A case from West Usamabara Mountains Doctor Scientanum Thesis 1993. Agricultural University of Norway.

Kaoneka, A.R.S., Y.M. Ngaga and G.C. Monela 2000. Case Study: Forest of Usambara Mountains: historical perspectives and future prospects. In M.F. Price and N. Butt (eds) Forests in sustainable mountains development state of knowledge report for 2000. IUFRO 5 Research Series. CABI Publshing.

Lovett, J.C. 1993. Climatic history and forest distribution in eastern Africa. In Lovett J.C. & Wasser, S.K. (eds.), Biogeography and Ecology of the Rain Forests of Eastern Africa. Cambridge University Press. Cambridge pp 341.

Lovett, J.C. 1996. Elevational and latitudinal changes in tree associations and diversity in the eastern arc mountains of Tanzania. Journal of Tropical Ecology 12:629-650

Lymchai, C.J., S.D. Limo, R.V. Ndondi, M.Z. Owenya, P.A. Ndakidemi and N.F. Massawe , 1998. Participatory Rural Appraisal, in Kwalei Catchment, Lushoto. Selian Agricultural Research Institute.

Masayanyika, W.S.S. 1995. Linking conservation with livelihood security. The case of East Usambara Mountains, Amani Division, Tanga Region, Tanzania. M.Sc. Thesis, ITC AA Enschede, The Netherlands.

Meliyo J.L., J.W. Kabushemera and A.J. M. Tenge 2001. Characterization and Mapping Soils of Kwalei Sub-catchment, Lushoto District. Mlingano Agricultural Research Institute, National Soil Service, Tanga, Tanzania

NEMC (1995) National conservation strategy for sustainable development, Tanzania.

Poc's T. 1976. Bioclimatic studies in the Uluguru mountains (Tanzania East Africa) II. Correlations between orography, climate, and Vegetation. Acta Botanica Academiae Scientiarum Hungaricae 22:163-183.

Reinhard, W. 1987. Soil erosion control and agroforestry in the West Usambara Mountains. Evaluation of an Extension Approach. Technische Universitat Berlin.

Shelukindo, H. and Kilasi, G. 1992. Development, experience and re-orientation of soil erosion control and agroforestry activities in the West Usambara mountains, Tanzania. A paper present in the workshop on "National agroforestry and environment", SUA, Morogoro-Tanzania.

Tenge, A.J.M. 1995. Erosion effects on soil moisture and temperature regimes and crop yield on Eastern Usambara uplands in Tanzania. M.Sc. Thesis. The Ohio State University.

Wickama, J.M. and J.G. Mowo, 2001. Indigenous nutrient resources in Tanzania. Managing African Soils no. 21.

van der Willigen, T.A., and J.C. Lovett, 1979. Report of the 1979 Oxford expedition to Tanzania.Mimeograph, Oxford pp 94.

Galessa Watershed, Ethiopia: Processes, Major Findings and Lessons from the Exploration Phase in Ethiopia

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Abstract

Watershed management has recently received much attention in Ethiopia as an organizing framework for improved natural resource management and enhanced impacts from R&D interventions. The Ethiopian Agricultural Research Organization (EARO), in collaboration with the African Highlands Initiative (AHI), began working in a watershed mode since 2001 to explore watershed issues (from social and biophysical perspectives); inventory resources; and bring research to bear on watershed interventions in collaboration with local users. Galessa watershed was selected as a representative site for other highland areas with similar rainfall and altitude. The watershed exploration followed a number of procedures, including formation of core, site and farmers' representative teams; identification of villages in the watershed; preparation of different formats for collecting land, water, human, and livestock related information; identification of local institutions; identification and prioritization of watershed issues; and identification of entry points. The paper presents the results of exploration findings, including key problems in the watershed as seen by local residents and key institutions that could play a role in addressing the watershed problems. The paper concludes with a discussion of key lessons from the watershed exploration process in Ginchi Benchmark Site.

Introduction

Land degradation, food insecurity and poverty are prevalent problems in Ethiopia. Government and non-governmental organizations are attempting to improve the current situation through a host of new approaches to overcome the problems and bring the desired changes. Watershed management is one of the approaches that has recently received much attention in Ethiopia. A watershed approach uses hydrologically defined areas (mini-watersheds) to coordinate the management of natural resources. The approach is favored since it considers all activities within a landscape that affect watershed health and livelihoods. Evidence suggests that in addition to being a platform for leveraging resources for integrated conservation and development, the watershed approach improves collaboration and information sharing among diverse partners. However, experiences on how to diagnose social and biophysical issues, and opportunities in an integrated and participatory way in watersheds are very limited. The approaches and lessons documented from a watershed diagnosis process in central parts of Ethiopia will be a reference for intended watershed research and development practitioners.

Background

Many countries in Africa, Asia and South America have successfully designed their rural development programs based on watershed boundaries. In well-managed watersheds of India, return to investments in watershed development was found to be high, with cost-benefit ratios ranging from one to greater than two (Turton et al., 1998). In Sri Lanka, achievements in afforestation and crop production have been recorded as a result of water collected in earth dams built across 20,000 watersheds (Dharmasena, 1994). Neely et al. (1999) reported positive changes in biodiversity conservation, land management, income generation and capacity building as a result of integrated research and development activities in the Philippines and Burkina Faso. According to Sharma and Mishra (1995), average yield of wheat and maize increased from 1 to 3 t ha^{-1} and 1 to

2 t ha^{-1} at Sukhomojhri in India due to improved management of a model watershed. In addition, sedimentation rate of soil reduced from 300 to 30 t ha^{-1} yr^{-1}. In the two watershed management Vertisol sites of central Ethiopia, participation of farmers in problem diagnosis, prioritization and implementation was high. Consequently, Farmer Research Groups (FRGs) were formed to solve their priority constraints. The collective action in the watershed helped farmers to solve conflicts that usually arise due to excess water disposal from one farm to the other (Worku, 2004, personal communication). Kindu (2001) reported similar advantages for Yeku watershed in the Amhara National Regional State of Ethiopia.

Though a watershed approach has become one of the focal points of natural resources management and rural development, the issue of scaling up the benefits gained from watershed development to larger areas is still a great challenge in many countries. Lack of capital to develop infrastructures, lengthy loaning procedures and difficulties to timely supply inputs to farmers are major drawbacks identified during implementation of watershed management activities in two Vertisol sites of central Ethiopia. This paper shares approach and experiences of the watershed diagnostic phase in Ginchi Benchmark Site.

Methodology

Watershed site selection

In the year 2001, the Ethiopian Agricultural Research Organization (EARO) developed interest to integrate and promote its research findings in few model watershed sites. A multidisciplinary team was established to select three watershed model sites. Criteria considered for selecting the sites were: accessibility to the nearby research center; agro-ecological variations mainly rainfall (moisture stress, intermediate and high rainfall areas); representativeness (soils, topography and climate); suitability for watershed management (potential and challenges) and manageability (300-500 ha); diversity (crops, livestock, soils, vegetation, farming systems); and absence of intensive interventions by other government and none governmental organizations (Asgelil *et al*., 2001).

Team formation

A meeting was organized for the site team members and Holetta Research Center management to assign core team members. Core, site and farmer representative teams were formed for better facilitation of the watershed diagnosis and planning processes. The different villages elected their respective farmer representatives.

Watershed delineation

Arial photos were purchased from the Ethiopian mapping agency. The site team and watershed representatives walked around the boundary of the watershed and took coordinate readings at several sites. GPS readings were taken for the six villages, various watering points and other resources. Finally, the GPS readings were organized and entered for the development of the watershed map.

Inventory of resources and local institutions

Two formats were prepared for collecting socioeconomic information of the watershed. One was focusing on household family size and their age, education, wealth status and land resources. The other format was prepared to collect livestock population by type and number. Village representatives of the watershed facilitated the information collection processes. An interview with men and women farmers was carried out to document existing local institutions, their setup and functions. Existing information and future prospects of each watering point in the watershed was collected (Figure 1).

Figure 1: A water expert assessing the use of a watering point in the watershed

Identification of watershed issues

The numbers and location of villages in the watershed were identified with the help of key informants. An attempt was made to capture concerns of female and male farmers of the watershed through gender-disaggregated focus group discussions. Two sub-teams of research and development professionals were formed in each village to identify watershed issues with local communities. One group was to identify watershed issues with female respondents while another group was to identify watershed issues with male respondents in each village. The watershed issues were coded and synthesized based on the two categories (male and female) for each village (Kindu, 2004). Finally, social and biophysical issues from the different villages analyzed in spreadsheets, averaged and listed as watershed issues.

Ranking of watershed issues

The watershed issues listed by the villagers were prioritized following absolute and pairwise ranking methods. Individuals were approached for both types of ranking methods. Gender, age and wealth were some of the social parameters considered in the ranking processes. Absolute ranking was used for two villages and pairwise ranking exercised in other villages of the watershed. In each village old and young farmers, men and women, and wealthier and poorer farmers participated during ranking of the watershed issues. This was done to capture the views and priorities of various social groups.Finally, the top issues were known at a watershed level.

Feedback

The feedback meeting was conducted with farmers from the different villages to get their confirmation on the importance of top ranked issues, discuss possible solutions, solicit contributions from the farmers' perspective, and identify activities for immediate implementation. A pre-prepared feedback guide was followed for achieving the feedback objectives. Some of the points listed in the feedback guide include: Explain objectives of the meeting; get community's reaction and comments on the agenda; share top-ranked issues and validate whether the problems are real priorities; allocate time for farmers to discuss the top-ranked issues and make sure to have equal participation of farmers; identify what the farmers and site teams to contribute to each of the top ranked issues: and finalize with a list of 2-3 immediate action points (minimally 1-2 actions by community themselves, and one or two involving researchers).

Identification of entry points

The site team examined each of the top ranked watershed issues, identified researchable and unresearchable issues, and separated issues that would be handled by research and other institutions. Spring development was picked as an entry point since it was a high concern and priority for all watershed residents, and represented an immediate solution to a multi-faceted problem. Detailed biophysical and social information was collected for all watering points. Similarly, the status of the watering points was pictorially documented. The pictures will in the future serve to evaluate changes before and after watershed interventions.

Results

Selected watershed sites

A multidisciplinary team selected seven candidate model watershed sites in central parts of Ethiopia. The seven watershed sites fall within high, intermediate and low rainfall agro-ecologies. Galessa, Gare Arera and Tumano Abdi watershed sites selected to represent high rainfall areas where as Godino Mariam and Shershera Jole watershed sites selected to represent intermediate rainfall agro-ecologies. Similarly, Adulala Mariam and Tede Dildima locations identified to represent low moisture agro-ecologies. Finally, Galessa watershed was selected as a representative site for other highland areas with similar rainfall and altitude.

Team formation for Watershed diagnosis

The members of the core team were from socio-economics, soil and water management, hydrology, animal sciences, agronomy and forestry. The site team was involved in planning meetings, provided a pool of expertise for specific technical aspects and attended field days. Farmer representatives participated in different studies, meetings and experience sharing fora; shared lessons and experiences gained with the community; mobilized the community for various development and research activities; created linkages with other villages to perform activities that needed cross cutting issues; and brought community concerns and shared them with the core team members.

Delineation, size and administrative location of the watershed

Results of the watershed delineation are depicted in Figure 2. The total area of the watershed is 258 ha. The watershed encompasses *Tiro*, *Toma*, *Lege Aba Tebo*, *Kemete Lencha*, *Ameya* and *Sombo* villages. Majority of the villages fall under Galessa Qoftu *Kebele* Administration (KA). A section of the *Toma* village is located in Galessa *Qota Gishir* KA. The watershed map with various reference points is indicated in Figure 2.

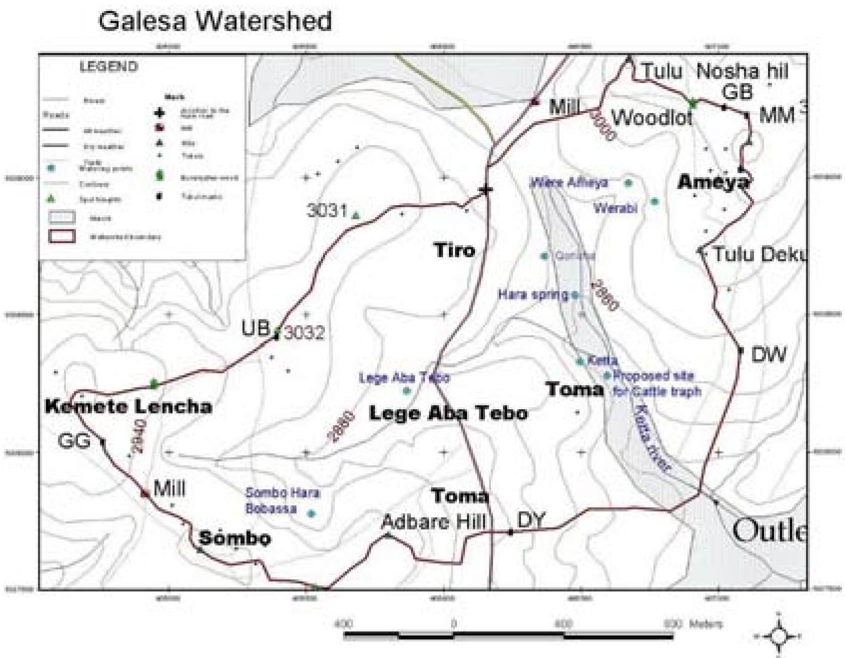

Figure 2. A map for Galessa watershed

Inventory of resources and local institutions

Human and livestock resources: Total number of households and human population interacting with the watershed are 171 and 894, respectively. The total livestock holdings for the farmers that have interaction with the watershed are 1606. Farmers have different forms of interaction within the Galessa watershed. Four types of farmer-watershed interaction have been identified (Table 1).

Table 1. Households and livestock population that have interaction with Galessa watershed

Farmer – Watershed Interaction	Number of Households	Number of Livestock
Farmers whose residential houses and farmlands are entirely inside the watershed	20	180
Farmers whose residential houses are inside the watershed and their farmlands are both partially inside and outside the watershed	99	967
Farmers whose residential houses are inside the watershed and without farmland	2	5
Farmers whose residential houses are outside the watershed and their farmlands are entirely inside the watershed	50	454

Water resources: Six water sources have been identified in the watershed. The water sources are used for human and livestock consumption. Some of the watering points are seasonal, while others are perennial. *Keta* watering point has already dried because of the nearby Eucalyptus tree plantation. More than two villages currently use each of 3 watering points.

Local institutions: Local institutions are important for mass mobilization and technology dissemination. Idir, Senbete, Debo, Mahiber, Ekube and Jabir are local institutions that exist in the watershed. Idir and Senbete are support systems where members assist each other during misfortunes (death, crop failures, lose of livestock and burning of houses) as well as strengthening social ties. Ekube facilitates rotational savings (without interest) to members where as Debo assists farmers to support each other during periods of heavy workloads. Jabar is a person with status in traditional belief system. The location reserved for the belief is called Jabi. Jabi serves as an indicator of historical patterns of landuse and reserve for germplasm. One farmer can be a member of more than one institution. Some institutions like Idir and Debo can be used for natural resources management that requires collective action. Soil and water conservation, spring development, tree nursery management and quality seed increase scheme for important crop varieties can be promoted through Ider and Debo systems.

Identification of watershed issues

Forty watershed issues were compiled from different age, wealth and gender categories.
Due to similarities among the issues, they were categorized and reduced to the following 18:

1) loss of water, soil, seeds and fertilizer due to excess run off;
2) water shortage for livestock and human beings;
3) poor water quality;
4) problems associated with lack of common drainage;
5) crop failure from occasional drought;
6) soil fertility decline;
7) feed shortage; low productivity of animals;
8) shortage of oxen;
9) land shortage due to population pressure;

10) lack of improved crop varieties;
11) wood shortage;
12) loss of indigenous tree species;
13) effects of eucalyptus on soils,
14) crops and water;
15) theft of agricultural produce;
16) conflict from paths, roads and farm boundaries;
17) lack of access to improved seeds; and
18) conflict between villages over watering points.

Ranking of Watershed Issues

Of these 18 issues, water shortage, runoff, soil fertility decline, loss of indigenous tree species, wood shortage, lack of feed and oxen shortage were ranked as top watershed issues (Table 2). Farmers produce crops on slope lands without adequate soil conservation measures. As a result, substantial quantities of soils are washed out yearly resulting in shallow soils. Excess runoff is creating loss of seeds and fertilizers. Most farmers do not practice improved soil and water conservation techniques although aware of the problem. Farmers seriously felt the problem of soil fertility and understood that their soils had become progressively shallow and infertile. Soils used to be very fertile, deeper and did not need any amendments. The changes in fertility were attributed to continuous cultivation, soil erosion and lack of access to cattle manure and inorganic fertilizer. Wood and animal feed shortages are problems faced by many farmers within and beyond the watershed. As a result of feed shortages, animals die at their early age, supply low milk yield, marketed at low price and provide weak draft power. Getting sufficient and quality water is a difficult task for most farmers. Farmers sometimes get sick during peak cropping seasons due to water born diseases and this affects availability of labour during peak cropping seasons.

Table 2. Ranks of social and biophysical issues at village and watershed levels

	Ameya	Sombo	Tiro	Toma	Average
Loss of seed and fertilizers because of of runoff	**1**	**2**		4	**2.3**
Water shortage for livestock and human	3	3		3	**3.0**
Poor water quality	**2**	3	3	**1**	**2.5**
Conflict from lack of common drainage					
Crop failure due to drought	3	4		5	4.0
Soil fertility decline	3	5	1	**2**	**2.8**
Feed shortage	3	3		5	**3.7**
Shortage of oxen	3	**1**		**2**	**2.0**
Land shortage due to high population	4	3	3	3	**3.3**
Lack of improved crop varieties	5	6		5	5.3
Wood shortage	3	4	2		**3.0**
Loss of indigenous tree species	3	5	1	**1**	**2.5**
Effects of Eucalyptus on soils and water					
Theft of agricultural products	5				5.0
Conflict from paths and farm boundaries		6			6.0
Low productivity of animals	4	6	5		5.0
Lack of access to improved seeds	4	6	4	3	4.3
Conflict of villagers over watering points	5				5.0

Note: Figures in columns are ranks with respective villages
Rank 1 is more priority than rank 2

Addressing water, soil erosion, plant nutrients depletion, wood and feed problems require collective action since all affect the livelihood of farmers. Farmers in and outside the watershed leave part of their land fallow. The duration of the fallow is one season. Fallowing is practiced to enhance soil fertility and increase feed availability. If farmers fallow part of the landscape this year, they use the same land for cropping in the subsequent year. Farmers in each season deliberately demarcate land for fallowing and cropping to avoid damage of crops due to free grazing system. Fallowing and free livestock grazing are watershed issues that require collective actions. Watering points in the watershed are communally owned and protected. Hence, watering points require communal management and collective action to overcome conflicts between neighbouring villages over watering points. Water flow is influenced by soil conservation measures. Soil conservation in the upper part of the landscape influences the quantity of water in lower landscape. Water quantity and quality can be improved through a watershed level soil and water conservation practices.

Feedback

Farmers from different villages confirmed that drinking water, soil erosion, soil depletion, wood and feed shortages are priority problems of the watershed. However, farmers from Ameya village emphasized the problem of sheep disease and suggested to include it in the list of top ranked watershed issues. The understanding of the farmers on the causes and possible solutions of priority problems was high. The promise of farmers for cost sharing to upgrade existing watering points was highly positive. Farmers suggested compost, green manure and inorganic fertilizers for improving the fertility status of the soil. Similarly, farmers proposed establishment of credit system to minimize shortage of oxen. As to the lack and poor access of improved crop varieties, farmers requested to obtain seeds of some of the potato varieties that have been already introduced in the nearby localities. Most farmers in the watershed could not access some of the crop varieties although they are aware of them. They have observed promising results of some of the potato varieties introduced by HARC. Farmers suggested to strengthen the already established working relation with forestry division of Holetta Agricultural Research Center to increase the coverage of lost indigenous tree species. The will of the farmers to participate in research and development activities is an area that needs to be strengthened and used while implementing watershed management interventions.

Entry Points

Spring development is the entry point in the watershed. The watershed core team in collaboration with farmers identified six watering points. The community and the core team members decided to upgrade three watering points. Perennial nature, continuous flow and consumption by high number of population are some of the criteria considered for prioritization of the watering points.

Conclusion

Eliciting Representative Views from Communities

Forming farmers' representative group facilitates resources inventory activities in the watershed: It is sometimes difficult to quantitatively or qualitatively document the real resources within the watershed. For instance, farmers are sensitive to tell the number of children, livestock, the size of land and some other resources that they own. Forming a group that represents the different villages facilitates the processes of documenting resource information in the watershed. The information from the village representatives can be used to check against the information generated from farmers. Village representatives need to be knowledgeable about the area and should be elected by the villagers.

Documentation and popularization of approaches

If followed from the beginning to the end for a watershed study, the approach assists to save time and resources (time and money). Resources for carrying out detailed exploration activities for various watersheds are limited.

Hence, proper documentation and dissemination of experiences and processes for the model watershed sites helps to initiate similar activities in other areas. It is possible to shorten the diagnosis phase and go faster to the implementation phase for prospective watershed sites through internalizing the approaches followed n the model watershed sites.

Early awareness creation and stakeholder involvement

Involvement of local people, officials and other stakeholders at different levels paves the way for success in watershed studies. Handling of social and biophysical issues in watersheds requires participation of various stakeholders including local people, water experts, GIS experts, researchers with different disciplines and other partners. Watershed issues are complex and need integrated and collaborative approaches. Early awareness creation fora and participation of various stakeholders are very important elements to establish good rapport among the partners. Initial responsibility sharing and preparation of terms of reference facilitates internalization of the watershed agenda by partners and brings in the desired collaborations.

Reflection at multiple levels

Reflection of the watershed studies helps to improve approaches for subsequent actions. A number of lessons have been recorded from repeated reflection processes while studying various watershed issues. For instance, individual farmers were ranking more than 18 watershed issues. Then, ranking of more than 18 issues was found too much and monotonous for farmers. It was possible to minimize the list of watershed issues and correct other deficiencies for subsequent ranking because of having early reflection meetings. Similarly, team members tried to capture farmers' justification while ranking one issue over the other and improved late arrival to the watershed site after having reflection meetings.

Site team participation

The presence and full participation of site team members for developing guidelines and running different exploration activities avoids confusion while meeting and discussing with watershed communities. The site team sometimes did not meet ahead of the field exercises to thoroughly discuss approaches. Because of this, confusion and misunderstandings among the team members had occasionally been observed. Developing approaches or trying to bring a common understanding on developed approaches among team members during the meetings wasted time and was inconvenient to farmers.

Farmer involvement in issue identification and ranking

Identification and ranking of watershed issues with the same farmers and village reduces expectations and quickens exploration activities. Some farmers did not understand the objectives of the whole exercise well. Farmers who participated in ranking might not be involved in the listing of watershed issues and vise versa. There was a case where a village ranked watershed issues that were identified in other villages. This type of approach creates higher expectation, consumes much time to explain the background and can suppress some problems on watershed issues. For instance, the issue of sheep disease was repeatedly raised during the feedback meeting by some of the community members as one of the priority problems. Ranking a long list of watershed issues using either pairwise or absolute methods also creates discomfort for farmers. The list of watershed issues ranked by absolute and pairwise ranking methods were more than 18. The number of team members' assigned to handle the ranking exercises for the different villages was very few. Farmers in each village did ranking one by one or individually. While some farmers did the ranking, others were waiting for their turn. Farmers felt uneasy sitting and waiting for long hours. Very slow response and understanding of some of the interviewees also wasted a lot of time to explain the watershed issues. Farmers also complained about the repetitive nature of the pairwise and absolute ranking methods.

Ensuring commitment of farmers and local administrators

Farmers and local administrators express their commitments very fast when research and development partners try to work with them on priority issues. The water issue was ranked first by the watershed communities and was therefore identified as the entry point. The community in the watershed met several times to discuss what to contribute for upgrading the existing watering points and agreed to contribute money according to their wealth categories. The first grade farmers (wealthy farmers) agreed to contribute more money than the second grade farmers and so on and so forth. They also agreed to supply locally available material, and labor.

Identification of key actors

Identification of farmers and Kebele Administrations that have different forms of interaction with watershed resources is necessary to understand their needs, contributions and decisions. Some farmers live outside the watershed but own land in the watershed. There are other three groups of farmers that have different degrees of interaction with the watershed. Similarly, the watershed is found within two Kebele Administrations. The needs and contributions of the farmers that fully live and own lands in the watershed vary with farmers that have less degree of interaction with the watershed. The decision of the Kebele that administers more farmers and own more land in the watershed is powerful as compared with the other.

References

Agelil D., Demeke N., Gebeyehu B., Getinet A., Gezahegn A., Girma M., Kindu M., Teklu E. and A. Worku, 2001. Selection of pilot watershed sites for sustainable resources management. A study report, Ethiopian Agricultural Research Organization (EARO), Ethiopia. p 27.

Kindu M. 2001. Practices, constraints and agroforestry interventions in Yeku watershed. north-eastern Ethiopia. *Ethiopian Journal of Natural Resources*, 3: 149-166.

Kindu M. 2004. Ginchi/Galessa benchmark site AHI phase three (2003) annual report. Ethiopian Agricultural Research Organization (EARO), Addis Abeba, Ethiopia. p 64.

Dharmasena P.B. 1994. Conservation farming practices for small reservoir watersheds: a case study from Sri Lanka. *Agroforestry Systems*, 28: 203-212.

Neeely C., Buenavista G., and J. Earl, 1999. Looking back on the landscape: impacts and lessons from the SANREM CRSP. SANREM,USA. p 76.

Sharma S. and P. Mishra, 1995. Watershed Management in Dry land areas: Principles and practices. In: Singh R.P, 1995 (ed). Sustainable development of dry land agriculture in India.

Turton C., Warner M., and B. Groom, 1998. Scaling up participatory watershed development in India: a review of the literature. ODI (Overseas Development Institute) agricultural research and extension network papers no. 86, London. p 16.

Learning Cycle Towards Enhancing Farmer Innovation: Experiences of AHI-Areka, Southern Ethiopia

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Abstract

The African Highlands Initiative (AHI) together with the national agricultural research institutions (NARIs) has been conducting participatory research since 1997 to solve land-based natural resource problems and livelihood issues. In achieving this mission, a number of research activities were conducted in Areka (Southern Region by Research & Development site teams led by Areka Agricultural Research Center. Over time, the AHI program has evolved through various phases. In phase 1 AHI was organized around three separate but interlinked thematic technical agendas: integrated pest management (IPM), improvement and maintenance of soil productivity, and characterization and diagnosis of the benchmark sites. In Phase 2 AHI moved to more integrated, area based approach to test and demonstrate improved integration of technologies and practices required to address NRM issues. The approach entailed bottom-up problem identification, priority setting, planning and resource allocation, and use of participatory methods by AHI teams. Introduction and testing of useful "on-the-shelf" technology options that could be quickly taken up by farmers in their farm plots were regarded as entry points. Generally, in phase 2 there was better technical integration and adoption by farmers, increased farmer involvement, empowerment and change of attitudes both by the farmers and researchers due to the participatory methods employed. Phase 3's focus is on developing, testing and institutionalizing participatory and INRM approaches and methods relevant to solving production, land degradation and associated natural resource management issues in watersheds located in the benchmark sites. It was hypothesized that if participatory methods were used, with an integrated multi-disciplinary approach involving more stakeholders, research would have greater effectiveness compared to the conventional research approach used by NARIs. The conventional approach was not very effective in integrating technologies to solve farmer problems and that community participation in the research process was low, limiting the appropriateness of solutions. Over time, various methods have been used to increase farmers' capacity to innovate, develop system compatible technologies, improve partnerships among all stakeholders and promote scaling up of technologies, methodologies and processes. Farmer research groups, farmers' innovation schemes, farmer-to-farmer dissemination channels and the spiral towards INRM will be discussed. This paper reviews the approaches followed, achievements gained, lessons learnt and progress made in the AHI program at Areka benchmark site in phase one and two, and possible expectations in phase three.

Introduction

Areka is one of the two benchmark sites of the African Highland Initiative (AHI) in Ethiopia, administered by Areka Agricultural Research Center (ARC). It is located in the southern part of Ethiopia, 430km south west of Addis Ababa. Like other agricultural research centers in the country, ARC has been undertaking mainly on-station-based research where the degree of participation of farmers in the research process is very low, whereby the research agenda was discipline-based and commonly non-integrated. The technologies developed using these approaches generally benefited better endowed farmers with access to good land, credit, external inputs and so on. The major research agenda was dominated by plot level research with limited attention to the management of natural resources (mainly soil). Resource poor farmers were usually by passed. Thus research results were either not adopted by the end users partly because the research process did not fully involve them and the farmers' criteria would not been taken into consideration. Realizing this event, the government has recently started to press research and development institutions to empower farmers in the research and development processes. Areka Research Center in collaboration with AHI has been conducting on-farm and participatory research at Areka benchmark site (in Gununo Peasant Association at a particular village called Gegecho) since 1997 to partly address the above mentioned concerns. FPR has been considered as an essential tool to address the farmers' needs. AHIs' main focus was natural resource management (NRM) to increase farmers' capacity to improve in their own, to develop system compatible technologies, to improve partnership among all stakeholders and to promote scaling up of technologies, methodologies and processes. Several activities and methods were used to meet its objectives in the benchmark site. The objective of this paper is to review and document the methodologies and approaches used by the site team in achieving participatory research in NRM and lesson drawn from the approaches for future use.

Background

The basic principle of this approach is that agricultural technology must emerge from the farmers' needs as they identify them. Farmers conduct experiments and evaluate the appropriateness of a technology on the basis of their own criteria. FPR requires interdisciplinary collaboration between researchers and farmers. Although research and development work was started decades back, majority of farmers in Gununo area remain dependent on food aid at least for some months in a year. A survey report revealed that only 44.2 percent of farmers meet their family food requirement through production and purchase (Annual report 2000). A total of 23.3 percent farm households do not meet their food requirement. None of the farmers interviewed produce extra food to save for another year. Thus it is high time for researchers, development workers and farmers to design and use research methodologies that ensure the development and adoption of agricultural technologies to create agricultural production that will benefit the resource poor farmer.

Methodology

The research process in Areka, as a collaborative effort among many research and development institutions namely ARC, AHI, Ministry of Agriculture, EARO, CIAT, NGOs started in 1997 with identification of an appropriate benchmark site that would represent national and regional NRM scenario. Criteria was set to identify appropriate locations and also address the concerns of stakeholder institutions on NRM, followed by a training course on PR and related topics to national researchers and partners. Various participatory tools were used to identify and prioritize major system problems. Community meetings were held to establish guidelines for establishing FRGs, on group formation, on group composition and responsibilities. The approach used in setting the future research agenda for the participatory technology testing and development and methods to be use for implementing work plans were also reviewed. Finally social, economic, technical and policy constraints affecting farmer participation, technology adoption and dissemination were analyzed. Continual team mentoring and discussion fora, annual reports, workshop proceedings, consulting key participating individuals and personal observations were used in facilitating the research process and also as sources of information and documentation. Fig 1 shows the whole steps followed in the research process.

PROCESSES, PRODUCTS AND IMPLICATIONS

Processes in pilot site selection

To achieve the primary objective of the project, focus was given to areas with high land degradation, mainly where erosion and loss of biodiversity is prevalent. In the Ethiopian context, areas receiving high amount of annual rainfall and are densely populated are known to have the most degraded natural resources, partly because of migration to the highlands due to malaria. Thus the basic criteria used in selecting the site were high elevation and high population density, and resource degradation. Accessibility was considered as a second criterion. The lead institutions in selecting the site were bureau of Agriculture and Agricultural Research Centers. Secondary data was also used to screen appropriate sites. The most appropriate peasant association fulfilling the basic criteria was Zaba but because it was inaccessible to research and development actors the second best peasant association called Gununo was selected. The Gununo site is characterized by very high population density (about 523 people km^{-2}), high amount of total rainfall (1329.9mm) and small fragmented and degraded land holdings (0.20 ha per household). It is located at an altitude of 1980-2100 masl.

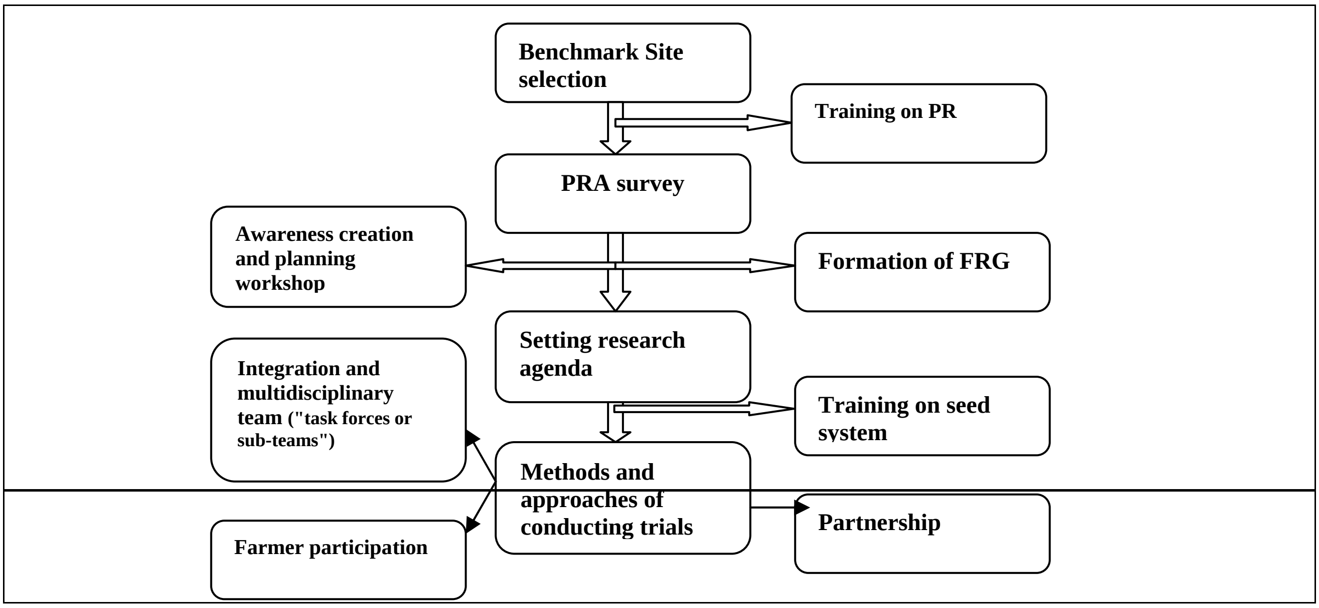

Figure 1. Research and development steps followed in implementing the PR research at Areka

Processes in problem identification and prioritization

Training on participatory research (PR): At that time, the level of knowledge of researchers and development workers on even the necessity of involving farmers in the whole research process was in its infant stages and some of them did not even see the necessity of integrating farmers in the research process. Thus training was organized in 1997 through AHI and ARC to researchers and development workers to introduce the concepts and principles of participatory research. Participatory research appraisal tools such as semi structured interviews, proportional piling, pair wise comparison, transect walk, resource mapping, social mapping, historical analysis, and problem analysis were included in the training. The training was given by experienced regional and local expertise. As PR was new to the area, researchers and extension workers got valuable knowledge that laid base to the current demand of PR by the government.

Participatory Research Appraisal survey was conducted immediately following the PR training. This survey was carried out by a multidisciplinary team for two purposes; partly as a follow up the training course to get firsthand experience, and partly to generate general information about the production constraints, social and biophysical characteristics of the site. The whole team of participants of the PR training including the resource persons were involved in the PRA. The team conducted PRA exercises in two sites for the purposes of better understanding of the approach and considering the relative importance of generating more information in the vicinity of the research center (ARC) for future use. For convenience the survey team was divided into four groups namely crop husbandry, livestock husbandry, natural resource and socio-economic groups. Care was taken to include participants of different disciplines to join each group. The district Office of Agriculture and the respective Peasant Association leaders arranged community meetings. The final output of the survey was presented for the whole community for validation.

Priority problems identified by farmers through the PRA process were oxen shortage, sweet potato butterfly, CBD, high fertilizer price, lack of credit facility, shortage of farm implements, shortage of improved crop varieties and untimely provision of improved seed, shortage of dairy cows and soil erosion. Farmers view on possible solutions were also documented for possible integration into the research agenda. The information obtained also helped ARC as a base for planning additional research activities in the regular research process.

Facilitation forums and workshop

The outcomes of the PRA survey, both agricultural and non-agricultural issues, were presented to a wider forum for creating awareness so that different stakeholders could share responsibilities, particularly on non--agricultural and development-oriented interventions. Bureaus of Water Resource, Health and Agriculture, local administrative council, Agricultural Research Centers, FARM Africa and farmers and their representatives were stakeholders represented in the workshop. The outputs of the PRA survey were presented and discussed and future plan was worked out together.

Farmers Research Groups as promoters

The site team together with the community and their leaders established farmers research groups (FRGs) to ensure farmers participation and enhance farmer innovation in the research process. Thereafter, the community & site team discussed the roles and responsibilities and composition of the committee of farmer research groups. Discussion was made with farmers on roles and responsibilities of FRG and composition. The FRG had 24 members selected by voting. There was one committee established to lead the group, consisting of five members, three from participating and two from non-participating farmers to increase potential for dissemination. Farmers recommended the chairman of the Peasant Association (PA) to lead as the chairman of FRG committee. The committee has one secretary and three members as well, considering gender. The stakeholders agreed on the following roles and responsibilities of farmer research groups namely:

- Facilitating technology testing, adoption and dissemination of participatory NRM research products and lesson
- Facilitate meetings, field days and cross-farmer visits
- Monitor and evaluate research activities at plot and farm level. It includes whether or not research activities are based on farmers priority, activities were implemented at right time and the outputs from those research activities are adopted and disseminated further
- Discuss on progress, shortcomings and possible solutions for solving system constraints in the farm and community
- Facilitate linkage between farmers and site team members (researchers and extension workers)
- Support promotion of participatory research
- Ensure continuation of research process and engagement of farmers in the area

Working through FRGs enabled continuous information flow between farmers and researchers and their institutions through: (a) organizing community meetings once in three months to discuss about new research findings and emerging farm constraints (b) reporting about the working performance of FGR lead members (c) informing community members about technological options and findings to be used in the forth coming cropping season. In addition, it has empowered farmers in handling experiments properly and recording data whenever required. It has also improved mutual confidence and facilitated feed-back about the newly integrated technologies between farmers and researchers and FRG members, which developed towards reliable research partnership. On the other hand, there were certain challenges with few FRG members. (A) Some FRG members requested incentives for the time they invested in meetings, visiting farmers' experiments and delegating the community in other forums, which was partly justifiable as it had consumed their time that would have been used on their farms and other duties (B) Some FRG members were not implementing the responsibilities as they were either carrying many other responsibilities (e.g. the chairman of the peasant association) or were not committed enough to deliver the promises timely (C) Some members were dominating the discussion and directing the research agenda towards free handouts and payment for labour that would have been against the principles of PR and farmer innovation. (D) There was limited transfer of knowledge and technologies to non FRG members. In some cases, FRG members delivered seeds of improved crop varieties to farmers far away from the research area following kinships while the immediate neighbors did not access it (Opondo & Tilahun, 2003).

PATHWAYS TOWARDS INTEGRATED RESEARCH APPROACHES

Formation and strengthening of partnerships

There were different stages of partnerships. At the initial stage stakeholders were engaged in planning and designing research activities. Organizations involved in this partnership included Agricultural Research Centers (Areka, Awasa and Nazreth), Office of Agriculture, Awassa Agricultural College, NGOs (FARM Africa, ILRI), Forestry Research Center, EARO HQs and RRF (System Agronomist). At the implementation stages, the number of partners was reduced to Areka and Awasa Agricultural Research Centers, Boloso Sore Office of Agriculture (BOA) and ILRI (on request). Schools and churches around the site also participated in specific assignments. Areka Research Center played a leading role in establishing themes and teams, based on the PRA findings. This partnership has improved the horizontal and vertical linkages between institutions who used to work separately in the same location. For instance, though ARC and BOA worked on soil and water conservation schemes in the area for decades, they were independently investing labor, money and time and duplicating efforts in the country where resources are extremely limiting.

With recent arrangements, the Office of Agriculture engaged their staff, facilitated the community to discuss on soil erosion-related resource degradation, and shared experiences on the success and failure of the past attempts and facilitated current efforts in agricultural development, which has partly helped in gearing the research agenda towards participatory research and development. Working together has increased confidence of extension workers in encouraging adoption and dissemination of technologies, as it was observed in dissemination of improved wheat varieties and forage napier grasses. The formation of reliable partnership enabled dissemination and scaling up of technologies (e.g. crop varieties, soil conservation schemes) and processes (e.g. decentralized seed multiplication and dissemination through churches and schools). It has also improved farmer to farmer and farmer to extension linkages, documentation of innovations and technologies, organizing dissemination fora and training in a sustainable manner. These processes also enabled farmers to innovate system compatible practices.

Some partners withdrew from the platform for the following reasons. a) They were demanding more funds and benefits beyond the capacity of the project b) Some were promoting their own research and development agenda in isolation that undermined partnership c) Limited contribution due to other institution of commitments and overlap of activities and d) Continual change in government policy directions on agricultural development.

ROLES OF MULTIPLE DISCIPLINARY TEAMS

Initial team formation followed a mix of discipline lines including researchers and development workers. Because most researchers of ARC were junior, researchers from other two research centers (Melkasa and Awasa) strengthened the team in their respective fields. The principle behind was that formation of integrated multidisciplinary teams, promotion of farmer’s participation at all stage of the research and establishment of strong partnership would enhance farmer innovation and increase technology adoption. Thus research "task force" was formed based on the established research agenda and embodied both individual and collective responsibilities. The research "task forces" had a leader and different sub-team against specific research activities. The following were the four task forces with their sub teams:

a) Soil fertility maintenance and improvement team, which handled issues related to soil and water conservation, integrateing soil fertility and pest management, agroforestry and livestock feed.
b)Improving crop yield through participatory selection of improved crop varieties.
c) Improvement of income and investment though diversification and intensification by integrating marketable commodities (crops, livestock) and and credit.
d) Dissemination and scaling up of available technologies and practices.
Some research activities (e.g. seed system, participatory variety selection) called for multiple actors and involved all sub-themes.

FORMULATION OF PARTICIPATORY RESEARCH AGENDA

The participatory problem analysis revealed that the priority problems identified by farmers, in term of importance, were oxen shortage, sweet potato butter fly, CBD, high fertilizer price, lack of credit facility, shortage of farm implements, shortage of improved crop varieties and untimely provision of improved seed, lack of provision of dairy cow and soil erosion.

Farmers' participatory research approaches using technologies that address immediate problems of farmers as entry points were used (table 1). The most preferred entry points were high yielding crop varieties of maize, wheat, bean and teff. After few farmers undertook varietal tries in the first year and benefited from high yield of the newly introduced varieties more and more farmers became interested in testing other technologies. As the landscape is an erosion-prone environment with declining soil fertility, farmers requested low cost soil fertility management options together with the varieties in the second year. On sample farms with high slope, research on soil conservation schemes was coupled with biological stabilizers having multiple use (food, feed, cash and soil protection). Those farmers who did not have erosion problem but feed shortage planted different forage species on available niches and selected best fitting species based on their preferences. High value crops like Banana and enset (food crop) were planted on the bund as biological soil stabilizers. Integrated pest management activities like controlling sweet potato butterfly, coffee berry disease and others were managed through combination of resistant varieties, soil fertility management interventions and cultural practices. Research monitored the various variety dissemination channels for future intervention in scaling up of technologies and processes. Farmers' interest to try and adopt improved technologies was enhanced through credit scheme. In the study, farmers' were asked about their immediate strategies to get out of poverty and received credit for oxen, cows, sheep and cash based on their own choices. Researchers monitored which credit scheme was successful to address farmers' problem of income and enabled them to have access to more agricultural inputs.

SUPPORTIVE TRAINING EVENTS

Training workshops on seed system for primary stakeholders to help them understand the objective of seed system to enable farmers to manage crops for seed purpose so as to build capacity of farmers for innovation. The training covered production of major crops (maize, haricot beans, wheat, barley, sweet potato and potato) for seed production and crop management including cultural practices, field supervision and control, crop protection (both in field and store), harvesting, handling, storage and marketing of seed. The training included classroom sessions and field visits where farmers were involved in presenting their experiences on seed production storage and usage. The training benefited farmers to understand the differences between composite (open pollinated) and hybrid seed with special reference to maize, differential management of open pollinated and composite varieties, management of disease and pest that are transferred by various agents, e.g. cultural control of smut on maize and sorghum.

PARTICIPATORY MONITORING AND EVALUATION

Farmers' participation

Research "task-forces" used participatory approaches that involved farmers at all research stages. Farmer's knowledge was incorporated into potential solution and testing. Farmer innovation (farmer-led experimentation) was encouraged by providing farmers with the necessary information, materials and techniques.

In the beginning stage of participatory research, it was felt important to focus on simple trials and then increase complexity with time. Farmers Research Group led by committee was formed to facilitate and strengthen researchers-farmers, farmer-extension and farmer-farmer linkage.

Results

WHAT HAVE WE LEARNED? SUCCESSES AND CHALLENGES

Successes

1) Five food and economic field crop varieties, i.e. maize, wheat, haricotbean, potato and teff, tested and adopted by the FRGs were disseminated to many other neighboring communities. The woreda BOA can thus confidently involve these varieties in the extension program.
2) Drought resistant, high yielding forages (e.g. elephant grass) had wider acceptance due to its high productivity per unit area in this region where land shortage is critical and feed availability is very low. Currently, even non-trial farmers of bounding villages are requesting for its planting material.
3) Important fruit and multipurpose trees and soil and water conservation practices were evaluated and adopted by many community members
4) Farmers' capacity to innovate and communicate can easily with researchers
5) Researchers have understood farmers' multiple criteria of selecting crop technologies, developed a capacity of working with farmers and other stakeholders better than the previous days.

Challenges

1. Conflict between neighboring farmers while constructing soil and water conservation practices and those neighboring them as the run off from conserved soil affected the non conserved soil due to problems in water disposal. Thus it will be necessary to practice such activities in a watershed level that will call farmers having common problem to work together in a collective manner.
2. Lack of interest to test the varieties under various scenarios (drought vs good year) Farmers have intention of utilizing varieties for production directly from one-year observation and because of that they do not want to repeat the whole varieties, particularly the non preferred ones in the first year, in the treatment for two or more years.
3. Farmers considered credit as aid and they were reluctant to repay credits, partly because the area is known to experience food shortage and food aid.
4. There was poor over all coordination of the PR work mainly due to frequent turn over of the site coordinators for study leave and over lap of other official activities. Because of turn over of members, new members with in adequate experience had to join and this has taken some steps back
5. Partner institutions were o loose in participation when they felt of limited direct benefits
6. From PR with farmers, researchers drew lesson form different dimensions ……

References

Participatory Rural Appraisal report, 1997. Un published report, AHI-Areka Benchmark Site, Areka Agricultural Research Center, Ethiopia

Annual Report, 2000. Annual report of AHI-Areka Benchmark Site, Areka Agricultural Research Center (ARC), Ethiopia

Annual Report, 2001. Annual report of AHI-Areka Benchmark Site, Areka Agricultural Research Center (ARC), Ethiopia

Annual Report, 2003. Annual report of AHI-Areka Benchmark Site, Areka Agricultural Research Center (ARC), Ethiopia

Chris Oppondo & Tilahun Amede, 2003. Proceedings of Transition Workshop for Areka/Awasa AHI Site Team in Ethiopia, 27-31 Jan 2003.

Water Resources Management in the Baga Watershed: Past, Present and Future

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Abstract

Characterization and diagnosis of water resources in the Baga watershed was conducted in the period between November 2003 and April 2004. This inclusive methodology of generating realistic data on the production, management and governance status of water resources was used with an intent to draw upon the information, insights and perception of the local population who are the owners, managers and users of water resources in the boundaries of their watershed. Participatory approaches that included use of group discussions, interviews with key informants, semi-structured interviews, questionnaire administering and open-ended discussions were employed.

Among the findings, trends on use, management and status of water resources in the six sub-watersheds' and the whole watershed were obtained. It is evident from the findings that water resources were in very good state in the years prior to 1950s. There was plenty and clean water for both irrigation and domestic use. Among other factors increased population pressure, uncontrolled forest clearing, introduction of undesirable tree species and drought adversely affected water resources in the watershed. The state of water resources gradually declined with time reaching alarming status in the present years. At present water for irrigation and domestic purposes is no longer meeting the demand of the population. There is serious shortage of irrigation water and water for domestic use especially during dry season. Replacement of undesirable tree species, enforcement of by-laws that protect catchments areas and water sources were among many interventions proposed by the community as solutions that would reverse and restore water resources in the Baga watershed.

Introduction

A popular myth, which is often expressed today, is that "the next great war will be a water war". This is in response to the growing pressure on natural resources, which is being experienced throughout the world in the context of increasing demand. With the very high numbers of water courses which are shared between different units, water and its use is undoubtedly a cause of tension and often strains relations between countries (Gleick, 2003). Tanzania is not exceptional in this case. The country's numerous and varied national and local water resources including those of Baga watershed are beginning to be threatened by over utilization and inadequately planned management as well as by lack of basic information and public awareness of their values, functions and products (Gleick, 1998-99).

This paper presents past and present management and status of water resources in the Baga Watershed. It also outlines the process where knowledge, views and ideas of the community in the watershed were incorporated in development of future sustainable water resources management in the watershed.

Background

The vision of ministry of Water and Livestock Development is to achieve a sustainable water resources and livestock development and management which is responsive to the needs, interests and priorities of the Tanzania population, both in rural and urban areas by year 2025. Its mission is to ensure that livestock and water resources management and development are carried out in collaboration with all stakeholders in an economic, environment and social sustainable manner (Ministry of water and Livestock, 2002).

In order to accomplish the ministry's vision and mission communities in the areas concerned need be involved in planning of management that is intended to improve status of water resources in their area. To effectively do this these communities need empowerment? Community need;

a) A clear understanding of what is happening and why. There should be a program to develop understanding of the situation and raising awareness;
b) A shared vision for the future. Stakeholders from all levels have to come together, to discuss the issues and seek locally acceptable solutions.
c) Be involved and committed. Governance and livelihood issues, which obstruct people, to participate in the process should be addressed and capacities at all levels to use information in planning should be built.

In view of all the above it seems imperative in this case to involve the community of Baga watershed in narrating the past and present water resources management and their status and proposing options that would with time reduce water resources degradation in the Baga watershed.

Objectives

The objective was to characterize water resources in the Baga watershed through participatory development of understanding of the situation (in the past and present), a shared vision for the future and raise awareness of the community on water resources use and management issues and from which develop locally accepted solutions.

APPROACH TO WATER RESOURCES CHARACTERIZATION IN THE BAGA WATERSHED

The status and management of water resources was constructed through the use of primary and secondary data such as PRA, reports of earlier engagements, gray literature that existed and key informants. Characterization started in office by intensive literature review of reports such as farmers, key informers, maps drawn by farmers were reviewed. Most of the biophysical data was obtained from reports of works carried out by previous parties of AHI. The gaps were identified and strategies to fill gaps were worked out. Major gaps on historical trends on natural resources management in the watershed were filled through discussions with key-informants. Participatory approaches that included use of group discussions, interviews with key informants, semi-structured interviews, questionnaire administering and open-ended discussions were employed.

Characterization made use of the administrative map of each village, with information gathered through community mapping superimposed on top. Major features such springs, streams and rivers in the participatory drawn maps were perfected in the office by thorough review after which base maps were developed. To have digital boundaries delineation, geo-referencing was a necessary step. This was done using a "Global Positioning System, GPS" equipments with assistance of few key informants who knew very well the boundaries and water resources in each of the six villages in the watershed. The GPS reading were downloaded in the computer and plotted on base map already prepared. The GIS laboratory ARI-Mlingano conducted further refinements, construction and printing of the maps.

Open ended discussions were conducted with key-informants and individuals who use water and those leaving close to water sources with the aim of gaining an understanding of the past and present status and management of water sources, so as to assist in better targeting of interventions which will restore water sources in the watershed. Participatory approach and stakeholder's involvement were used to encourage wider ownership and to empower the users of the water. The use of stakeholder participation in Integrated Water Resource Management holds great promise for use in protecting, conserving and rationalizing the use of our water resources. Participation by stakeholders in water management programmes is required not only to build the necessary consensus for policy reform but also to promote more resource efficient and socially responsible water management that benefits all sections of society, especially the poor and marginalized.

Results

WATER AVAILABILITY PAST AND PRESENT

Discussions, physical evaluations and outcomes of questionnaires have revealed serious water resources degradation in the Baga watershed. According to the community engaged, there were ample water resources and unlimited water supplies in the years prior to 1960's. In each of the six villages in the watershed there was a big number of water sources (springs, streams and rivers) and all were in very good conditions. Springs had very high recharge capacity and water flows in streams and rivers were very high and the level of flow was more or less the same throughout the year. During the time water resources were well protected, thus degradation did of these resources did not exist or was at a very low level.

According to the community the status of water resources in the watershed deteriorated gradually with time in 60's. It peaked up after 70's and reaching alarming rates in the present time. Tables 1 and 2 present's numbers and status of springs, rivers and springs in the watershed.

Table 1: Number and status of springs in the Baga watershed

Village	Number of operational Springs	Number of seasonal Springs	Number of dead Springs
Kwekitui			
Mbelei	18	3	2
Kwadoe	29	3	1
Kwalei	12		
Kwehangala	19	8	-
Dule	23	-	2
Total			

Presently, the community has started to fill the effects of water resources degradation. Water, which was in ample supply is now a scarce resource in the watershed and is a course for concern. They are observing decreasing numbers and discharges of springs, as a consequence number of streams and rivers have also declined (Tables 1). In addition to this water flow levels in those streams and rivers that flow throughout the year is very low especially during dry season. Figure 1 presents historical trends of these factors elucidating the changes that took place from 1930's to 2003.

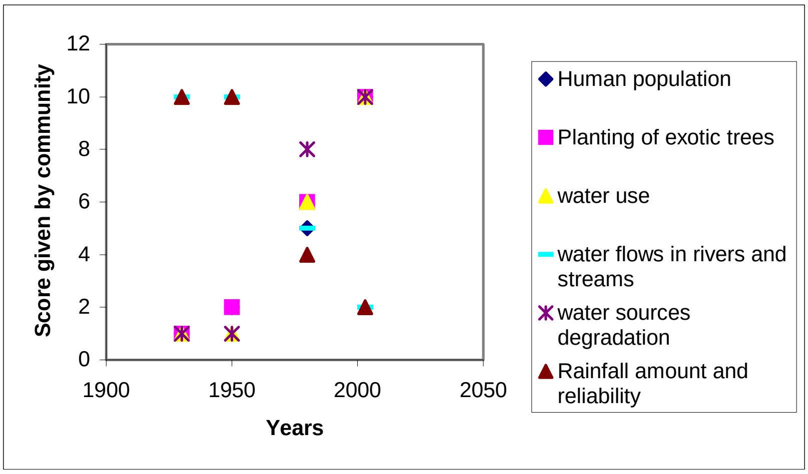

Figure 1: historical trends of some of the factors responsible for inadequate availability of water and water resources degradation.

Domestic water facility is a problem in the watershed. Only one village (Mbelei) is connected to a network of clean piped water line. Other villages depend on streams and springs, which are not, protected thus such diseases as stomach disease like amoeba, dysentery and typhoid have been in health centers across the watershed. It is reported that during dry season pipelines some springs and streams dries out especially in the months of January and February. Amongst the six villages in the watershed a large number of springs in Kwekitui dry out during dry season. This affects most women who have to walk long distances to fetch water and thus spend more than one hour waiting for water. In the case of Kwekitui it was reported by the women that during dry season they spend between six to seven hours to get one bucket of water. The community to be responsible to the inadequate availability of water and degradation of water resources pointed out to a number of factors. These included human population, introduction of exotic trees and water use. Others included water flows in streams and rivers, water resources degradation and rainfall amount and reliability.

Water use for domestic livestock and crop production purposes has increased considerably. This as pointed out by community was a result of increased human population and use of water for irrigation especially in valley bottoms, which were initially left as wetlands and to a lesser extent supplement irrigation on upper slopes due to more severe drought, which is regularly occurring. Contrary to the increased demand, the availability of water has been dwindling with time. This is mainly as pointed earlier due to drying or reduced discharge in the springs, drying up of some streams and rivers and declining flow levels in these streams and rivers. This diminishing capacity of water supply in the watershed is associated with water sources degradation, which has increased sharply from 50's to 80's (Figure 1). The main causal factors for this degradation as pointed out by community are; planted exotic trees (*Eucalyptus spp and Acrocarpus spp*), cutting of indigenous trees and grazing around water sources, cultivation around wells, springs and river banks leaving bare surface as the culprits for increased evaporation of water from the sources.

Plate 1. Cultivation of vegetables closely around springs, streams and irrigation canals

Other main factors mentioned were decreased rainfall amount and reliability and clearing of water catchments, which both contribute to reduced capacity of the catchments to recharge water sources.

More specifically the community has categorized their water scarcity problem into three main areas these include;

- Poor management of water catchments and sources
  This is as was mentioned earlier is lack of protection of water catchments and sources where there is encroachment from cultivation and grazing and planting of undesirably water species, which are believed to dry up these sources.
- Inefficient water distribution, poor construction and management of water canals
- Ownership and management of water resources

Why This Water Resources Degradation Was Left Unchecked In The Years After Independence?

The community pointed out that changes in social, political, economic conditions and in the attitudes of people starting 1960's as major contributing factors to the prevailing water resources degradation in the watershed. Before colonial era traditional knowledge (taboos and beliefs) were used to protect water catchments and water sources in the watershed. Traditional laws were forbidding cutting tree such as Ficus thonningii (Mvumo), Ficus sycomorus (Mlui), Syzygium cordatum (Mshiwi) and Albizia gummifera (Mshai). It was believed that whoever cuts Ficus thonningii (Mvumo) would be followed by evil spirits and if the tree would be used as fuel wood, its smoke would kill livestock. For Mlui it was believed that, once somebody touches it, its extract (white sap) would blind the person. It was also a taboo to cut Ficus sycomorus (Mkuyu), albizia spp (mshai) and Syzygium cordatum (Mshiwi) for the elders emphasized that they possess evil spirits (ghosts), and that the ghost would follow the person and brings disasters to family and community in the Watershed. Traditionally it was forbidden to cut such trees as strategy to protect the water catchments and environment as a whole.

Traditional beliefs were also used to protect water sources in the watershed. Some examples of these were: Restricted use of cooking pots with soot to fetch water from springs or rivers, as this was believed would lead to drying up of the water sources. This was meant to maintain water cleanliness. Tree cutting was restricted around water sources with beliefs that there were snakes around. This was meant to maintain the buffer zone needed to protect water sources.

Unfortunately, respect to traditional and government by-laws gradually declined from 60's and rapidly declined from 1980's to 2003. Introduction of religion, education, cultural integration and increased democracy are among the factors, which are believed by the community to be responsible for this declined respect. Presently, though there are by-laws that were designed to protect water sources, such as leaving buffer zone of 12m around water sources and protection of catchment's areas for these sources. Unfortunately, these have not been working, mainly due to irresponsibility/lack of accountability for follow-up or reinforcement of these by-laws by sub-watershed leaders. Weak enforcement is also blamed on other social reasons such as closeness of the wrongdoers to the by laws enforcers and fear of the law enforcers to some people may be due to their social status (e.g. wealthier or witchcraft).

Discussion

PROPOSED MANAGEMENT OPTIONS FOR FUTURE SUSTAINABILITY

How Will The Community And Research Act To Reverse The Situation?

Realizing the grim situation of water resources in their watershed the community proposed a number of actions, which their thought if taken would alleviate the water sources and catchments degradation that is presently observed. Some of these community actions would need some research inputs in various forms ranging from awareness creation, capacity building and also field verification of some of the facts that were raised by the community.

Issues That Need Community Action Alone

The community thought that collective action would be a driving force into attempting to solve most of the identified water resources degradation causes. Amongst these were; to regulate planting schedules for vegetables growers through their association in order to reduce water competition among growers and introduce irrigation scheduling. Other issues that needed collective actions were; enforcement of by laws that govern natural resource management, construction and expansion of dams where possible to harvest and store water for use during drought. Improve, maintenance and protection of irrigation canals, by conducting "gunda" (mass call) for canal construction and maintenance.

Issues Needing Capacity Building

All those who use Baga's watershed water resources for their livelihoods are responsible for reversing the water resources degradation that is taking place. This means that government at all levels, other institutions, local leaders, and private business all have responsibility for restoring water sources. A partnership is needed that will decide on what are best approaches, so that people's actions work together and the actions of individual groups do not harm the livelihoods of others or threaten discharge or flow levels in springs and rivers. Local skill in coordinating this kind of partnership does not exist, there is therefore a need to build local capacity in developing and coordinating partnership which will decide how everyone responsible should be involved, and how decisions will be made. Introduction of water harvest techniques for domestic use and improvement of infiltration of rainfall through proper tillage and conservation methods that will increase ground water recharge are the two proposed solutions, which will also need capacity building amongst the community. Use of user-friendly materials such as leaflets and posters might also be useful in reaching a wider community.

It was pointed out by the community that bylaws designed to protect water sources and catchments do exist, but are not respected or enforced. Facilitation is needed in this aspect in two fronts. First is in documentation of the existing bylaws and together with all stakeholders assess if they fulfill the protection of water sources and if not have additional bylaws that will perfect the full protection of water sources. Secondly, facilitate the process where the outcome will be fulfillment, acceptance and reinforcement of bylaws that protect water resources in the watershed.

Issues Needing Research Verification

Exotic trees (*Eucalyptus spp , Acrocarpus spp and wattle trees*) planted near water sources were identified by the community to be responsible for drying water sources and have proposed that these tree species be eliminated in areas near water sources and be replaced by trees spp that will be compatible with water sources. The community admitted that they have no technique at there disposal to quickly remove the trees and replace them. They therefore requested assistance from experts to avail them with the technique. The experts also need to establish list of tree species believed to dry water sources and those which will enhance water sources so as to avoid use of unsuitable tree species in or near water sources.

Conclusion

Water supports watershed's community livelihoods through irrigation of vegetables, banana, and other annual crops both in valley bottoms and hill slopes. However, there is a concern for the future availability of water for community, food and sustainable management of ecosystems. Watershed's availability of water is steadily decreasing as populations grow. Government policies promote irrigation and irrigation improvements as away to improve food security and to reduce poverty. However, these policies do not fully recognize the links between poverty, people's livelihoods and the environment. The sustainability of watershed's water resources is threatened both in terms of quantity and quality. Unless the current water usage patterns and management patters are changed. Future water demand will significantly exceed available water resources, in terms of both quantity and quality. Ultimately, restoring discharges and flows is not simply a water management issue but a livelihoods issue. There is therefore a need to emphasize that for the identified solutions to be sustainable, to recognize the real causes and not just address the symptoms. Implementing of these solutions needs commitment of all the different partners. It may involve partners making changes to their livelihoods, activities, approaches, and attitudes, working practices and policies. Again, these changes need to be long term.

References

Weatherhead, K. 2003. Institute of water and Environment. Cransfield University Silsoe

Gleick, P. 2003. Water and Conflicts. In The African Water Page

Ministry of Livestock and water, 2002. Ministry of Water and Livestock Strategic Plan. Ministry of Water and Livestock Development.

Gleick, .H. 1999. The World Water. Island Press. Washington D.C

Towards Participatory watershed Action Plan for INRM in the East African Highlands: AHI Experiences in Lushoto Tanzania

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Abstract

The need for a watershed approach in addressing constraints faced by rural communities arises from the realization that solution to some issues requires higher-level organization involving more than one farmer or community. In this paper we share our experience in formulating a participatory watershed action plan with farmers in Lushoto District northeastern Tanzania. An in-depth exploration of biophysical issues confronting farming communities in 6 villages (collectively referred to as Baga Watershed) in Lushoto District identified issues that can be addressed at farm level and those that require collective action involving different communities scattered over a larger area. The delimitation of such an area is difficult since it will be dictated by not only biophysical characteristics (hydrological) but also by t€he extent of social interactions of the communities in relation to the biophysical issues at hand that make different neighbouring communities feel that they need to come together to address them effectively. Constraints that can be addressed at farm level include poor soil fertility, lack of improved seed and lack of breeding bulls. On the contrary, issues like pest and disease management, soil conservation, management of water sources, presence of undesirable boundary trees and management of traditional canals require a higher social organization involving several communities as can reasonably be determined by the issues themselves.

After identifying with farmers at village level issues requiring watershed level intervention, participatory watershed action plan was carried out where representatives from the six villages attended. Representative teachers from the local schools, and researchers, extension officers and the resident community development officer joined the farmers in this exercise. The watershed action plan set out a program for addressing the issues earlier prioritized by the different villages indicating what should be done when and by whom, as well as the kind of facilitation required. Farmers were enthusiastic with the exercise especially on the prospects for collective action involving the wider community in the watershed as they realized that their collective strength could be positively exploited to address issues that individual communities could not.

Background

Most of the upland ecosystems have been referred to as watershed or catchment areas that have been sources of water for the entire upland and lowland ecosystems including both human societies as well as fauna and flora within and along the ecosystems. Different scholars have defined watershed in hydrological point of view as a land where all of the water that is under it or drains of it goes into the same place or an area of land draws down slope to the lowest point (EPA, 2002). As for this paper watershed is referred to as an area which is dictated by not only biophysical characteristics (hydrological) but also by the extent of social interactions of the communities in relation to the biophysical issues at hand that make different neighboring communities feel that they need to come together to address them effectively.

Multiple practices have been initiated in order to achieve the integrated natural resource management in the watersheds. In many areas, participatory watershed planning has been carried out and the success stories have been reported. According to Fernandez (1997), participatory watershed planning is a matter of guiding and organizing in such a way that the population of the watershed unit may come together and with help from facilitators identify problems and needs and work for the benefits that can be recognized in measurable terms by families, individuals and groups living in the watershed or within its area of influence.

In order therefore to arrive to an accurate identification of peoples' priority issues in the area, the contribution of the innovative ideas, the incorporation of people's own traditions and lore, development in self confidence as the project proceeds, a jealous control over resource use, self support over the medium and long terms; a strengthening of peoples own forms of organization and the bringing into being of a virtuous circle of improvement, the participatory element must be genuine one, with no personal preferences shown on any manipulation of the community (Klisbergy,1997 in Fernandez, 1997). Basing on the situation that has been reported to exist in the Usambara highlands especially in Baga watershed, local communities with the facilitation of African Highland Initiative (AHI) facilitators embarked on an exercise of developing a watershed action plan by applying participatory approaches involving different stakeholders. The main task of this activity was to develop an achievable watershed action plan using participatory approaches that will enhance effective management of natural resources in the Baga watershed in highlands of Lushoto Tanzania where AHI operates. Specifically the exercise aimed at identifying the burning issues that when implemented can promote effective management of natural resources in the respective highlands, characterizing the issues according to the priority on the need to the watershed villages in the highlands; setting deadlines of different activities that have been proposed to be carried out in the watershed and proposing the follow up mechanism for Participatory Monitoring and Evaluation (PME) of the whole action plan that has been prepared using participatory approaches.

Methodology

To develop an action plan for the watershed, information was gathered from the community through the use of a number of participatory approaches and tools. Key informers, leaders and individual interview, focused group discussions with different categories (gender, location on landscape, and resource endowment), were employed to identify major watershed problems. Focus group meetings also facilitated the ranking of the issues identified during PRAs, prioritization of the issues according to the need.

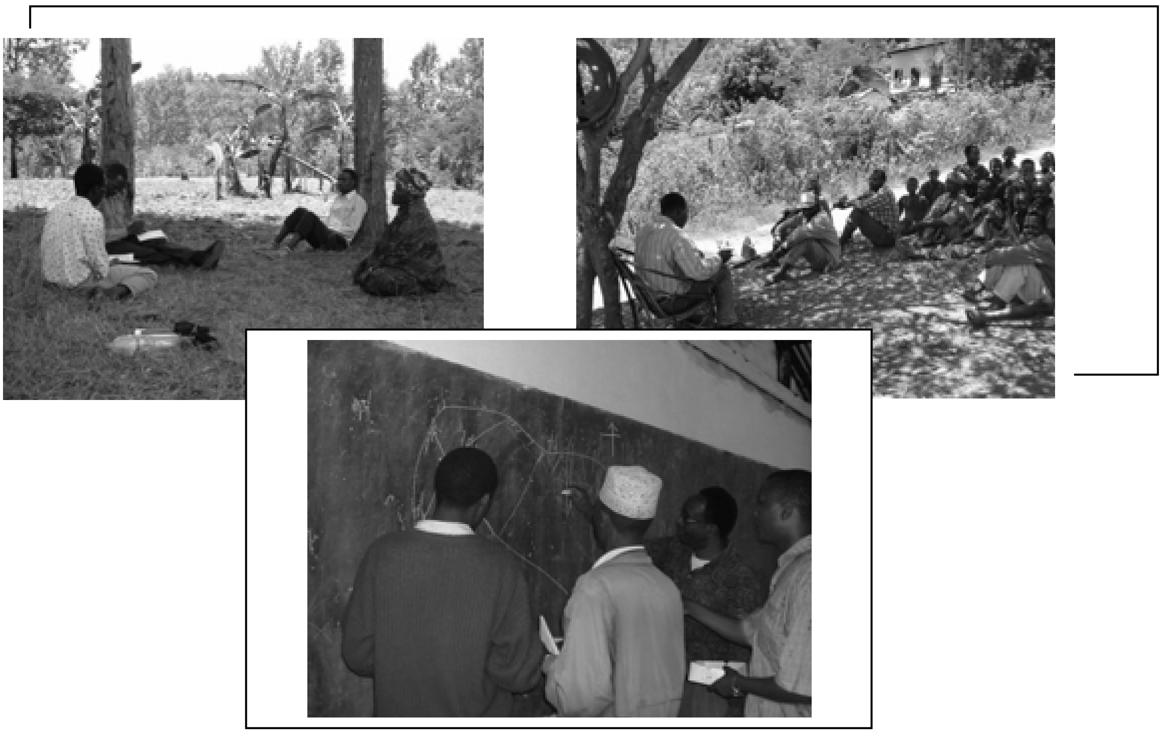

Plate 2: Group heads of watershed forum presenting they findings and to other members of the forum

A watershed forum was then called to formulate the action plan for the issues that need to be solved (Plate 1 and 2). The forum identified different groups and individuals that will be responsible for making follow ups of the planned activities setting deadlines for the specific activities to be worked out and setting participatory monitoring and evaluation of the plan that has been prepared. Five (5) representatives from each of the 6 watershed villages attended the planning meeting. Among the five, there were two men and two women, and the fifth was a teacher who represented his/her school, which is one of the village stakeholders other stakeholders were also involved during the process. Generally the approach for the meeting could be either conducting a meeting in each village or having representatives from each village and meet at one venue. Representatives opted for the second option and researchers, and staff from extension services and non-governmental organizations facilitated the process.

Results

The issues for planning in the Baga watershed were in four major areas. These include; water resource related issues, trans-boundary issues (tree/crop/water interactions), land productivity that included crop and livestock related issues as well as social issues. For each major area bottlenecks were discussed and their solutions and alternatives suggested. To ensure success in implementation of the plan participants proposed; formation of committees that will be involved in implementation of different issues, development of implementation program, implementation modality, responsible person/group and time frame to deal with the issues that require a higher social organization involving several communities at the village and at the watershed level. Specific issues, their solutions and alternatives of the four main areas (water resources, land productivity, trans-boundary and social are discussed below.

WATER ISSUES

Water source issues are presented in detail in Monsoor etal, in this volume.

Crop production

Community mentioned decline soil productivity as a result of soil erosion and declined soil fertility as main causes of declined crop productivity in the watershed. Several solutions were proposed which include conservation of soil against soil erosion, use of organic and inorganic fertilizers to fertilize the soil.
Unavailability and high prices of quality seeds for crops grown was another culprit for low yields of crops observed in the watershed. Participants explained that in the villages within the watershed, there are no more existing good varieties of seeds simply because the seeds that were brought have been attacked by diseases and they do no longer exist. Participants referred seeds of crops like beans to have been affected completely.

The proposed solutions for this problem was to provide new seed varieties which have been tested for their resistance to diseases and drought, farmers should form seed production groups and buy the seeds in small quantity in order to try them in the area. Participants also mentioned the need for AHI and farmers to share the costs for purchasing of the required seeds for testing and multiplication. Prioritization of the seeds required in the watershed was also conducted where by seeds that are resistant to diseases/drought and that will also have short maturity period to include potatoes, tomatoes, maize, cabbage and some perennial crops like coffee and banana were recommended to be availed to farmer seed production groups in the area for testing and multiplication.

Livestock production

During the discussion the major issue regarding livestock production that has been discussed here was the establishment of the breeding bull (Dairy) centers. Participants mentioned lack of bull centers in the villages within the watershed as one of the burning issues. They agreed to establish a dairy bull center in each village for all six villages, which are within the watershed. Meeting representatives from different villages were required to introduce the idea to their own villages and they have to select bull keepers among themselves at village level. The representatives agreed to have established bull fodder plot near bull keepers home and the arrangement for bull box (shed) construction in each village should be made prior to the purchasing of the bulls. Moreover, they should have to lay-down the running procedures for a bull center, cost for maintenance and hence financial contribution and fund raising from the centers and users. The agreement was that farmers with the assistance of AHI should see the feasibility of cost sharing for bulls purchasing from improved herds.

Trans-boundary issues

Different issues were raised and were considered as trans-boundary issues that need a higher level of organization within the villages and the watershed at large. The issues that were hoisted included Plantation of undesirable boundary trees, diseases and pests, soil erosion and farm boundaries. Regarding undesirable tree species, *Eucalyptus* spp planted at the boundary to protect government natural forests, Sakarani estate and woodlots owned by the absentees land owners were mentioned to have affected villager's neighboring farms and water sources. Furthermore, other trees including Miwati (*Accacia meansii*) and indigenous avocado tree spp were also mentioned to have the same effects. For the case of diseases and pests, it was mentioned that, diseases, pests and insects affect peasants whose farms border the forest. Similarly farms that are not properly managed cause the spreading of the diseases insects and pests to the properly managed farms. According to community, farms seriously affected by soil erosion are those that are not planted with trees, grasses or without terraces. These farms were identified as cause of sedimentation to other farms, which are located on the lower slopes. Uncontrolled fires affect soil and forests in the watershed. Example given by the community was fire started at Mponde village that had affected neighboring Kwadoe village. It was also pointed out by the community, that charcoal burning contributes to soil erosion, such that fire that is used in charcoal burning can also burn farms as what happened at Kwadoe and Mtunda, the areas that are out of the watershed where the fire from these villages burnt the tea farms/plantations. Road construction/maintenance was identified by community to be one of the main causes of soil erosion in the farmer's fields.

A number of solutions on tree species affecting water and crop productivity were identified, these included; conducting stakeholders meeting to discuss the issues pertaining to the undesirable trees (i.e. Sakarani and ward leaders), planting alternative trees, collaborate with stakeholders who planted tress (i.e. Eucalyptus) to uproot them, planting of exotic (e.g. avocado) trees. Others were provision of the bylaws that will put emphasis on uprooting trees mentioned to have affected the soil and water, which will also need people to plant alternative tree species and the need of consultations with experts.

SOCIAL ISSUES

Through facilitation the community was able to identify the social capital existing in the watershed. These were three, problem solving mechanism, local experts and by-laws. Problem solving mechanisms included elder's council, religious leaders, ten cell leaders, and village ward and division leaders. The local experts are those who know different tree species, practice traditional medicine, traditional birth attendants and fortunetellers. Last but not least for social capital is existence of by-laws towards protection of natural resources.

Participants from watershed villages mentioned necessary conditions for effective collective action and these included collaboration/cooperation, holding meetings and formulation of work program, developing working calendar, existence of bylaws, trust, closeness, willingness to work together, creativity, and good leadership. The community identified a number of areas where collective action is needed and this are bylaw formulations on free grazing, tree harvesting, forest and wild fires, sell of immature crops and on management and conservation of forest and water resources. Other areas where collective action is needed are in construction of irrigation canals, soil conservation, and trees on farm boundaries and livestock issues especially on the bull issue.

It was pointed out by the community that adherence to bylaws is weak therefore it was recommended by the community to urgently review the current bylaws and examine their suitability, and applicability and assess on whether if additions are needed and obstacles towards implementation of the current bylaws. Hence the community has proposed AHI to facilitate the committees in the villages to work on bylaws, educate local communities on the importance of bylaws. The community had also proposed seeking advice from elders on how implementation of the bylaws can be carried out and on the need of ward council to advocate the importance of people to participate in work.

Conclusions

Involvement of users in watershed management has significant implications for watershed research, principally that improving the sustainability of watershed management will require not only better technologies and policies for resource use, but also better organizational mechanisms and processes through which stakeholders can come together to make decisions. In many ways, watershed management is about 'managing the invisible' in the sense that, up to a certain point at least, the outcomes of changes in natural resource management practices are incremental and often not immediately observable. Sustaining participatory watershed management when the outcomes of people's efforts are not visible is hard. Thus, an important contribution of research to participatory watershed management is, as expressed by Woodhill et al. (1999) 'to make the invisible visible'. Establishing collective research or learning capacity in local communities may be particularly important to achieving sustainable participatory watershed management because of the importance of local institutions and collective action in the watershed environment. The research or learning process can be a way to unite diverse stakeholders around common interests and goals. Most of the activities planned in the participatory watershed action plan of Baga watershed in Lushoto are firmly linked with research so as to ensure awareness creation and identification of appropriate technical solutions.

References

Warren, P. 1998. Developing Participatory and integrated watershed management. A case study of the FAO/Italy-regional project for participatory upland conservation and development (executive summary and metadata only) Community forest Case study series 13. FAO and Cooperazione Italiana. Rome

EPA, 2002. Watersheds: What is watershed? In http://www.epa.gov/watershed/whatis.html

Fernandez, E.B. 1997. Strategies for strengthening watershed management in tropical mountains. XI world Forest Congress, Antalya, Turkey

Dutta, S.K and M. Ray, 1997. Doon Valley watershed management an endeavor for sustainable eco-restoration through people's participation. XI World Forestry Congress, Antalya, Turkey.

Michaelsen T., 2002. Participatory approaches in watershed management planning. FAO (Unasylva # 164; Watershed Management)

Johnson, N., Helle Munk Ravnborg, Olaf Westermann, and Kirsten Probst, 2001: user participation in watershed management and research. CAPRi working paper no. 19**.** CGIAR Systemwide Program on Collective Action and Property Rights Secretariat: International Food Policy Research Institute.2033 K Street, N.W. Washington, D.C. 20006 U.S.A

Swallow, B., D. Garrity, and M. V. Noordwijk, 2001. The effects of scales, flow, and filter on property rights and collective action in catchment management. CAPRi Working Paper, No. 18, Washington, DC: International Food Policy Research Institute.

Woodhill, J., J. Frankenburg, and P. Trevethan, 1999. The challenges of change for the West Hume Landcare group. In *Fertile ground: The impacts of participatory watershed management.* ed. F. Hinchcliffe, J. Thompson, J. N. Pretty, I. Guijt, and P. Shah. London, UK: Intermediate Technology Publications Ltd., 354-368.

Chapter 7:

Managing New Working Relationships

Challenges and Opportunities in Leading a Multidisciplinary Team of Professionals from Multiple Institutions: Lessons from AHI Lushoto

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Abstract

Forging strategic partnership to address the complex natural resource management issues in the highlands of Eastern Africa is one of the cornerstones of the AHI approaches in mitigating natural resources degradation. Such partnership brings together professionals from different institutions with different training, interest and experience. Apart from the highly specialized nature of the professionals, they are also charged with different tasks as dictated by the mandates of their institutions. The management of such teams brings about organizational challenges that require effective leadership in order to exploit the capacities existing in our institutions. In a study involving African Highland Initiative (AHI) site coordinators from Ethiopia, Kenya and Tanzania leading multi-disciplinary teams of professionals from different institutions it was established that this is a challenging task requiring patience, commitment and vision. As the team sets to work there is an overall lack of enthusiasm and an element of fear for the unknown. Several questions are raised in the areas of motivation, rewarding system for a group product and loss of professional identity in their areas of specialization. With time however, these fears subside for those who persist and leadership becomes more interesting and less challenging. It is concluded that there is a need for cultural change in our institutions as well as the professionals to accommodate the increasing needs for teamwork in addressing the complex natural resource management issues for improved systems productivity in the highlands of East Africa.

Introduction

There is a growing consensus on the need to experiment with new ways of working with local communities in efforts to improve the management of natural resources for environmental sustainability and improvement of the livelihoods of the people. Multidisciplinary teamwork where different professionals from different institutions come together to address common issues is one of these new ways of working that has been adopted by AHI. This was necessitated by the reality that NRM issues confronting highland farmers in Eastern Africa require broad based solutions that goes beyond biophysical technologies to social, economic, policy and institutional factors. There is no single discipline or institution that is equipped enough to handle this. The need to team up between different disciplines and institutions poses a significant challenge to leadership. Having a multi-disciplinary team is one thing but working together to effectively address a common issue is quite another. Putting people together in groups representing many disciplines does not necessarily guarantee development of shared understanding (Clark, 1993). Mitchley (2004) echoes this by pointing out that multidisciplinary team approach does not necessarily include integration.

To exploit synergies and provide holistic outcomes therefore, multidisciplinary teams must adopt an interdisciplinary working model that ensures different disciplines and institutions do not only come together but also work together to attain the required cross-fertilization. Drivers for successful multi-disciplinary teamwork include personal commitment, clarity of roles and having in place a common goal and a group of people with vision to take the others through (Wilson et al. 1996; Pirrie et al. 1998) and mutual understanding between professionals.

The presence of an efficient leadership that minimize the barriers to working together by facilitating exchange, mutual understanding and acceptance among team members (Mitchley, 2004) is therefore of paramount importance. The emphasis in teamwork is on working together to deliver an integrated service to end users (Wilson and Pirrie 1999) and leadership must see to it that this is achieved.

Among the challenges a multi-disciplinary team leader should expect is to have to cope with team members who are reluctant to learn or accept other members' disciplines, tendency of scientists to pursue questions that are of interest in their own disciplines (Bawa and Lele, 2004), logistics (Pirrie et al. 1998), attitude of team members and limited institutional support to some of the team members. Teams exist within an institutional framework and the degree to which different professionals enjoy support from their institutions differ considerably (Pirrie et al. 1998). Some institutions vaguely support multi-disciplinarity while in others, team members are not sure of the support from their institution. Other institutional bottlenecks include the lack of an incentive scheme that recognizes and reward team product. Multi-disciplinary teamwork takes time but eventually yields good results as long as the rules of the game are honestly adhered to. Team members must be fully involved from planning to implementation and in sharing the products of the work.

In this paper the experience of coordinators in leading multidisciplinary teams of professionals from different institutions was studied in three sites in Ethiopia, Kenya and Tanzania. Information was collected through individual and informal interviews of site and former national co-ordinators. The objectives were to document the challenges in leading multi-disciplinary team of professionals and to identify opportunities that can be exploited to ensure effective team leadership. The study is justified by the fact that we lack information on and experience in leading multi-disciplinary teams from different institutions. Information from this work will contribute to the perfection of better strategies for the management of multi-disciplinary teams from different institutions for improved performance.

Methodology

Formal and informal individual interviews of site and national coordinators from Ethiopia, Kenya and Tanzania were conducted through e-mail communication and face-to-face talks. Two (2) sites in Ginchi and Areka in Ethiopia, 1 site in Kenya (Kakamega) and 1 site in Tanzania (Lushoto) were covered in this survey. Respondents were requested to critically look into and narrate challenges they faced during their terms as leaders of multi-disciplinary team of professionals from different institutions. The position of national coordinator was abolished in the current (Third) phase of AHI (2002 – 2004). The coordinators interviewed included those currently holding their positions and those who have left for other duties, studies or on account of positions becoming redundant. They were also requested to indicate the major lessons learned and give recommendations for improved team leadership. Information collected was synthesized and results summarized.

Results

In all the sites studied the imbalance in skills and experience among team members was cited as one of the major challenges to leadership. Coordinators faced the challenges of bringing team members to the some level of understanding of project approaches. Most scientists were new to the approach and they could not see how quality data within their disciplines can be obtained from a multi-disciplinary research work. In Ethiopia for example, researchers preferred to keep to their disciplinary identity first and integration with other disciplines later. In extreme cases some researchers never believed in multi-disciplinary research at the beginning and pulled out of the team (Tanzania) to stick to the conventional ways of doing research. Few in this category who remained in the team were not flexible enough to accommodate ideas and experiences from their colleagues although later, this changed. Coupled with this, was the lack of respect to other disciplines and researchers adhering to research quality at the expense of overlooking farmers' indigenous knowledge and experience. These differences among the researches were a big challenge to coordination. As noted above, there have been changes in various attributes with time as shown in Figure 1 for the Lushoto site. From the figure, interpersonal antagonism between team members and antagonism between AHI activities and other activities has decreased as team members and institutions understand and accept albeit gradually, the positive contribution of AHI.

Meanwhile, experience in skills of team members, acceptance of multidisciplinary (MD) team work, leadership competence and internalization of the AHI approach has increased although the later at a slow pace.

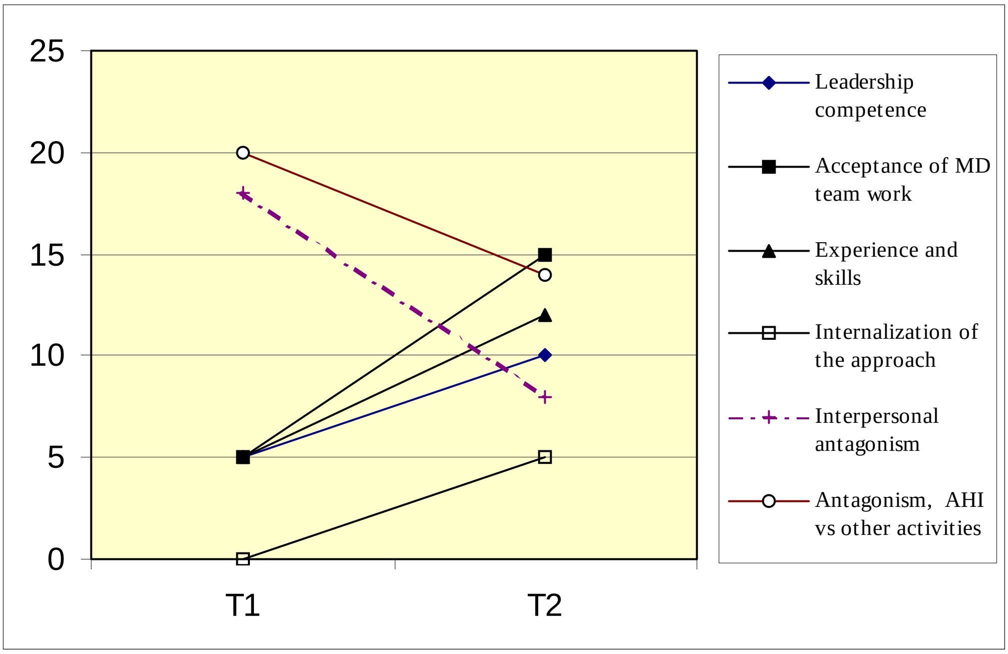

Figure 1. Changes in various attributes with time at the Lushoto site, Tanzania.

Common in all sites was the imbalance of the disciplines with more dominance of biophysical sciences compared to social sciences. The former have limited understanding of social science research methods. This affected the teams especially in conceptualizing Phase III of AHI, which is more on methodologies and approaches at watershed level than technology development. Emphasis is more on social sciences including community mobilization, policy, bylaws and institutional factors for enhancing INRM. In Kenya and Ethiopia the absence of memorandum of understanding is cause in leadership hurdles because of lack of clear-cut roles and responsibilities of participating institutions and researches. Some heads of institutions are not clear on the project objectives and activities and these are not even incorporated in their annual institutional plans. This makes it difficult for sites to get contribution form some experts in some institutions. There is lack of terms of reference for participating researchers making them less committed to AHI activities. Their institutional heads does not critically follow them up and they are they not even evaluated based on their contribution to project.

Consequently, some team members have not internalized the AHI activities as an integral part of their programs. Because AHI activities are considered secondary this had led to poor participation in project activities in some sites and slow pace of integration of the approach into the national R&D programs. It was noted also that the reward system based on individual (disciplinary) rather than team performance does not recognize the product of teamwork hence discouraging researchers. Coordinators have then to cope with demoralizing situations among team members. Most sites noted that the majority of team members are scientists with several other responsibilities in their institutions, others coordinating multiple projects. Apart form making it difficult for them to commit sufficient time to AHI activities it is also difficult for the coordinators to plan joint team engagements in the sites.

The differences in aspirations and attitude were pointed out in three of the sites studied as another challenge to coordination. The high turn over of team members, some going for further studies and others for other jobs disrupts project activities and calls for concerted efforts by coordinators and partner institutions to scout for replacement. In almost all sites studied replacement is a slow process. Different age groups have different aspirations; young scientists vying for further long-term studies (not accommodated by AHI) and the older and more experienced vying for increased remunerations hence better jobs. The coordinators have to cope with these challenges in trying to keep team members together despite of their differences. In most sites, participating scientists have higher expectations in terms of economic and educational gains which cannot he met within the structure of the project leading to some members wishing not to participate or do so with divided commitment.

There is an overall failure to balance project goals with personal gains with some members comparing gains across projects and hence would favor to put more time in more rewarding projects. Finally, the universal reality of limited resources is another stress to coordinators especially when team members have to come from distant institutions (e.g. Tanzania). In some sites the lack of basic equipment including cameras has greatly affected the capture of important incidences for process documentation. Another problem is the late arrival of funds to sites partly caused by late submission of work plans or financial bureaucracies in the different countries. This leads to delays in implementing planned activities, disrupts plans of other activities and influence teamwork morale.

Discussion

Leadership is always a challenging task. Often, one is confronted with scarce resources in terms of manpower, funds and materials, which have to be used optimally to realize set goals. Naturally individuals in any organization are seldom homogenous and would differ in attitude, the way they receive things and react to situations, and in their aspirations. They also have different qualities they acquired in the struggle to acquire a career. This would be in knowledge, experience and skills. The extent of challenge to leadership will inevitable be influenced by the groups' heterogeneity. Good and effective leadership of multi-disciplinary teams can be considered a function of two factors namely the style of leadership and the attitude and commitment of team members to work together for a common goal. The extent to which coordinators are transparent and involve all team members in the whole process from planning to implementation of projects and in sharing the products of their work will greatly determine the groups' performance. In some sites, coordinators tend to concentrate most activities and decisions to their offices plus some few individuals around them while in other sites there is shared responsibility. The former has high potential to disrupt operations should the coordinator leave while in the later case any of the team members is prepared to take over powers should the position fall vacant. Further, there is less workload when the approach of shared responsibility is adopted and coordinators would not feel overloaded. Transparency is now a catchword in many organizations as one of the factors for improved performance. This allows team members to know what is taking place and contributes to making things work better, because they feel involved. Further to this, leadership must ensure that the roles and responsibilities of each team member are clear to and there should be frequent communication to keep members informed (Wilson, et al. 1996).

From the results AHI activities are yet to be fully considered as an integral part of the NARS to augment their efforts in delivering appropriate NRM options to farmers. The fact that some scientists and research managers consider AHI activities as non-core or secondary activities shows that internalization has not taken place. Experience from elsewhere (Pirrie, 1998) show that this problem is not unique to AHI. The problem could be due to lack of or limited sensitization of team members and research managers on the role AHI was designated to accomplish. Although at the onset NARIs agreed on collaboration there was no formal mechanism to ensure project activities would be part and parcel of the NARIs research programs and that the AHI approach would be internalized. This was a serious blow to efforts towards institutionalization of the AHI approach.

There is therefore a need to do more homework in sensitization of researchers and research managers on this. An important issue to be tackled would be to formalize through memorandum of understanding, the collaboration between the partners and establishing terms of reference for participating scientists so that each one knows their roles. Further, the rigid motivational system within most NARIs should be re-visited to allow some flexibility in rewarding a joint research product.

Heads of participating institutions should, in collaboration with the site coordinators, closely follow up the performance of their staff so that project activities are considered important in their career. Most NARIs motivates researchers using publications as one criteria and this workshop has given researchers a forum where they can share and discuss the products of their work, which is one of the motivations. However, publication based motivation is still dominated by single discipline products. To accommodate the new approaches to

NRM that is, teamwork involving different disciplines there is a need for concomitant changes in the reward system (Mitchley, 2004). As pointed out by Bawa and Lele (2004) there should be a social and cultural transformation of research enterprise through teaching and education and provision of incentives for people to do things differently.

Imbalance in knowledge and skills especially the significant shortage of social scientists should be addressed. Efforts towards imparting social science skills to biophysical researchers is a step in the night direction as this is an important factor in interdisciplinary work; to get know some aspects of the others disciplines and to be able to appreciate and develop respect far other peoples disciplines. Further, training of a new generation of researchers for multi-disciplinary teamwork should now impart skills on working in a team composed of different disciplines (Ramakrishnan, 2004).

Although there seem to be a lot of challenges to leadership, there is an emerging trend in most of the issues raised, of a future that will see less antagonism among team members and between AHI and NARI activities (Fig 1) and hence minimize burden to the leadership. In Figure 1 aspects like competence of leaders, experience and skills are increasing. The pace of internalization is slow while antagonism between AHI and NARI activities is decreasing.

Conclusion

It is concluded that leading a multi-disciplinary team of professionals from different institutions is a challenging task. However, this is more of a problem at the beginning. As team members get to know each other better and accept and appreciate each other's professional background the work becomes more satisfying, antagonism decreases and leadership becomes more interesting. Through teamwork one get to know more professionals and is exposed to more talents hence broadening their horizons and thus make one more competent in addressing the intricate issues in NRM. This also means an expansion in scope and opportunities in their careers. Emerging trend in some aspects such as experience and skills and teamwork spirit is encouraging. Internalization of the AHI approach is lagging behind leading to researchers and research managers to consider AHI activities as non-core or secondary to their normal activities. We therefore recommend the following:

- More sensitization of researchers and research managers using successful examples from the sites, on the role and importance of AHI in managing natural resources in highland ecosystems.
- Establish memorandum of understanding between partners and terms of reference for researchers.
- Articulate for recognition and reward of team product to motivate researchers in multi-disciplinary teams.
- Build and strengthen leadership capacities in the sites. Sites should opt for more transparent and joint leadership and devolution of power to lessen burden on coordinators while ensuring smooth succession.
- Establishing clear institutional arrangements to ensure internalization of the AHI approach. There should be strategic forums for sharing the successful cases in AHI. There should be increased advocacy and sensitization of the AHI approach to potential stakeholders and other institutions.

References

Bawa, K and S. Lele, 2004. An integrated approach to the management of tropical forests for extraction of non-timber forest products (NTFPs), Karnataka State, India. Paper presented at the IRMMA Conference (Interdisciplinary Research and Management in Mountain Areas) Banff, Canada. 23 – 26 September 2004).

Clark, P.G. 1993. A typology of multidisciplinary education in gerontology and geriatrics:
Are we really doing what we say we are? Journal of Interprofessional Care, 7, 3, 217-227.

Mitchley, J. 2004. Scenarios for reconciling biodiversity conservation with declining agricultural use in the mountains of Europe (BioScene). Paper presented at the IRMMA Conference (Interdisciplinary Research and Management in Mountain Areas) Banff, Canada. 23 – 26 September 2004).

Pirrie, A., Wilson, V., Elsegood, J., Hall, J., Hamilton, S., Harden, R., Lee, D. and J. Stead, 1998. Evaluating Multidisciplinary Education in Health Care. Edinburgh: SCRE.

Price, M. 2004. Climate change in mountain areas: Cooperation in uncertain future. Paper presented at the IRMMA Conference (Interdisciplinary Research and Management in Mountain Areas) Banff, Canada. 23 – 26 September 2004).

Ramakrishnana, R.S. 2004. Sustainable cultures to sustainable development. Paper presented at the IRMMA Conference (Interdisciplinary Research and Management in Mountain Areas) Banff, Canada. 23 – 26 September 2004).

Walton, M., Banks, P. and R. Bradasch, 2004. Healing broken connections: Kluane National Park and Reserve. Traditional knowledge and Regional Integration. Paper presented at the IRMMA Conference (Interdisciplinary Research and Management in Mountain Areas) Banff, Canada. 23 – 26 September 2004).

Wilson, V., Finnigan, J., Pirrie, and E. Mcfall, 1996. Encouraging Learning: Lessons from Scottish Health Care Organisations. Edinburgh: SCRE. (Unpublished report).

Wilson, V and A. Pirrie, 1999. Developing professional competence: Lessons from the emergency room. Studies in Higher Education, 24, 2, 211-224.

Operationalizing R&D Linkages: A Framework for the Integration of Diverse Learning Approaches

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Abstract

Operationalizing research and development (R&D) within a fluid continuum encompassing both understanding and application can be a daunting task. For research to make significant contributions to development, it is important that action research methods be taken on board. This enables research to address process-related questions about how to achieve real outcomes, such as, "What works, where and why?" This type of question can in turn only be answered by achieving actual development outcomes on the ground, requiring effective facilitation. Yet action research should not be considered as a substitute for more formalized, empirical forms of research. Empirical research in diverse disciplines represents a means of generating development inputs (i.e. technology, policy) and achieving a more objective assessment of the situation so as to formulate well-informed interventions. It can therefore be productively utilized as an input to both development and action research. This paper presents a typology of distinct learning approaches designed to operationalize the R&D continuum. It summarizes lessons for achieving quality within each approach, and for their integration into a fluid R&D continuum. A set of cases is presented to illustrate the critical importance of each learning approach and their integration in practice. The paper concludes with a discussion of implications for institutional arrangements and partnerships that may best enable the application of the approach within everyday R&D practice.

Introduction

Despite many decades of development-oriented research, global challenges to economic development and social justice are today as great as ever. While knowledge generation is but one contributing factor to development outcomes, researchers are being held increasingly accountable to concrete outcomes by both donors and end users (Meinzen-Dick et al., 2003). This is because while research in some fields has yielded significant advances for human health and welfare, in others its impacts have been limited despite considerable investment (Hammersley, 2004; Meinzen-Dick et al., 2003). The limited impact of research can be traced in large part to the institutional disconnect between research and research methods on the one hand, and development practice on the other (Agbamu, 2000). As stated by Hammersley:

"There are times when we initiate inquiry without having been stimulated by a practical problem. Moreover, science and philosophy have become institutionalized; in other words, they are specialized occupational activities that are carried out outside the immediate context of other activities – and they therefore generate their own intellectual problems. Even where they are oriented towards providing knowledge relevant to some practical issue, they do not usually form an immediate part of courses of action directed towards dealing with that issue … Recognizing intrinsic relevance as a stimulus to inquiry points to the possibility of a much looser relationship between research and other kinds of activity" (2004:170).

In addition to the institutionalized separation of research and practice, one sees greater status awarded to theory over praxis within Greek and Western philosophy. The institutionalization of research as a specialized form of inquiry and the negative backlash to action research within the scientific community are both evidence that this distinction is alive today (Hammersley, 2004). The challenges faced in operationalizing research-for-development are therefore embedded in a much larger historical and institutional context which shapes the nature of institutions, scientific inquiry, and the definition of roles and responsibilities in knowledge creation.

Action research is increasingly seen as a promising approach for improving the impact of research on development (Hagmann and Chuma, 2000; Reason and Bradbury, 2001). This is envisioned in multiple ways, ranging from the new definition of research objectives and methods to the reformulation of roles (from outsider observer to participant, individual to collective). Yet action research has yet to take hold in terms of its perceived validity, funding levels, and the degree to which it has been institutionalized as part of standard R&D practice. Understanding about action research objectives and methods remain continue to remain unclear among R&D practitioners. These trends are in large part due to this deeply entrenched historical disconnect between research and practice, which has institutionalized the lack of concern and skills for bridging the divide within *both* research and development circles. Yet confusion also stems from the fundamental tension between theory and practice, which requires the subordination of one relative to the other in the short-term when making funding decisions and defining priority objectives and actions (Hammersley, 2004). This article tries to validate the role of action research in development, not as a substitute for more conventional or empirical forms of research but as a complementary learning approach. It then attempts to operationalize how theory and practice, as well as diverse forms of research, might be operationalized within a more fluid and effective R&D continuum.

Background

EMPIRICISM

The notion that the ability to perform good research is lost if research becomes involved in practical action has prevailed into the current era, as evidenced in the institutionalization of research and the prevalence of empirical research methods. On one hand, empiricism represents a reaction to religious forms of reason from the Middle Ages, in its emphasis on experience as the origin of all knowledge. While this represents a closer union between theory and reality, strong reliance on the scientific method as the means to deduce knowledge through experimental validation of empirical propositions[1] has kept empirical research largely in the hands of specialists ("researchers") and separate from the domain of practice. This is true for both the biophysical and social sciences, in which the formulation of new understandings through systematic observation by specialists remained unquestioned until only recently.

Action Research

Different from empirical research, action research implies an "intimate, two-way relationship between research and some form of practical or political activity-such that the focus of inquiry arises out of, and its results feed back into, the activity concerned" (Hammersley, 2004:176). As defined by Lewin (1946) and Dick (2002), action research is a flexible spiral process which allows action (change, improvement) and research (understanding, knowledge) to be achieved at the same time. It is particularly suited to deal with "operational research challenges" due to its closer linkages to practice (Hammersley, 2004) and the participation of research in social processes and social capital generation (Gustavsen, 2003).

Action research differs from empirical research in several fundamental respects. First, the objectives of action research are defined differently, in terms of addressing practical or political problems. Given such objectives, research questions often target processes or approaches (*What works under condition X?)*. Secondly, methods used are different. Rather than fixing a methodology up front based on a theoretical proposition and pre-determined information gap, action research proceeds with a 'best-bet' approach which is reflected upon and modified as experience is gained through action. These approaches may be defined at the level of the beneficiaries themselves or at the level of outside change agents (for example, approaches to community facilitation). While research methods in empirical research are often 'pre-tested', modification of methods once data collection initiates runs contrary to scientific principles. Finally, the role of the detached observer is no longer required, as the researcher can either become engaged in the change process or remain an outsider observer.

There are also diverse forms that action research itself can take, depending on the theoretical stance, methods used, the definition of roles, whether it is an individual or collective process, and whether it contributes to

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[1] Empirical propositions affirm relationships between two or more type of objectives implicitly defined in locally independent categories, and must be potentially refutable on non-logical grounds (Pierce, 1956).

specific (immediate) or wider problems (Hammersley, 2004). In the way it is defined in this paper, it involves social learning at both beneficiary (community, organization) and program levels, in which diverse actors jointly contribute toward solving practical problems. However, a distinction is made between action learning and action research depending on the degree to which learning is synthesized and codified. While diverse social actors (local and external) jointly engage in change processes (problem definition, strategy development, monitoring), research in the sense of formal analysis and documentation may remain more specialized. Furthermore, an important distinction is made between action research designed to address specific (localized) problems, in which local actors or beneficiaries own the learning process and formalized data collection is minimal, and that designed to answer more strategic or general research questions – in which the process of inquiry is often specialized and data collection more formalized.

When placing research in the context of development, research assumes an instrumentalist orientation that requires the learning process to serve practical or political goals directly to be of value (Hammersley, 2004). This is not to say that there is no intrinsic relevance to research or that “pure” research has no value, but that research-for-development implies contributions to concrete development outcomes. While interactive or participatory methodologies may aid in capturing such knowledge, more *EXTRACTIVE or EMPIRICAL* research methods are often required to gather quality data due to the level of sophistication of methods or the need to control for the influence of overly outspoken individuals (i.e. through systematic sampling procedures in social research).

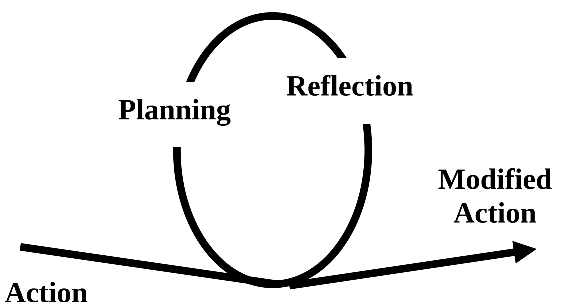
A TYPOLOGY OF LEARNING APPROACHES FOR R&D

The aforementioned typology of research-for-development can be roughly translated into three distinct learning approaches for development, as well as the particular objectives, methods and skill base that can help to achieve quality within each.

Participatory Action Learning: Facilitating Change Processes

Participatory action learning (PAL) is an actor-based approach that educates and empowers through implementation and frequent re-evaluation of ‘best bet’ approaches so that their continuous refinement can better lead to desired outcomes. It may be carried out within R&D institutions as a process of institutional change, or by local communities as they seek solutions to common problems. The approach is composed of iterative cycles of institutional or community-level action and reflection (Box 1) that empowers by placing the nexus of development strategizing in the hands of the beneficiaries themselves. Its aim is to bring about change within the communities or institutions where it is carried out. The learning process does not lend itself to formalized methods in which a development or change strategy is identified up front and implemented in a linear fashion, because approaches tend to be ill-defined at the outset and require learning through action. Such an approach is best suited to social, institutional or political change processes that require learning through action and enable actors to confront context-specific situations that hinder desired change as they emerge.

BOX 1: Participatory Action Learning



(Hagmann, personal communication)

Increasingly, PAL approaches are utilized within social learning contexts, where multiple actors collectively construct meanings (problem definition, objectives) and work collectively toward solutions (Maarleveld and Dangbégnon, 1999; Pretty and Buck, 2002). Methods for ensuring quality in PAL include simple planning and monitoring frameworks, effective facilitation and an inclusive change process that effectively integrates broad-based concerns and perspectives. Simple planning and monitoring frameworks may be of many different kinds. One used recently within AHI is broken down into 3 basic steps, which are implemented following problem definition: planning (to be carried out prior to any local development action), reflection (to be conducted periodically to monitor progress and enable corrective action), and re-planning (to ensure that observations are converted into actions) (Table 1). Effective facilitation requires an experienced facilitator knowledgeable of community dynamics and clear about the subject and objective(s) of the change process, and who has a talent for devolving control and decision-making to others while providing useful tools for organizing group decision-making and action.

Table 1. Guide for Participatory Planning and Monitoring of Change Processes

1. **Planning**
- Objectives (What does the community or organization want to achieve?)
- Approach (How are they going to go about it?)
- Plan for Participatory Monitoring and Evaluation (What is going to be observed as the process is implemented?)

2. **Reflection**
- Successes (What went well?)
- Challenges (What did not go well?)
- Findings (What did we learn as we went?)

3. **Re-Planning**
- Recommendations for the Way Forward (Given the above observations, what should be changed in the approach to better accomplish stated objectives?)changed in the approach to better accomplish stated objectives?)

The development and open negotiation of performance indicators can be a means of integrating broad-based concerns into the process by ensuring that specific indicators receive attention during each consecutive step. Without such open negotiation of indicators, certain values and perspectives may become lost in overly general reflections that lend themselves to co-optation by more outspoken individuals.

ACTION RESEARCH: UNDERSTANDING CHANGE PROCESSES

The term action research (AR) is used here to refer to research on PAL (development and change) processes. The research dimension aids in documentation and systematization of lessons as target activities are implemented, monitored and adjusted through time. By systematizing observations on change processes, it provides answers to the questions, “What works, where and why?” This not only aids in actor-based learning at local or institutional levels, but also allows for impact to be scaled up beyond the immediate field site through the sharing of experiences with other development actors. As it is superimposed in time on action learning, the two are generally considered a single approach – “participatory action research” (PAR). As stated above, action research is an iterative process which integrates action (change, improvement) with research (understanding, knowledge) (Lewin, 1946; Dick, 2002). The differentiation of the two approaches is useful for several reasons. First, while individuals may be skilled in both areas, the skill base needed for effective facilitation in PAL is distinct from that required for effective systematization of experiences (AR). In the former, a personal commitment to social change, effective communication and group management, and social awareness of group dynamics are valuable skills. In action research, while the former skills are also valuable as they enable observations on power dynamics and development process, research skills (appreciation of – and methods for – documentation, validation, and synthesis) are also crucial. Secondly, the immediate goals of the two differ. While in the former the primary aim is action (i.e. enabling localized social or institutional change), in the latter the most immediate aim is research (systemization of experiences for subsequent sharing). Herein lies the fundamental contradiction highlighted by Hammersley (2004). Yet rather than resolve this contradiction through the subordination of either action (PAL) or research on action (AR), here the attempt is to differentiate among them and see how they can be logically and operationally linked.

Action research has been employed to enable change in the classroom (Elliott, 1991; Stenhouse, 1975), industry (Coghlan et al., 2004), agricultural extension services (Hagmann, 1999; Percy, 1999), on farm (Hagmann and Chuma, 2002), in environmental management (Gardner and Sinclair, 2003), urban communities (Kelly et al., 2004) and public health (Basu, 1996; May et al., 2003). It enables a second level of observation, separate from the immediate beneficiaries of PAL, of the change process itself. This enables consideration of whether the approach is effective in enabling achievement of broader program goals that may or may not emerge from the community or beneficiaries themselves (i.e. equity, sustainability). So in addition to being a means of systematization of experiences, it can be seen as a second level of PAL at program level or among external change agents. In the best case scenario, research questions (*How to we best do X?*) and best-bet approaches are defined up front yet continuously refined as learning-through-action takes place. This can represent a challenge for regional research programs. While *approaches* should be flexible and iterative, defining higher-order strategic *questions* at regional level is necessary to enable ongoing reflection on a common question and regional synthesis of findings. Examples from AHI include: a) “How can effective “integration” and “participation” in watershed management be achieved?”, and b) “What conditions are needed to enable individuals to make greater investments in common (as opposed to individual) goods (i.e. widespread benefits from development, improved management of common property resources)?”.

Operationalizing action research requires consideration of both roles and methods. In action research, action research can be carried out by the facilitators themselves or can involve an independent researcher. While some practitioners prefer the latter (Hagmann, personal communication), within AHI action research is being conducted by program-level facilitators. Within AHI, a simple framework similar to that utilized in PAL has been employed for action research ($). Inherent in this framework is the level at which observations are carried out (facilitator or program level).

EMPIRICAL RESEARCH: INPUTS TO DEVELOPMENT

While some would argue that action research is the only useful form of research for enabling change, it is argued here that empirical research in many cases has a crucial role to play. While the latter is generally considered to be more tailored to academic than applied goals due to its overly rigid methodology (fixed questions and methods) and extractive (as opposed to interactive) forms of knowledge generation, there are several instances where empirical research has an important role to play in social change. First, it can assist in filling critical information gaps hindering development by shedding light on more illusive dimensions of perceived problems and solutions that defy easy observation by local residents or other program beneficiaries.

In such cases, research questions can often be targeted by the beneficiaries themselves. Other cases may require that research be targeted by outsiders so as to inculcate certain values (equity, sustainability) in the development process. One example involves stakeholder negotiation in natural resource management, in which local knowledge about cause and effect may be highly contested due to divergent ‘stakes’ of different actors. If effective scenarios for improved cooperation in natural resource management are to be developed, empirical data may be needed to more objectively determine the effect of different management practices on established goals (i.e. the effect of different land uses on water resource degradation), and to de-politicize the negotiation process. A second example involves empirical research in social science, in which rigorous social ‘sampling’ may be required to counter-balance the tendency for more outspoken actors to dominate community fora and to more objectively determine the concerns and priorities of different local actors. These examples are illustrated in more detail in the case studies which follow.

BOX 2. Action Research Guide for Program-Level Action Learning and Process Documentation

I. PRIOR TO ANY ACTIVITY / STEP:
Objective: What is the program trying to achieve?
Approach: What will be done to achieve the objective, and how?
(What steps will be taken? Why did you choose these steps? Who will you involve, and why?)
Plan for M&E: What is going to be observed and documented as you go?

II. FOLLOWING ANY ACTIVITY / STEP:
Approach: What did you actually do to achieve the objective?
(Did you modify your approach? If so, how and why?)
Successes: What went well?
(What worked? What do we need to do to find out?)
Challenges: What did not go well?
(What were the stumbling blocks? Why did they occur?)
Findings: What were farmers' (beneficiaries') suggestions on the way forward?
What you're your own observations about the process?
Lessons: What lessons or insights can be derived from these experiences?
(Strengths and weaknesses of the approach, from what you have observed in practice.)

III. PRIOR TO ANY FURTHER ACTIVITIES / STEPS:
Recommendations: What would you do the same and differently next time?

Yet the tendency in empirical research is for the research imperative derived from the scientific community's standards for success (peer-reviewed publications, scientific questions driven by theory to determine which questions to ask. If empirical research is to play a role in social change within particular contexts, the aims of research must clearly target development outcomes. This brings in the question of critical information gaps and uncertainties, namely defining which information or empirical research outputs are crucial to enable change, and which is marginal. Equally important is to ask ourselves who should define these. In some cases, researchers or project personnel may define the research questions according to key information gaps which will enable them to better target interventions or to understand program impacts. In other cases, local actors will define critical information gaps according to their priorities or the need to resolve contradictory understandings at the local level. In other cases, local residents can identify key problems and solution parameters while researchers work alone to develop the technology (for example, crop breeding). Depending on the minimum level of technical knowledge required to derive reliable information, local residents can often be involved as researchers although following scientific standards of quality control.

Articulating Linkages among Diverse Learning Approaches

At this point, it is important to consider how these three learning approaches can be effectively articulated toward achievement of stated development objectives. Figure 1 illustrates how the diverse learning approaches are linked in practice. The iterative series of loops signifies the development or PAL process. We enter the loop once we engage the community or organization in planning, action and reflection. In PAL, communities or organizations engage in a series of learning events composed of planning, action, reflection and re-planning components. Each of these learning events should provide important inputs to the next learning event (altering the course of action), which is itself an indication that reflection is leading to real change. Action research is embedded in the PAL process, and also represented by the series of loops. Observations made by facilitators or independent action researchers help to guide the facilitation process itself, and therefore do not exist in isolation from the participatory action learning process. Empirical research, on the other hand, may serve to inform the approach from the outset based on what is known from the literature and practice, and may be inserted into the PAL process throughout to fill critical information gaps. Empirical research objectives must adhere to the overall development objectives, but specific questions may emerge from the community or beneficiaries themselves, or from the facilitators as they identify critical information gaps that through action research that could improve development interventions.

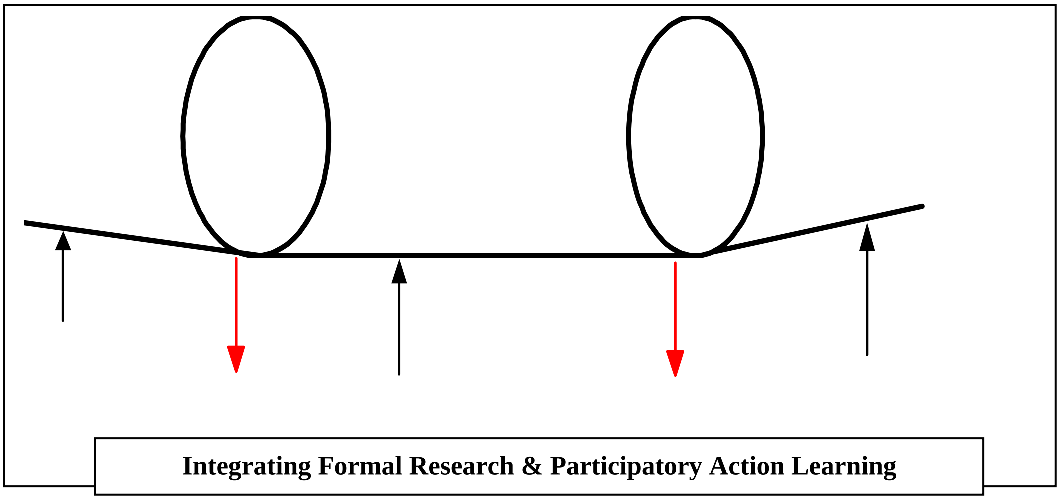


Figure 1. Embedding Empirical and Action Research in Participatory Action Learning Processes

BOX 3. Protocol Format for Integrated Research and Development

1. Background and Justification
    a. Overall Objective (from integrated research and development interventions)
    b. Background leading to this intervention and why it is important
    c. Justification: brief overview of related research and practice, what is known, possible solutions and knowledge gaps
    d. Overview of expected results (outputs and outcomes) associated for different beneficiaries/audiences

2. Description of Research and Community Action Processes
    a. Overview of the work:
        i. Main STEP in the process for improving watershed management and the major objective associated with this step
        ii. Sub-Steps related to the step with associated objectives and main areas of community action and associated research (A and/or B)

Then for each SUB-STEP:

    b. Describe the community action processes and associated research (PAR)
        i. Describe the specific research questions and objectives
        ii. Describe the community action process
            Activities, methodology, results expected
        iii. Describe action research process (repeat for each research question)
            1. Research question, Activities , Methodology (including data collection, analysis),
            2. Results expected: outputs targeted to whom and outcomes
    c. Describe formal research
        i. Research question (repeat for each research question)

Objectives, activities, methodology (data collection, management and analysis), integration of work into community action process, results expected: outputs targeted to whom and outcomes

3. Implementation and management plan

Implementation plan, management plan, roles and responsibilities of investigators and collaborators, monitoring plan with indicators, dissemination and reporting plan

For planning purposes, activities targeted under each learning approach must be integrated. The overall objectives toward which all research and development interventions are targeted must be clearly stated from the outset. At this point, a protocol for integrated research and development interventions similar to that in Box 3 can be utilized as an integrated planning tool (Stroud and German, 2003).

Table 2. Planning Framework for Integrating Diverse Learning Approaches in Research and Development

Major Activity / Stepa	Objective	Development Intervention (PAL)	ACTION RESEARCH QUESTIONS	EMPIRICAL RESEARCH QUESTIONS
Watershed Diagnosis	To identify major watershed problems from the perspective of local residents.	*Primary Research Question:* How can watershed problems affecting local residents be effectively diagnosed?		
		1. Focus group discussions by gender, age, wealth and landscape position to identify key watershed problems, and opportunities and barriers to their resolution. 2. Program-level planning. 3. Participatory watershed action plans.	1. What is an effective approach for planning at local & program level? 2. How can problem diagnosis be balanced with the need for immediate impact, so as to keep community interest high?	1. What are watershed priorities by gender, age, wealth & landscape position? 2. What are key opportunities and barriers to addressing identified problems in the watershed?
Soil & Water Conservation and Management	To enhance the positive synergies between water, soil and tree management in micro-catchments.	*Primary Research Question*: How can NRM practices (SWC structures, tree planting, drainage systems, etc.) enhance agricultural productivity through decreased erosion while also enhancing spring recharge long-term?		
		1. Spring development with spring management plans (responsibilities, rules, sanctions). 2. SWC structures and niche-compatible afforestation to control erosion, enhance water recharge & minimize income loss (from soil, seed & fertilizer loss). 3. Social organization, negotiation & local policy reform for integrated catchment management.	1. If a high-priority entry point (spring development) is used, will outcomes of future R&D investments be greater? 2. What are the necessary conditions for people to invest in a shared resource? 3. What are effective approaches for reaching the overall cluster objective(s)?	1. What is the impact of chosen SWC measures on run-off, soil & nutrient loss, & infiltration? 2. What are farmers key indicators for SWC, and how do these change over time? 3. Which trees are compatible with different niches? How do prioritized tree species perform in different niches?
Integrated Production & Nutrient Management	To improve farmer incomes and system productivity (crops, livestock, trees) while enabling sustainable nutrient management.	*Primary Research Question*: How can income be improved through increased agricultural productivity (crop, livestock, tree and nutrient management) and marketing while also enhancing system nutrient stocks?		
		1. Scale out tested crop varieties with integrated nutrient management, training, and group organization for sustaining farmer-to-farmer spillover. 2. Introduction of improved feed and livestock husbandry practices. 3. Quantify total fuel needs to minimize use of dung for fuel (system nutrient decline), and identify viable solutions (fuel-efficient stoves, afforestation).	1. What is an effective and sustainable approach for scaling out tested varieties & integrated nutrient management technologies? 2. What are effective approaches for improving livestock & feed production, minimizing system nutrient loss, and meeting fuel needs without system nutrient depletion?	1. How can soil fertility be maintained while increasing farmer income through increased production & value addition (seed potato)? 2. Which varietal & integrated nutrient mngt. practices perform best in Galessa watershed?

An example planning framework with some of the above entries (Table 2) illustrates the value of integrating diverse learning approaches. While a single research question and objective help to focus all learning approaches toward a single goal (thereby keeping them integrated), articulating the role of different learning approaches enables positive synergies between social learning at community (beneficiary) level, action learning and research at program level, and the resolution of critical information gaps.

Case Studies

CASE STUDY: PARTICIPATORY WATERSHED MANAGEMENT

Participatory Action Learning

Enabling improved natural resource management at landscape or watershed scale presents several challenges. First, the interests of diverse groups and interactions among them must be acknowledged and managed so that interventions do not favor some groups at the expense of others. Second, gains to diverse landscape-level components (trees, crops, livestock, water, soil) must also be managed given that strong trade-offs often exist. While participation is essential to manage such a complex agenda, it also must be managed so that different groups have a voice in the choices and outcomes. Thus, the key role of effective facilitation in balancing diverse and often contradictory agendas, and action learning approaches to foster adaptive management of biophysical innovations as well as social change.

Throughout the eastern African highlands, several problems related to agroforestry were identified during watershed exploration. In all sites, certain tree species cause water to dry up when cultivated near springs, and compete with crops when located on farm boundaries. In Galessa (Ginchi benchmark site), limited land cover resulting from extensive deforestation and limited agroforestry has led to an extreme shortage of fuel wood, exacerbating soil fertility decline through the use of cow dung for fuel. So a key challenge in the region, and particularly in Galessa, is to integrate more trees into the system without further exacerbating tree-related problems. A standard approach to afforestation is to elicit farmers' demands (tree species and numbers) and to establish a single nursery with the desired number of trees, or to simply promote the species that are available by development agencies. The problem with these approaches is that they fail to consider the trade-offs of different tree species, or to consider the niches where different species are compatible.

In AHI's watershed management work, we are developing new approaches to stakeholder negotiation (German et al., 2004a; Tesema and German, 2004). Action learning is required in two respects. First, rather than take an individual approach to integrating trees on farm, we are looking at species compatibility *by niche* so that afforestation activities alleviate constraints (fuel, timber, income, fodder) while minimizing negative impacts on water, crops and soil. The problem lies in negotiating restricted land use rights on private property for particular niches (farm boundaries, watering points). A case from Galessa watershed illustrates the role of action learning, in which working approaches are not known until tested (Box 4).

If this approach had not worked, new approaches would be generated through identification of the weaknesses in the first approach (during PM&E) and then tested. This case study illustrates a broader approach currently being tested in AHI sites, in which stakeholders specific to each niche (Table 3) are brought together to negotiate more optimal outcomes.

Table 3. Niche-Specific Stakeholders in Agroforestry, Lushoto District, Tanzania

Niche	Stakeholders
1. Farm boundaries	- Owners of boundary trees, neighboring farmers, missions, churches
2. Forest buffer zone	- Farmers in buffer zone, Ministry of Natural Resources and Tourism
3. Watering points	- Individual landowners, water users
4. Within farmland	- Individual household members (by gender, age)

BOX 4. Case Study: Removal of Eucalyptus from Springs in Galessa Watershed

For several years, farmers from Ameya village (Galessa Watershed) had tried to convince the landowner of the only year-round spring to remove his Eucalyptus from the area because they had observed significant declines in spring discharge following woodlot establishment. The owner consistently refused, and the villagers were threatening to take him to government courts to resolve the case. The conflict was in a state of escalation when the watershed program initiated. fter some debate with the Watershed Committee on the best approach to follow, it was decided to first attempt to resolve the case informally through the involvement of village elders. The elders were encouraged to talk to the landowner on an individual basis prior to open negotiations, which became a decisive factor in the landowner attending the scheduled village meeting as it helped to minimize feelings of antagonism. After brief introductions to the problem by PA, Watershed Committee and AHI representatives, each party present at the meeting was asked to present their view on the situation. When the Eucalyptus owner expressed his views on what he would lose in labor and money if he were to cut down the woodlot, other farmers began to attack him openly. The facilitator intervened to legitimize the landowner's position and right to speak. The ultimate consequences of a dried up spring on current and future generations brought the landowner to offer a concession to remove the Eucalyptus in exchange for one tree planted elsewhere on his property by each household. Initially, the proposal was rejected, yet after one farmer agreed to plant a tree, all others followed. All parties, including the landowner, left the meeting in high spirits.

A second way in which action learning is required in agroforestry activities is in adaptive management of tree nurseries. Learning to manage technical dimensions of tree nurseries is only one component of effective nursery management. It is also important to consider how group organization will influence outcomes. In Galessa watershed, technical recommendations from project personnel were initially determining the number of nurseries in the watershed. Yet through dialogue with local residents, it was determined that two nurseries were needed to enable effective management due to the distance of one of the watershed villages to the nursery site (making follow-up more difficult for them), and the availability of a viable spring in this village. An action learning approach will also be employed in the development and testing of rules and regulations for nursery management, including responsibilities (who must water, and when), benefits (who gets access to which trees) and sanctions (what is the consequence if people do not meet their responsibilities). In this way, conflict and misunderstanding is minimizes from the outset. Yet whether or not these rules work in practice can only be known through vigilant monitoring of group management over the life of the nursery, and timely resolution of problems encountered along the way. In this respect, participatory monitoring and evaluation plays a crucial role in the success – both technical and organizational – of afforestation activities.

Action Research

Action research at project level also has a crucial role to play in the aforementioned activities. First, it enables the planning of quality ("best bet") intervention approaches. Without effective process planning (i.e. the objectives and approach of afforestation interventions) (Box 5), interventions designed to facilitate stakeholder negotiations or effective group management in afforestation would be less likely to succeed. Furthermore, the need for stakeholder negotiations and collective action may not even become apparent in the absence of interdisciplinary planning and dialogue, and the process may resort to the status quo of individualized decision-making and action. This, in turn, would risk further exacerbating identified watershed problems (water supply, competition between trees and crops). Second, monitoring and evaluation of the approach is required at project (and in AHI's case, site team) level. This enables adaptive management of interventions, so that problems that would escape local-level identification (i.e. the lack of equity, the pitfalls of individual decision-making, or poor technical management of nurseries) may be fixed in a timely manner. Finally, process research and documentation is required so that lessons on how to manage an effective watershed management process may be distilled and disseminated to others who could benefit from such approaches. See Box 6 for an example of lessons distilled from PAL processes on spring management.

BOX 5. Process Planning at Site Team Level, Ginchi Benchmark Site

I. Objective:
To optimize gains to diverse system components and users from afforestation activities through the development of rules for niche-compatible afforestation.

II. Approach:
- Remind participants of watershed findings related to niche incompatibility (drying of water, negative impact of trees on crops and soil).
- Discuss experiences from other sites, where widespread afforestation has caused as many problems as it has solved because tree planted was done without considering tree properties.
- Open discussion: Do we need to be smart about what trees we put where? Why or why not?
- Feedback findings of tree niche study (see *Empirical Research*, below): a) niches identified, b) niche compatibility criteria, c) trees fitting and not fitting compatibility criteria.
- Group work: break into 5 groups by niche to discuss: a) whether rules are needed to regulate planting of niche-incompatible species or to balance the needs of diverse users, b) whether rules regulate existing trees or only those planted in the future, and c) how to ensure rules are followed.
- Return to plenary to present findings on how many trees were demanded by individuals in the watershed. Discuss implications of unregulated afforestation activities (nearly 4,000 "incompatible" trees requested). Is it important to revise these demands? Where should economically-important but niche-incompatible (harmful) species be planted?

BOX 6. Principles Distilled from Conflict Resolution in Spring Management

- The case study in Box 1 illustrates some general principles that can be employed in other cases where stakeholder negotiation is required to address natural resource management problems, namely:
- The crucial role of a third party both knowledgeable of and respected by each stakeholder (in this case, village elders) to aid in minimizing the problem in the minds of each party prior to face-to-face dialogue.
- The facilitator does not need to maintain a neutral stance toward outcomes, but must openly legitimize all stakes to seek a middle ground.
- The importance of compromise (each party making some concessions for the benefit of the other).
- If successful, community (informal) conflict resolution and negotiation is more effective in resolving long-standing disputes than legal enforcement mechanisms.

Empirical Research

Empirical research also has a crucial role to play in watershed management. In AHI benchmark sites, it has either been used or is envisioned for problem identification, as inputs to stakeholder negotiations (generating objective understanding of cause-and-effect), and for monitoring impacts. For the first of these, we opted for formal research rather than a participatory rural appraisal (PRA) in the identification of watershed problems. The reason for this is that we wished to systematically capture diverse opinions on key problems, and understand how diverse groups prioritize these problems. During a PRA, findings are generated by "consensus" at community or focus group level, where more outspoken individuals can more easily dominate problem identification and prioritization. Individual or focus group problem identification, coupled with individual ranking, enables a socially-nuanced understanding of how different social groups prioritize watershed problems. Our findings demonstrate how issues reflecting female domains of activity such as domestic water supply receive a much higher rating by women than by men, while issues affecting male rights (i.e. rights to land and irrigation water) and responsibilities (road maintenance) are prioritized more highly by men. Similarly, wealth influences how issues requiring significant resource inputs (labor, capital) are ranked, while landscape position influences access to drinking and irrigation water and the corresponding ranks for these issues (German et al, 2004c).

Empirical research is also required as an input to stakeholder negotiation. In the case of niche-compatible afforestation activities, empirical research in social science was utilized to identify local knowledge on key niches, niche compatibility criteria by niche, and a list of species both compatible and incompatible with each niche. While such activities could have been conducted in a participatory action learning mode, it would be more difficult to work with key informants more knowledgeable about the properties of indigenous and exotic tree species. It would also have required protracted meetings with many participants, taxing people's patience in the process. Empirical research in biophysical science is also envisioned to clarify some of the doubts about biophysical cause-and-effect. For example, if certain tree species interact negatively with neighboring crops, at what distance do these effects become significant.

Similarly with water resources, how important is tree location (i.e. distance to watering points or location with respect to underground flows) in the effect exhibited by different species on water resources? Such information can play a crucial role in stakeholder negotiations, because it give a concrete reference upon which to negotiate optimal outcomes. Furthermore, it helps to de-politicize negotiations on sensitive issues, for which different versions of "local knowledge" could be leveraged in support of particular outcomes beneficial to the bearer of that knowledge. In general terms, objective knowledge on sensitivity of particular system goals (maximizing water discharge or crop yield) to change in key parameters – whether obtained through rigorous social or biophysical research – represents an important input to watershed management.

Discussion

While the above cases and planning tools illustrate how the integration of diverse learning approaches can be attained, significant challenges remain to making such an approach part of standard R&D practice. First, all actors must reach a common vision about the ultimate end to which each learning approach (action learning, action research, formal inquiry) is put, about the important role played by each, and about the process through which specific sub-objectives are defined (namely, community-based action learning). The scientific community continues to value theoretical over applied research, despite the fact that theory and practice have much to gain from one other. This will hinder attempts to reach common objectives, or to ground research questions in development process. Furthermore, there tends to be a mutual under-appreciation among researchers and practitioners with respect to the critical importance of each other's methods and skill base to development (Bebbington and Farrington, 1992; Turton and Farrington, 1998). The second major challenge is the development of effective institutional arrangements to link the diverse learning approaches and their required skill base. Currently, the most empowering action learning processes are found within development organizations, classrooms and other domains of "practice", skills for formal research in diverse disciplines are concentrated in research organizations, and quality action research has yet to be institutionalized in most parts of the world. Clearly, a new skill base would need to be integrated into existing institutions and new institutional linkages forged between research and development organizations in order to institutionalize such an approach. An immediate solution to this problem would be funding of strategic research in which the strengths and weaknesses of different institutional affiliations, linkages mechanisms and training programs would be systematically tested and documented. An approach such as this one might begin with a more detailed look into the roles and responsibilities of different actors (empirical and action researchers, PAL facilitators), the skill base required to operationalize these roles, and where these resources reside within existing institutions. Knowing where existing institutions fall in their disciplinary mix and mandate (research, development), it is possible to identify critical gaps and build partnerships based on complementarities. At this point, an action research-action learning approach could be utilized to test what is required to enable effective inter-disciplinary and inter-institutional cooperation within diverse institutional models. Research questions could be designed to fill critical information gaps around such partnerships, namely, "How can joint accountability to a unifying objective, and to concrete development outcomes, be established?", "Which institutional arrangements are most effective in unifying diverse learning approaches?", and "What is required (training, incentive systems, field experience) to generate a common appreciation of the respective strengths of diverse learning approaches?" Clearly, action-based learning is required across 'learning cases' to approximate effective answers to such questions on learning approach integration.

Conclusion

In contrast with the general tendency to either value or discredit the more marginalized learning approaches (action learning, action research), this paper highlights the critical role played by each in a fully operational R&D continuum. While participatory action and social learning approaches are known to generate the most successful results with respect to fully empowering development processes, empirical research has an upper hand in filling critical information gaps that defy local knowledge or more 'participatory' forms of research. Finally, action research has a crucial role to play in synthesizing action-related findings ("*What works, where and why?*") for a broader audience – thereby multiplying the impacts of location-specific development interventions, and in understanding how empirical research results can best inform development practice. A number of useful didactic and methodological tools are presented to justify the importance of diverse learning approaches and their articulation and to enable their application by the research and development community. Yet questions remain on which institutional arrangements would be best suited to enable more widespread application of such an approach. The paper is written in an attempt to encourage other R&D actors to reflect upon the relevance of the model within their own practice, and to contribute to a broader debate on how to best put it into practice.

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References

Agbamu, J. 2000. gricultural Research–Extension Linkage Systems: An International Perspective. A*gREN Network Paper* 106a, ODI.

Basu, S. 1996. Need for Action Research for Health Development among Tribal Communities of India. *South Asian Anthropologist* 17(2):73-80.

Bebbington, A. and J. Farrington, 1992. The Scope for NGO-Government Interactions in Agricultural Technology Development: An International Overview. *AgREN Network Paper* 33.

Coghlan, D., P. Coughlan and L. Brennan, 2004. Organization for Research and Action: Implementing Action Researcher Networks. *Systemic Practice and Action Research* 17(1):37-49.

Dick, B. 2002. Action research: Action *and* Research. Paper presented at the seminar *Doing Good Action Research,* Southern Cross University, Monday February 18, 2002.

Elliott, J. 1991. *Action Research for Educational Change*. Buckingham: Open University Press.

Gardner, J.S. 2003. Evaluation of Capacity and Policy Development for Environmental Sustainability: A Case from Himachal Pradesh, India. *Canadian Journal of Development Studies* XXIV(1):137-153.

German, L.A. Berhane Kidane and Riziki Shemdoe, 2004a. Social and Environmental Trade-Offs in Agroforestry: Integrating Knowledge Domains to Enhance 'Win-Win' Scenarios in the Highlands of Eastern Africa. Paper submitted for consideration in special issue of *Environment, Development and Sustainability* (August, 2004).

German, L.A., J.G. Mowo and M. Kingamkono, 2004b. Scaling Out Strategically: A Methodology for Understanding Patterns of 'Spillover' of Farm-Level Innovations. Paper submitted to *Agriculture and Human Values* (August, 2004).

German, L.A., Tilahun A. and A. Stroud, 2004c. Participatory Integrated Watershed Management: Evolution of Concepts and Methods. Proceedings of the conference *Integrated Natural Resource Management in Practice*, ICRAF Headquarters, Nairobi, 12-15 October, 2004. CD-Rom.

Gustavsen, B. 2003. New Forms of Knowledge Production and the Role of Action Research. *Action Research* 1(2):153-164.

Hagmann, J. 1999. *Learning Together for Change: Facilitating Innovation in Natural Resource Management through Learning Process Approaches in Rural Livelihoods in Zimbabwe*. Weikersheim: Margraf Verlag.

Hagmann, J. and E. Chuma, 2000. Tying Up Loose Ends: Integrating Soft and Hard Methodologies in NRM Research and Extension. In: I. Guijt, J. Berdegué and M. Loevinsohn (eds.), *Deepening the Basis of Rural Resource Management,* pp. 109-121. The Hague: ISNAR.

Hagmann, J. and E. Chuma, 2002. Enhancing the Adaptive Capacity of the Resource Users in Natural Resource Management. *Agricultural Systems* 73:23-39.

Hammersley, M. 2004. Action Research: A Contradiction in Terms? *Oxford Review of Education* 30(2):165-181.

Kelly, J.G., L.S. Azelton, C. Lardon, L.O. Mock, S.D. Tandon and M. Thomas, 2004. On Community Leadership: Stories About Collaboration in Action Research. *American Journal of Community Psychology* 33(3/4)205-216.

Lewin, K. 1946. Action Research and Minority Problems. *Journal of Social Issues* 2:34-46.

Maarleveld, M. and C. Dangbégnon, 1999. Managing Natural Resources: A Social Learning Perspective. *Agriculture and Human Values* 16:267-280.

May, M.L., G.J. Bowman, K.S. Ramos, L. Rincones, M.G. Rebollar, M.L. Rosa, J. Saldana, A.P. Sanchez, T. Serna, N. Viega, G.S. Villegas, M.G. Zamorano and I.N. Ramos, 2003. Embracing the Local: Enriching Scientific Research, Education and Outreach on the Texas-Mexico Border through a Participatory Action Research Partnership. *Environmental Health Perspectives* 111(13):1571-1576.

Meinzen-Dick, R., M. Adato, L. Haddad, P. Hazell, 2003. Impacts of Agricultural Research on Poverty: Findings of an Integrated Economic and Social Analysis. IFPRI Discussion Paper 111, 87 pp.

Percy, R. 1999. The Experiential Learning Cycle and its Application towards the Transformation of Governmental Extension Services in Sub-Saharan Africa. *International Journal of Lifelong Education* 18(5):370-384.

Pierce, A. 1956. Empiricism and the Social Sciences. *American Sociological Review* 21(2):135-137.

Pretty, J. and L.E. Buck, 2002. Social Capital and Social Learning in the Process of Natural Resource Management. In: C.B. Barrett, F. Place and A.A. Aboud (eds.), Natural Resources Management in African Agriculture. New York, NY: ICRAF and CABI Publishing.

Reason, P. and H. Bradbury, 2001. *Handbook of Action Research*. London: Sage.

Sanginga, P. 2004. Facilitating Participatory Processes for Policy Change in Natural Resource Management: Lessons from the Highlands of Southwestern Uganda. Proceedings of the conference *Integrated Natural Resource Management in Practice*, ICRAF Headquarters, Nairobi, 12-15 October, 2004. CD-Rom.

Stenhouse, L. 1975. *An Introduction to Curriculum Research and Development*. London: Heinemann.

Stroud, A. and L. German, 2003. Planning Guide for Integrating Community Planning and Research. *AHI Technical Notes Series No.* B7.

Tesema, T. and L. German, 2004. Stakeholder Negotiation in Watershed Management: The Case of Ameya Village, Ginchi Benchmark Site. Poster presented at the AHI Regional Conference, World Agroforestry Centre, Nairobi, October 12-15, 2004.

Turton, C. and J. Farrington, 1998. Enhancing Rural Livelihoods through Participatory Watershed Development in India. *ODI Natural Resource Perspectives* 34:1-4.

Institutionalization of the AHI's Inter-disciplinary and Multi-institutional Approach into the DRM System in Tanzania

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Abstract

Due to complexity of farmers' environment in the African highlands, AHI's research approach emphasizes an inter-disciplinary and multi-institutional participatory research, which seeks the active involvement of various stakeholders knowledgeable in other fields. AHI's main objective is improvement of the livelihoods and household incomes of inhabitants of the highlands while retaining the long term productivity of the land. On the other hand, the Department of Research and Development (DRD) having their own perspective, has also been challenging. So, how does one achieve a bottom-up process that has strategic links across the region? How does one negotiate these levels to gain appreciation between levels and actors? Various operational mechanisms are discussed and evaluated. To have effective performance and implementation of the various linked agendas, one has to foster and manage 'unequal' members and diverse teams at site, national and regional levels to enhance positive interactions and to ensure clearly articulated complementary roles and responsibilities. Propelling and dispelling factors, difficulties and achievements for effective, functioning to integrated, multidisciplinary team work are summarized and lessons learned presented. Various types of partnerships between research organizations are elucidated and progress lessons are reviewed. Analysis of partnership issues is made against a 'partnership assessment framework' that was developed for monitoring and evaluating these relationships. Different partnership configurations that link research to development have emerged and have varying strengths and weaknesses

Introduction

The complexity of farmers' environment, in many parts of the highlands of the tropics, makes it difficult for scientists (of one discipline from one institution) to come up with appropriate new technologies or recommendations. This complexity results from both bio-physical and social-economic factors (eg variation in bio-diversity and soil variability, wealth status etc). Conventional agricultural research tends to lead to general recommendations, identified in a process during which the complexity is reduced by limiting the number of researchable factors and by disentangling the research into separate disciplinary fields (URT, 1991). Adoption rates of technologies developed through this process are often disappointingly low (AHI, 2001; Mowo et al. 2002).

AHI uses a multi-disciplinary team approach in which partners with different disciplines from different institutions work together with farmers in the R & D process, developing a basket of technological options for different farmer categories specifically focusing on the complex NRM in the humid highlands of East and Central Africa (AHI, 2001). On the other hand, the Department of Research and Development(DRD) of the Ministry of Agriculture and Food Security (MAFS) implements different research projects many of which use different participatory research approaches. So far there is no common framework to assess or monitor these approaches for institutional harmonization.

This paper looks at the multi-disciplinary and multi-institutional participatory research approach adopted by AHI and compares it with approaches followed by research projects under DRD. The specific objectives of this study are (1) to analyse the potential and limitations of participatory research methods/approaches being used by AHI and different research projects in institutes run by DRD and (2) look for possibilities to integrate these approaches for effective technology generation and dissemination in Tanzania.

Methodology

The following methods were used to solicit opinions of different stakeholders in the process of carrying out participatory research and development.

- Discussion with AHI Lushoto team about how they operated
- Discussion with DRD staff on how research teams plan research and development
- Discussion with groups of farmers on the appropriateness of the approaches (AHI vs DRD)
- Discussion with researchers on the appropriateness of the approaches (AHI vs DRD)
- Case studies of joint analysis of participatory research methods being used (AHI vs DRD)

Discussion with AHI Lushoto team about how they operated

Lead questions/themes in discussing with the AHI Lushoto team were as follows:

- How they organized participatory research in addressing NRM issues
- What lessons the team has learned

Discussion with DRD staff on how research was planned

Lead questions/themes in discussing with DRD staff were as follows:

- How they organized participatory research in addressing NRM issues
- What problems did the team experience

Discussion with farmers on the appropriateness of the approaches (AHI vs DRD)

Lead questions/themes in discussing with farmers were as follows:

- Whether involving them in identifying problems and working together with researchers to solve their problems was of any help
- Whether they were able to identify researchers of different disciplines or from different institutions during researcher visits (not clear)
- Whether they found working together with researchers and other stakeholders was of any help

Discussion with researchers on the appropriateness of the approaches (AHI vs DRD)

Lead questions/themes in discussing with researchers were as follows:

- How they felt working in an environment where scientists of different disciplines and from different institutions work together
- Whether they encountered any problems
- Whether they found it important to work in joint teams of researchers with different disciplines and from different institutions
- What motivation they have in working with researchers and farmers

Case studies of joint analysis of participatory research methods being used (AHI vs DRD)

The first step in this joint study was to develop a sound framework for the assessment of participatory research methods used in different projects/institutions that combined natural resource management. Using this framework (based on identified principles and values) different participatory methods used were assessed. The general objective of the study was to assess the different participatory approaches used by different projects in DRD and AHI in order to harmonize the approaches and come up with a common framework on which the research system in the DRD will operate. In the study 9 research projects using participatory research methods were picked up for in-depth analysis.

The selected case studies were:

- The Participatory Learning and Action Research (PLAR) on Integrated Plant Nutrient Management (IPNM) project based at ARI Mlingano, Tanga.

- The Participatory Plant Breeding (PPB) approach under the Eastern and Central African Bean Research Network (ECABREN) at ARI Selian, Arusha.
- The Indigenous Soil and Water Conservation Project (ISWC) coordinated by Cooperative College, Moshi.
- Farm-Level Applied Research Methods for Eastern and Southern Africa (FARMESA) based in Dar es Salaam.
- Sorghum and Millet Improvement Program (SMIP) based at ARI Ilonga.
- African Highland Initiative (AHI) in Lushoto, Tanga Region
- SADC/ICRAF Agroforestry Project in Tabora Region
- Lake Zone Client Oriented research Project (COR-LK) in Ukiriguru Mwanza.
- Integrated Residue Management Project at ARI Tumbi, Tabora

Results

Discussion with AHI Lushoto team about how they operated

In addressing NRM, AHI Lushoto deals with a range of institutions (Lyamchai and Mowo, 1999). These include SECAP, NTSP, TAFORI, TIP; researchers in NRM from SARI, ARI Mlingano and HORTI Tengeru, stockists, policy makers, the government machinery (DALDO, DED, DC, Local governments), farmer representatives and farmer groups such as UWALU and Lishe Trust) and religious institutions.

The process involves selection of partners who are committed to addressing NRM issues and exploring all possible researchable problems which are later prioritized. Selection of researchable problems is based on agreed principles and potential for success. Later resources needed are identified (within AHI and/or from partners). Roles to be played by each partner in all other phases of research (planning, write ups, implementation, monitoring and evaluation) are identified. Activities are jointly carried out.
The approach encompass multi-disciplinary team approach, Inter-disciplinary team, multi-institutional, working with stakeholders in the R & D process, developing a basket of technological options for different farmer categories to select what is feasible, specifically focusing on integrated NRM in mountain ecosystems (AHI area of specialization). Now this is actually the model most research programs are advocating.
The team felt advantaged by being able to locate most partners in Tanga region and nearby Arusha region. This has reduced the costs of organizing visits and meetings of partners.

Discussion with DRD staff on how research is planned

The DRD is a department within MAFS mandated to administer (coordinate) agricultural research in Tanzania. It is organized along 7 research zones. Research planning has been decentralized to the Zonal Centres. Participation of researchers of different disciplines and institutions within a zone is through operations of the IPR, ZTC and the ZEC. Research problem identification is either by single or multi-disciplinary approach and often involves farmers. Research proposals are first discussed at department meetings and later at Institute research meetings. Potential projects are forwarded and discussed at IPR (researchers and stakeholders). Approved projects go to ZRC (researchers and stakeholders). ZEC (policy makers, researchers and other stakeholders) make final approval for funding. Implementation (either on-station or on-farm) is by researchers and target farmers. Monitoring and evaluation is done by scientists and extension service. Adoption of findings is done by target farmers. It was evident that collaborative research projects had their own mode of planning and use different participatory approaches.

Discussion with farmers on the appropriateness of the approaches (AHI vs DRD)

Farmers felt that due to the nature of constraints being handled in the watershed, AHI needed expertise not only in agriculture, forestry and animal husbandry but also in other disciplines. Although farmers were not able to readily recognize researchers’ disciplines, they were quite happy that research teams were able to address many issues involving livestock, crops, land and water. Farmers in other projects where single discipline experts are involved (e.g. crop production) were at loss when confronted with livestock or water harvesting issues.

Discussion with researchers on the appropriateness of the approaches (AHI vs DRD)

Researchers felt that involvement of farmers ensures sustainability of projects since they consider them their property. By adopting a holistic and integrated approach to NRM rather than solving one problem at a time, and working in interdisciplinary and multidisciplinary teams ensures effective use of the available resources including manpower. Researchers now realize that by working closely with the farmers they are able to continually reflect on their performance, learn and gain experience from the communities they worked with. Through feedback researchers are able to revisit their strategies and approaches in time thus minimizing chances of making mistakes.

However, while AHI believes that the success in research in NRM requires collaboration (among professionals, institutions, farmers and farmer groups etc) with the skill mix and resources, researchers were concerned about high costs when involving many stakeholders (farmers, researchers, extension service, private operators) in an inter-disciplinary and multi-disciplinary manner.

CASE STUDIES OF JOINT ANALYSIS OF PARTICIPATORY RESEARCH METHODS BEING USED (AHI VS DRD)

Most cases did not incorporate broad aspects of implications of technology such as marketing and natural resources management aspects (AHI, 2002). Likewise the question of scaling up was not well addressed. The mandate of the research agenda is narrowly defined and the link between research and extension is weak in most of the cases studied. Integration of disciplines is weak with only multidisciplinary being well addressed. Interdisciplinary is not given due consideration. Reports from researchers are in a format that is not useful to farmers and feedback to farmers by researchers such as through use of extension materials and discussions is lacking. Most of the projects studied were fairly effective on three of the five impact areas identified. These are: Sharing of information and knowledge between farmers and farmers seeking for innovations to progress collectively, adoption and adaptation of improved techniques and practices, and orientation of farmers towards markets. The involvement of farmers in technology development ensures effective dissemination and adoption of technologies since farmers become part of the whole process (Rutatora et al. 2004). Of the cases studied AHI and ISWC were well ahead in this aspect.

The impact of the different cases on farmer organizations was also scrutinised. Aspects of farmer organizations are missing in most of the cases studied. In most cases farmer groups are built by outsiders with no due consideration to existing structures. A close look at the relationships between farmer research groups, interest groups and community organization is necessary. A farmer organization should have a life of its own and organizational structure and should continue beyond project life or researcher intervention. It is concluded that research is not yet addressing farmer organizations adequately rather it is mainly using farmer research groups induced from outside. The projects that targeted the right categories of farmers were successful as farmers adopted the technologies. Good examples of this were AHI, ISWCS, PPB and COR-LK. Chances of scaling up/out technologies differed among projects. In the case studies ISWC project was excellent in this aspect as technologies were able to spread beyond the targeted areas.

Discussion

Participation of farmers and other stakeholders in projects within the agriculture sector in Tanzania is recognized as a requirement for adoption of project outcomes. However, experience gained shows that participatory methods being used differ throughout the country. This has been realized in a recent discussion on this topic with various researchers, farmers and members of different institutions ((AHI, 2003). Based on the nature of issues being addressed AHI, for example, recognizes the importance of involving partners with different skills (inter-disciplinary) and from different institutions (multi-institutional) in carrying out activities.

There are many experiences which can be learnt from the approach adopted by AHI. AHI's approach has the ability to build upon not only on farmers' knowledge but also on the experiences of many participants. It enables social customs and cultures of the participating communities remain intact which ensures adoptability of outcomes. Partners feel they own and have a share in responsibility. Besides focusing on resource poor, the approach allows flexible and collaborative exchanges among participants. There is clarity on who participates in what activities which enhances team spirit among researchers. Adoption is often high since farmers' capacity to analyze their constraints, to identify opportunities and mobilize the services they need is high.

AHI's approach is not without problems. Involvement of different stakeholders results in high operational costs (travel costs, perdiems etc). The long time it takes to establish committed multi-disciplinary teams and build confidence with farmers is the other shortcoming. It often happens that scientists become committed to other duties and AHI has to re-organize its timing of operations. The extractive nature of the process (too much data extraction from farmers demanding a lot of their time) versus the need to balance with tangible benefits e.g. provision of attractive technologies e.g. high value crops etc.

In the case of projects and institutions working under DRD, many participatory approaches are being practiced. They vary from weak to strong integration of disciplines as well as from weak to strong use of services and/or experts of other institutions. Experience gained indicates that knowledge available in the community is not sufficiently explored as not many farmers are reached. Farmers' capacity to analyze their constraints, to identify opportunities and mobilize the services needed is low. It has been found that working under government budgets limits institutions' capacity to involve many stakeholders.

Recent strategies by government encourage stakeholder participation in many activities in the agriculture sector (URT, 2001; URT, 2002). Private and community-based service providers will be increasingly needed, hence, future interventions may need to support the emergence of such private service providers, and remove possible constraints to their emergence. Strong linkages and synergies are being encouraged between the range of private and public agricultural service providers, for example among research, extension, information and communication, training and technical services. Grass-root level farmers' or community-based organizations and networks are being promoted and strengthened to become key development partners. This is because success of various projects depends entirely on the stakeholders' consent. Such consent can only be achieved as long as the respective institution meets the stakeholders" expectations by providing required services or commodities. In order to be aware of the stakeholders' needs, the respective research institution must work very closely with them and communicate regularly with a view to create better relationship and understanding between both sides. The truth is that current policy emphasis and trends will see stakeholders requiring better services from the respective institutions.

In order to harmonize the different participatory approaches used by different agricultural research projects and come up with a common framework on which the research system in the DRD will operate, several actions are needed to be taken. There is need to develop effective linkage and partnership among stakeholders. This can be achieved by holding joint planning and review meetings with stakeholders, defining roles among stakeholders (researchers, farmers, organizations, extension department etc.) and establish stakeholder inventory analysis and identification of partners in the project area. There must be a shared need and agreed strategy to integrate different participatory methods in agricultural research. Wide scale formation of farmer groups, farmer field schools (FFS) and farmers associations should be encouraged in order to strengthen stakeholder participation. A close look at the relationships between farmer research groups, interest groups and community organizations is necessary.

Conclusions

The approach adopted by AHI Lushoto team where researchers of different disciplines and from different institutes and farmers are involved in identification of research areas is seen as a practical example of effective participatory method. By accommodating farmers' ideas, social and cultural issues, this approach ensures adoption of technologies generated. A call is hereby made for MAFS to integrate and harmonize the different participatory approaches for effective technology generation and dissemination in Tanzania.

References

AHI, 2001. The African Highland Initiative (AHI): Technical Report, End of Phase I (1995 – 1997) Report. Kampala, Uganda.

AHI, 2002. Analysis and processing of the field assessment of participatory research. Proceedings of a workshop held at Courtyard Hotel in Dar Es Salaam, Tanzania January 21 to 26th 2002. Compiled by Anne Stroud and Jurgen Hagmann.

Lyamchai, C.J. and J.G. Mowo, 1999. African Highlands Initiative (AHI) Progress Report for the Lushoto Benchmark Site. SARI (Selian Agricultural research Institute, Arusha. Tanzania.

Mowo, J.G., Mwihomeke, S.T., Mzoo, J.B. and T.H. Msangi, 2002. Managing Natural Resources in the West Usambara Mountains: A glimmer of hope in the horizon. Paper presented at the Mountains High Summit Conference For Africa, Nairobi, Kenya. 6 – 10 May 2002.

Rutatora, D.F., Mowo, J.G., Mattee, A.Z. and R.S. Shemdoe, 2004. The Role of Indigenous Knowledge in Promoting the Development of the Agricultural Sector in Tanzania. Paper Prepared for the 3rd MAFS-SUA collaborative Research Workshop held at the TANESCO Training Centre, Morogoro, Tanzania. 24 – 26 May 2004.

URT, 1991. National Agriculture and Livestock Research Master Plan. Main Report and Annexes. Ministry of Agriculture, Livestock Development and Cooperatives in conjunction with Department of Research and Training, ISNAR, The Hague

URT, 2001. Agricultural Sector Development Strategy; MAFS, Dar Es Salaam.

URT, 2002. Agricultural Sector Development Programme. Framework and Process Document; MAFS, November 2002; Dar es Salaam.

Negotiating Agendas: Building Bridges across Boundaries

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The African Highlands Initiative operates an unusual organizational model that is meant to facilitate the integration of expertise so as to produce more effective, efficient working relationships between individuals with different disciplines working in a team, and in partnerships between research organizations and between research and development actors, and between researchers and the end users. Eight years of experience and work across international, national, and local organizations of various types provides a rich set of experiences from which to draw lessons on the overall agenda setting process at multiple levels and with multiple partners and perspectives. The facilitated process that was used in AHI at regional program level is described to move from individual institutional agendas to a more shared, over arching vision and framework which served as the 'reason for collaboration'. Various barriers and successes towards achieving 'buy-in' are discussed. Through AHI, agendas have also been negotiated in the national and benchmark site contexts (district and community). Linking agendas through these levels, each having their own perspective, has been challenging. So, how does one achieve a bottom-up process that has strategic links across the region? How does one negotiate these levels to gain appreciation between levels and actors? Various operational mechanisms are discussed and evaluated. To have effective performance and implementation of the various agendas, one has to foster and manage 'unequal' members and diverse teams at site, national and regional levels so they interact in a positive manner and understand their complementary roles and responsibilities. Propelling and dispelling factors, difficulties and achievements for effective, functioning to integrated, multidisciplinary team work and links between site and regional levels are summarized and lessons learned are presented. Various types of partnerships between research organizations are elucidated and progress lessons are reviewed. Analysis of partnership issues is made against a 'partnership assessment framework' that was developed for monitoring and evaluating these relationships.

Finally, strategies that have been used in different circumstances for managing and improving these processes within the AHI program and have led to different configurations and differing levels of 'success' in ensuring the contribution of research for development. Some examples of where research for development has worked well and has made a difference are highlighted to bring out principles for others.

Evolving Roles of Research Manager to Address New Demands and Challenges: NARI Manager's View and Implications for Research Institutions

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Over the past several years substantial amounts of research have been undertaken by National Agricultural Research Institutions (NARI) based in Tanzania. During this period, research managers have been subjected to assorted approaches, experiences and challenges related to aspects related to management of agricultural research such as different funding initiatives and philosophies, various levels of adoption and impact of developed technologies, as well as changes in policies - all of which have multiple implications for implementation. For decades support to the Tanzanian Agricultural Sector and related research was dominated by the Government with major assistance provided by donors. However, since the 1990s direct funding of research has diminished substantially, and donors have increasingly shifted attention to address more demand-driven, client oriented approaches to ensure impacts of research. This shift has greatly influenced the sustainability and direction of research. In order to optimise the use of limited resources and to adapt to this new focus, which is characteristic of the African Highland Initiative (AHI), has resulted in the urgent need for many research managers to establish more efficient ways of organizing and managing their agricultural research activities to accommodate more flexibility, efficiency, quality of service delivery and accountability. The need to identify strategies to empower farmers to identify their problems and promote their greater participation in identifying potential solutions to their problems has also been given greater emphasis to promote adoption and impact of developed technologies. Research managers have also been faced with the challenge of promoting a rapid shift from on-station, commodity oriented research, which dominated earlier research initiatives to accommodate more synergies through partnership and multi-disciplinarity at the farm and watershed levels. Partners involved in such an undertaking include the GOT, private sector, IARCs, farmer organizations, credit institutions, district councils to mention a few, with all stakeholders focusing on their respective contributions in improving smallholder production systems as a strategy to increase food security and alleviate poverty while conserving the natural resource base. Research managers have been faced with the challenge of identifying and promoting modalities for greater links between research institutions and the various partners to get to understand the roles of each other better in a changing system. This paper looks at the experiences of AHI in Lushoto as a model working arrangement and its implications to research organization in Tanzania in the context of the changing roles of the research managers.

Strengthening Community Learning and Change: The Role of Community Driven PM and E Systems

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Abstract

Community-driven participatory monitoring and evaluation systems offer new ways for strengthening learning and change at the community level. In this process, local communities agree on what changes they expect from their projects, what they need to do to achieve these objectives, identify local indicators to track these changes and finally identifying what factors can make their projects succeed or fail. The community-driven PM&E system serves as tool for strengthening the capacity of community-based organisations, especially farmer research groups, for process-oriented learning that supports self-reflection and shared decision-making. Learning to manage the PM&E process builds social and human capital assets of the rural poor which feeds into direct improvement of their livelihoods through more relevant and timely improvements on their projects and agricultural innovations, but also into a wider impact through improved capacity to make effective demands on service providers.

Although, there are various studies that focus on developing PM&E systems with the involvement of stakeholders, there are limited examples of where these systems are managed and supported by local communities, for their own purposes. This paper presents lessons from establishing community-driven participatory monitoring and evaluation systems within Enabling Rural Innovation (ERI) initiative in CIAT. These systems are being tested with various communities and partners in Malawi, Uganda, and Tanzania. Preliminary results indicate that there are several critical aspects in establishing these systems: (1) Developing a capacity building strategy for PM&E at the community level, is critical. Capacity building should includes diverse tools and methods that can encourage active participation of all members, such as graphics, role plays, stories from the farmers' daily lives, identifying local vocabulary for the technical terms, and using role-plays. (2) Ensuring that indicators are negotiated with communities and that communities focus on collecting information only on those indicators that are relevant, from their perspective. (3) The initial stages of establishing PM&E systems at community level require a strong mentoring and follow-up component from facilitators to ensure appropriate establishment of the project. (4) The PM&E systems provide relevant information that communities can use to improve the functioning of the projects, communication within the group, and for informed decision-making. (5) Integrating community indicators with project level indicators providing a more holistic view of the project benefits and can strengthen information feedback process between communities and R&D systems.

CEED: R&D Linkages; A Framework for the Integration of Diverse Learning Approaches

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Abstract

Coalition for effective extension delivery (CEED) is an alliance of five organizations that are supporting the capacity building of farmer groups and local institutions to respond to the changing system of demand-driven development processes specifically agricultural service delivery in line with National Agriculture Advisory Services (NAADS) vision. The CEED coalition members include CARE international-Uganda, the African Highlands Initiative (an eco-regional program), Kabale District farmers Association- KDFA (a farmer-owned institution linked to a national level federation) Africa 2000Network and Africare both international NGOs. CEED focuses on empowering poor farmers and their institutions to be active participants in the demand-to-delivery processes, and especially improving their capacity to influence policy development and play their role in the services delivery process. For decades farmers and government officials alike have become accustomed to the government providing (unsolicited) services for farmers. Reversing roles giving farmers the decision- making power in selecting services is a new challenge for all parties. Through farmer groups and farmer forum, communities are taking on new roles and expectations with enthusiasm, although competencies in group management, agroenterprise development and monitoring of the implementation processes are still needed. The empowerment process is geared towards preparing farming to take the new opportunities in the context of NAADS. The coalition members conduct participatory workshop at the community level to identify challenges in implementation of the NAADS program and negotiate on solution for the same. The CEED process has enhanced multi-stakeholder participation in developing a mutually negotiated vision for the farmer institutions, strengthened linkages among the coalition members and brought to surface complementarity among coalition members. This papers sheds lights to the lesson learned and new agendas and frontiers that are evolving which require the attention of a coalition.

The INSPIRE Experience of Working with Farmer Field Schools and Land Management Initiatives in Eastern Uganda

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Abstract

The inspire consortium was launched as an African network in 2001 in collaboration with the local district administration in Tororo district, Uganda. It consists of representatives from Makerere University, NARO, ICRAF, TSBF-CIAT, Appropriate Technology, Uganda National Farmers Assocation, Food Security and Marketing project (FOSEM), Africa 2000 Network, Sasakawa Global 2000, farmers, the District Agricultural Extension and local administration. The main roles of the lead organization are to synthesize data, develop fact sheets, facilitate on-farm evaluation, test improved soil fertility management practices and overall documentation and reporting. The main achievements of INSPIRE to date include the expansion of support for MSC and PHD students, the production of extension leaflets, project staff training across partners, and an increased awareness of soil fertility management needs in the district. There are three farmer field schools (FFS) projects running in Eastern Uganda in relation to INSPIRE. The focus of these three projects are: Soil Productivity Improvement (SPI) with support from Rockefeller foundation in Tororo and Busia districts; Conservation Agriculture (CA) through FAO TCP to the Government of Uganda (NARO) in Mbale and Pallisa districts and; Integrated Nutrient Management for Soil Productivity Improvement (INMASP) with support from EU to Makerere University in Pallisa district. The pilot projects have provided a common understanding of cross-cutting issues such as poverty alleviation, gender mainstreaming and HIV/AIDS to the communities and other stake holders and a common understanding of the need for a practical approach on how to integrate them into agricultural interventions at planning, implementation and monitoring levels. Many of the lessons learned from these FFS are associated with livelihood improvement and greater capacity building related to appropriate education and skills training, and incorporating a diverse stakeholders.

Chapter 8:

Emerging NRM Research Issues

Institutionalization and Scaling Up into NARIs and NGOs: Approach, Challenges and Lessons

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Abstract

The African Highlands Initiative (AHI) has collaborated with the National Agriculture Research Institutes (NARIs) in undertaking INRM work in the highlands of Eastern Africa. More often, collaboration has stretched beyond NARIs to include communities, civil society and non-governmental organizations (NGOS). The mode of working has been through the use of participatory approaches that bring stakeholders especially communities to the forefront in the design and implementation of research agenda. Since 1995, AHI in partnership with CIAT has promoted the use of participatory research, integrated research teams and muti-institutional collaboration among partner organizations that have been largely conventional and " top-down" in their approaches to working with communities. The lessons learned have been the basis of spearheading institutionalization and scaling up work within the collaborating partners and beyond such that the new approaches become part of the new way of conducting research that is responsive to the need of the farming communities and other land users. This paper gives an account of the approaches, lessons and challenges in the efforts to institutionalize the new approaches within national agriculture research organizations and NGO that have collaborated with AHI and CIAT.

Introduction

Despite the evidence of benefits of participatory approaches (Biggs, 1989; Richards, 1989; Ashby, 1996; Sanginga, et al, 2001), their incorporation, quality application and finally institutionalization in agricultural research organizations has been slow. Presumably, profound changes in research policies and practice are needed (Hall and Nahdy, 1999; AHI 2001; Buar and Kradi, 2001; Stroud, 2003).

In the Catholic Relief Services (CRS- EARO) and its Learning Alliance with CIAT (through its Rural Agroenterprise Development Project) and Foodnet, the links between agricultural research and development institutions associated with the small farm sector have been weak, with a poor record of adoption of innovations in terms of either technologies or methods, coupled with non-existent means by which the results of successes or failures can be fed back to the research process. CIAT and FOODNET have at their disposition methods and tools for capturing and systematizing market information, identifying market opportunities for small rural producers, and a participatory approach to the design of integrated commodity or market chain projects.

AHI is approaching institutionalization and uptake of lessons from use of participatory research approaches and processes through competence development and lessons sharing with manager of the NARS, researchers, collaborators (Extension and NGOS) and target communities. A series of workshop with the NARS managers and researchers are being conducted to generate a shared vision for the desired change and competences (professionalism needed) to deliver effective research products to the target beneficiaries.

Background

AHI's current mandate is to deepen capacity and use of integrated NRM principles and participatory methods that will result in role changes beyond technology development. This "paradigm shift" requires change in researchers' attitude, behaviour and practice and, to a large extent, institutional operations, arrangements and values that support the changes in practice.

Institutionalization is defined as the process whereby practices become regularly and continuously repeated, are sanctioned and maintained by social norms, and have major significance in the social structure, organizational procedures and staff performance (Springer- Heinz, 2002). The extent to which participatory methods become part and parcel of research organization operations is pivotal to the success of integration of these methods, and is core of AHI activities under methodology development and up-scaling within the NARS and beyond.

Principles of Learning Alliance

- Clear objectives
- Shared responsibilities
- Outputs as inputs
- Differentiated learning mechanisms
- Long –term relationships

A Learning Alliance between CIAT, CRS (NGO) and Foodnet is an attempt to put into practice a new model of mutual learning between research and development institutions, to enhance uptake and institutionalization of innovative concepts, methods and technologies that are aimed at improving the competitiveness of smallholder production.

There is pressure mounted from donors and rural communities for more effective development outcomes from research findings, research centers, and the international research centers in particular, are constantly searching for effective mechanisms.

The Learning Alliance concept is one attempt to advance and see institutionalization of key principals for successful rural enterprise development identified as (a) an entrepreneurial, market oriented focus; (b) participatory decision-making with partners; (c) a focus on strengthening existing local skills as well as building new ones; (d) a search for consensus among multiple actors; (e) equal access to opportunities for participating groups, and; (f) social, economic and environmental sustainability using a teritorial approach. All these will contribute to improvements not only in research focus (i.e. help research institutions identify their comparative advantages and niches vis à vis development partners) but also in the dissemination of good practices for collaborative learning to people and organizations with sufficient capacity to facilitate effective change, and thus lead to institutional learning and change processes that favor the rural poor.

Objectives

- This paper shares factors that that enable or impede uptake and institutionalization of participatory and new approaches within research and development organizations by comparing experiences from NARS and non- governmental organizations.

- Stimulate debate on the lessons gained and mechanisms needed in the way forward by carrying out an analysis of lessons from pilot cases in ECA region. Research questions

Hypotheses

- Institutionalisation of participatory research is contingent upon an interplay of factors, including external conditionalities, internal organisational arrangements and individual knowledge, attitudes and beliefs.

- Action learning processes triggers opportunities for individual and organisational reflection that lead to learning, innovation and understanding of changes needed, and of how to operationalize these changes, finally resulting in organizational change process.

Research Questions

- How is participatory research articulated within the context of R&D agencies?
- What factor enable and or impede the uptake of new research approaches?

- What are the implications of the new research approaches for organizational learning, institutionalization of participatory research, innovation and change?
- What is the perception of participatory research and how is it linked to the philosophy or R and D agencies?
- What is considered as indicators of best practices in participatory research and agro-enterprise selection and development?

Methodology

The sample population in this paper are the NARS managers, researchers and their collaborating partners from NARO in Uganda and EARO in Ethiopia. The author is collecting and documenting information on institutional change work as part of his doctorate study. The information is this paper was collected using multi-site ethnography, focused group discussions, participatory workshops and individual interviews since 2002. Responded include managers, researchers (and extension staff) and farmers (individuals and groups) that participate in regional and in-country works and participatory research activities and thus sampled purposively. The concept of culture theory is used to distill information on organizational practices, values and norms that influence interactions and uptake of new ideas and learning. In each of the participating countries workshops that bring managers, researchers and collaborating partners are convened aimed at self- assessment of progress, success stories and barriers to delivery of quality research. Each of the workshops/meetings ends with an agreed action plan on the actions to be undertaken until the next workshop is convened and new insights a shared leading to re-planning and re-implementation. .

Results

In AHI and CIAT cases, *the shift from a relief/production approach to a market/enterprise orientation* brought the challenge of working with a new client base, which involves the many other actors in the marketing chain, i.e. traders, processors, retailers, other specialist private sector groups and providers of business support services. This requires new skills (communication, negotiation and facilitation), professional (marketing specialties), approaches and tools to enhance impacts. AHI has steered the NASR in fostering interdisciplinary and inter-institutional work, policy linkages, participatory research and building on farmers/ local innovations and knowledge. Unlike in the CIAT-CRS case, where not all participants in the learning initiative are suited nor may wish to participate in a Learning Alliance process, most of the NARS scientist in AHI context were keen on gaining skills in new methods and participating in institutional change process. In all cases, staff turnover and consistency of participants in learning events affected the progress of planned activities. For example, in CRS case, changes in participants during the process truncates learning and necessitates that the other participants wait while the new arrivals get up to speed.

In the case of CIAT- CRS institutional learning and change has been noted. Ownership by the CRS country participants and their partners has increased as the process has progressed and tangible results are being observed. In some countries, CRS is now recognized as having a capability in market and agroenterprise development and other government and non-government organizations are seeking their support. In the case of AHI, evidence of researchers and their managers owning the institutional change process is gradual. R&D agencies are undergoing tremendous reforms as demand for client oriented and, market led research and development is being focal. In terms of hosting of the research institutions, evidence of occilation between the NARS being autonomous parastatals vs being under the ministries of agriculture in respective countries is noted. Researchers and managers in the pilot NARS countries attested to the fact. Much of researchers' and research managers time was being spend in working aimed at assessing their internal arrangements and coming up with ways of improving their service delivery.

- Researchers involved in participatory research activities suggested that their colleagues do not think it is an approaches that works for research activities. The debate about where the science and rigour is rampant. Individual upbringing, profession and training background shape the perceptions (positively or negatively) for or against upatake of new research approaches.

- Farmers are less willing to participate in all stages of research because of past experiences with the projects that gave them *compensation* for their land and labour. This the drive for handouts form projects is common, although farmers that participate in these activities genuinely are there and are benefiting.

- Demonstrating the impacts of participatory researchers vs conventional research and how the latter is linked to the market is a key challenge.

- Knowledge in participatory research is acquired through on-job training and universities and colleagues hardly teach these methods

In the AHI case, opportunities that potentially enable institutionalization of PR, approaches and innovations were observed and included

Policy environment that is emphatic to decentralization of development and research programs. In the two countries, I found that the government policy of decentralization and market led research of development programs was giving rural communities and stakeholders the opportunity to initiate development activities based on the priority needs of the communities. This was shift from the supply led development processes were the government was providing all the needed development projects and the communities were passive recipients. This shift towards decentralization is line in with the principle of participatory approaches of including the target groups in the R&D endeavours. A leader of the farmer research group said, the government policies are making the local administrative leaders and project staff to consultative meetings where we point out our development priorities and make decisions on where to start". The integration of marketing is a stimulus to the desire to generate income and food out of the farmer research group activities. Within the NARS there are projects that support and fund participatory research activities such as the Client oriented Research programs in EARO and DRD.

- Within the NARS new vision and strategies for new ways of doing business are being developed. For example, The Strategic Management Plan (SPM) by EARO, programs and research stations and the NARO/MAK/ICRA learning initiative in which the needs and preferences of the clients that are geared towards market orientation are articulated.

- Researchers competence in concept and application of participatory approaches that is being built through (i) training in new research methods and (ii) exposure visits to other projects where participatory project were advanced.

On the other hand, some challenges have been noted in the AHI case;

- Researchers noted emergence of diverse and confusing concepts as new project get started. For example, in EARO, projects such as Farming System Research (FSR), Farmer Participatory Research (FPR) and Client Oriented Research (COR). They are alls striving to address the needs of the farmers but with different strategies and funding sources. The point at which these projects converge is missing.

- Diverse methods for entering and working with communities and stakeholders are stated in all the new project. The challenge is how to integrated the methods and processes that each of this projects stand for. For example, IFAD supported FFS approaches, while COR and AHI have supported and facilitated formation of farmer research groups.

- Commodity programs (and division): Hierarchical arrangements and decision making from the top management of EARO down to research stations, programs and individuals. Programs are organized along commodities and mechanisms for integration are blurred if not absent, albeit for the annual review meetings that are conducted once a year.

- Incentive mechanism : The promotion is staff (researchers) is based the length of service in research and also the numbers of scientific and refereed publication produced by individual researchers on annual basis. This does not recognize work that is conducted in teams or the outcomes that are accruing to the communities nor failures when projects are being implemented.

- Coordination and harmonization of activities. Different projects that were implemented had different time spans and outputs to be delivered (FSR, COR, AHI, etc). This is coupled with weak links with partners from universities and NGOS that are working on participatory issues. This was attributed the fact that NGOS for example have their mandates and accountability mechanisms to the donors.

- Budget allocation from core funds. For example, researchers noted that EARO does not continue supporting the projects that support participatory approaches when they phased out. Even if they do, the funding levels are very small as compared to what the external donors were committing.

- Competence development program was found limited in some aspects such as personal development. As researchers are challenged to work with communities and diverse stakeholders, competencies to organize and manage stakeholders are limited. For example, researchers are not intensively trained in facilitation, negotiation and or process documentation skills. Researchers are appointed to manage broad program with the assumption that since they are good scientists they will automatically work with communities and also manage stakeholder platforms.

Policy environment impediments

For example, the Ethiopian government desired for imported technologies. The government of Ethiopia feels obliged to meet the food security needs of the country in order to ameliorate the chronic food insecurity that is experiences. Standard Extension packages program under the Ministry of Agriculture. Although the packages that farmers get were meant to boost their productivity, the packages are designed with no attention to the heterogeneity of the households and variations on AEZ. Food for Work programs through WFP- World Food Program adopted the Food for Work strategy as a means to stimulate communities to adapt and adopt natural resources conservation measures. For example, farmers worked on soil bund conservation, gully control, tree planting, road construction at a daily wage of 3kgs of wheat per day. High turn over of researchers and managers- this is affecting continuity of programs.

Conclusion

IMPLICATIONS TO CHANGE

Organizational change and willingness to pilot new research and development approaches are needed. By institutionalizing new approaches with organizations, the status quo is challenged and concerted efforts are needed to develop a shared vision between the top management and the intermediary levels.

Engaging all levels

In Ethiopia and Uganda AHI, with the involvement of a process change consultant in collaboration with the NARS managers and researchers are undergoing training to broaden orientation in new ways of conducting research. In Uganda all the zonal agriculture research and development center teams are getting training in integrated agriculture research for development to broaden researcher beyond technology generation and dissemination. The new orientation includes focusing on innovation for different typologies, zoning of agroecosystems, market chain and livelihoods analysis. On the other hand, in Ethiopia, the top manager of EARO, the center managers of research station and representatives of regional research and universities are brought together to assess internal barriers to institutional changes, new competences needed for managers, researchers and farmer, feedback culture among researchers and managers and among peers, and documentation of successful technological stories and how they fit in the innovation systems approach. All these efforts are still on going.

For effective institutionalization the research managers and their teams are seeking better ways for forging partnerships with non-research partners (in a new environment) where extension staff is being retrenched like in Uganda on one hand and also with NGO with different approaches and mandates such as handing out seed to framers vs training farmers to produce their own seed on the other. Secondly, market integration is now an ingredient in assessment of new workplans and proposal. All the NARS in the region are striving to have their technologies find their ways into the market. However, the researchers especially the biological scientists do not have that adequate skill for new orientations especially for market integration in their work by the nature of their professional training. The professional training of most of the NARS scientists is skewed toward generation of new technologies for high productivity. More capacity building is needed in this aspect as is also needed in new areas such facilitation, negotiation, innovation systems approach and action research skills.

Piloting Action research

McNiff (1988) suggest that action research enables the actors to engage in self- reflective inquiry to improve rationality of their own rationality and practices. In the institutionalization work, the managers and researchers are encouraged by AHI to view themselves as researchers so that they make a deep analysis of the changes that are needed in the systems in which they live. The conventional ways of research is that the researchers and their managers are experts that know and decide in advance what is good for them. Therefore with the action research methodology, AHI is engaging on the one hand with researchers and managers through a process of change by encouraging them to be aware of their own practices, to be critical of that practice and to be prepared to change it and farmers on the others.

New professionalism

The need to institutionalize new and approaches and upscaling catalyized by the emergence of innovation systems approach and demand for rapid impact are posing challenges to the way research is to be conducted. Conventionally researchers are trained to be "teachers" when they graduate as they are viewed as the experts and custodians of knowledge. Universities and other professional institutions reinforce the teaching paradigm by giving the impression that they are custodians of knowledge which can be dispensed or given (usually by lecture) to a recipient (a student) (Pretty and Chambers, 1993; Pretty, 1998). Normally, professionals are single-disciplinary, and are concerned with generating and transferring technologies. This perception and beliefs by researchers differ with people's conditions and priorities.

Becoming learning organizations

Accompanying change towards new professionalism is need for organizations to become learning organizations (Senge, 1990; Pretty, 1998; Senge, 1999). The NARS have to endavour to ensure that staff are aware of their changing environment, and the way they learn, both from mistakes and from successes of their research work. Organisational learning is considered a key discipline for dealing with the "white water" of dynamic, unfamiliar and uncertain contexts (Pasteur, 2004). Currently the NARS scientist and managers are working in the context of reforms and multiple realities and expectations which have to be understood through multiple linkages and alliances, with regular participation between professional and public actors for impacts of research intervention to be felt. It is only when some of these new professional norms and practices are in place that widespread impacts in the livelihoods of farmers and their natural environments are likely to be achieved (Pretty, 1998).

References

AHI, 2001. Stakeholders Strategy Workshop for Designing Phase 3 of AHI, held at ICRAF, 21-23rd March 2001.

Ashby J. A. 1996. What do we mean by participatory research in agriculture? In: New Frontiers in Participatory Research and Gender Analysis. Proceedings of the international seminar on participatory research and gender analysis (PRGA), 9-14 September 1996, Cali, Colombia. Centro Internacional de Agricultura Tropical (CIAT) Publication No.294, pp.15-22.

Baur, H and C. Kradi, 2001. Integrating Participatory Research Methods in a Public Agriculture Research Organization: A Partially Successful Experience in Morocco. AGREN Network Paper No. 109. ODI.

Biggs, S. 1989. Resource-poor farmer participation in research: a synthesis of experiences from nine agricultural research systems OFCOR Comparative Study Paper No 3 ISNAR The Hague.

Hall A, and S. Nahdy, 1999. New Methods and Old Institutions: The "System Context' of Farmer Participatory Research in National Agricultural Research Systems: The Case of Uganda. AGREN. Network Paper No. 93. ODI. UK.

McNiff, J. 1988. Action Research: Principles and Practice. Macmillan Education. London.

Pasteur, K. 2004. Learning for development: A literature Review. Lessons for Change on policy and organizations No. 6. Institute of Development Studies (IDS), University of Sussex. Pretty, J.N. and Chambers, R.., (1993). Towards a learning paradigm: new professionalism and institutions for sustainable agriculture. IDS Discussion Paper DP 334. IDS, Brighton

Pretty, J. 1998. Participatory Learning for Integrated Farming . In Proceedings of the Internet conference n Integrated Bio- Systems http://www.ias.unu.edu/proceedings/icibs

Richards, P. 1989. Farmers also experiment : A neglected intellectual resource in African Science. In Discovery and Innovation, Vol. No. 1 March 1989.

Sanginga, P., Lilja, N., and B. Gurung, 2001. Assessing the Benefits of Rural Women's participation in Natural Resources Management. Proceedings of the Natural Resources Management (NRM). Small Grants End- of - Project Workshop, Cali, Colombia, 13-17, 2001.

Senge, P. M. 1990. The Fifth Discipline: The Art and Practice of the Learning Organization. Currency Doubleday. New York.

Senge, P.M. 1999. The Dance of Change: The Challenges of Sustaining the Momentum in Living Organizations. Nicholas Brealey Publishing. London.

Springer- Heinz, A. 2002. "The use of impact Evaluation: Orienting Research towards impact". A paper presented at the CORAF/WECARD/CTA Technical consultation on institutionalization of impact assessment, in La Somone, Senegal.

Stroud A. 2003. "Transforming institutions to achieve innovation in research and development". Chapter 5 In: Pound B, Snapp S., McDougall C., Braun A. eds. Managing Natural Resources for Sustainable Livelihoods: Uniting Science and Participation. London UK: Earthscan Publications Ltd. P. 88-112

Enabling Rural Innovation in Africa: An Approach for Integrating Farmer Participatory Research and Market Orientation for Building the Assets of Rural Poor

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Abstract

There is a large body of literature indicating that farmer participatory research (FPR) is vital for reorienting technology development, accelerating adoption and creating wider impacts of agricultural technologies in small-scale farming. Generally FPR has not been targeted to enable farmers to access existing and new markets, or diversify and increase their income sources, and generally having a strong 'empowerment' dimension. FPR, as conceived and practiced by most research organizations, has been looking more towards research products that assist development rather than towards enabling a development process with research inputs. Recent initiatives are demanding more from research. Prior initiatives to link farmers to markets have focused on export crops and regional and international trade and lack a process of community learning and building local capacity to solve problems in production and marketing. This paper outlines a novel approach for demand-driven and market-oriented agricultural research and rural agro-enterprise development. This approach termed Enabling Rural Innovation (ERI) offers a practical framework to redirect and link FPR and participatory market research (PMR) in a way that empowers farmers to better manage their resources (human, social, financial, natural) and offers them prospects of an upward spiral out of poverty. The ERI approach uses participatory processes to build the capacities of farmers, farmers' groups and communities to identify and evaluate market opportunities, develop profitable agro-enterprises, intensify production through experimentation, while sustaining the resources upon which their livelihoods depend. Research and development partners need effective facilitation skills for provision of market and technical information, and building human and social capital of rural communities, with focus on gender and equity in the access to market opportunities and technology innovations, and in the distribution of benefits and additional income. The key steps and principles of ERI include: building and managing effective partnerships, participatory diagnosis building on community assets and opportunities, rather than constraints and problems; building farmers' capacity for market opportunity identification and agroenterprise development, stimulating farmers' experimentation processes to access, generate and adapt knowledge and technologies; participatory monitoring and evaluation processes for critical learning and reflective feedback for scaling up and out promising options and innovations. The paper illustrates the application of ERI with case studies from pilot sites in eastern and southern Africa.

Conflicts in Natural Resource Management

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Abstract

Conflicts and disputes, both violent and non-violent are ubiquitous, especially in situations where control over resources is being negotiated. In the field of natural resource management (NRM) there are differing conceptions of 'biodiversity', 'ownership', 'environment', and 'development' in which are embedded conflicting ideas. There has been a lot of research into NRM conflicts, but there is little recognition of the root causes. Participatory, open-ended stakeholder identification and analysis are key. Environmental Governance refers to the processes of decision-making and the processes by which decisions are implemented. Different definitions of governance put emphasis on participation, processes, institutional arrangements, accountability, and building constituencies for environmental management. These can be examined at global, regional, national or local level. A conception of environmental governance which emphases the balance of power – the politics of decision-making – will get closer to understanding the roots of conflict than one which is more strictly 'technical'. Historically, in many parts of the developing world, power has been centralized, (a command and control approach) and conflict over natural resources was often quashed by the state either through the threat or use of force, or through co-option (as per the colonial model). Through the current vogue for decentralization, central government should take on a role of monitoring and technical support. Decentralization of NRM is especially appropriate, because: a) resources are a direct source of profit (not a long-term, intangible investment such as health or education); b) people rely upon natural resources daily, hence pressure for participation; c) effective NRM requires local knowledge. Decentralization requires transfer of powers and an accountable representation. Transfer of discretionary powers should be in form of secure rights, not 'privileges' which reduce autonomy. Examples of decentralization from Kabale, Uganda and Rwanda show differing outcomes and impacts. In Kabale, financial and human resources are inadequate and poor revenue collection and utilization reduces the effectiveness of local-level governance. In Rwanda, the level of popular participation is questionable and varies across districts and communities. Rwanda must also address underlying issues of post-conflict identities. NRM is even more likely to be conflictual than other kinds of development interventions because the stakes include such fundamental issues as economic livelihoods, a sense of community, and boundaries of political autonomy and/or control. When groups disagree over interests, this is not a conflict but is rather a dispute. Conflict is qualitatively different, arising from disagreements over values and ideology. Values include perceptions of rights, and are linked closely with issues of identity and freedom; things about which we cannot easily negotiate. Environment and land use can be part of spiritual beliefs, cultural values, etc. (e.g. transhumant pastoralism as a way of life; maize for indigenous Amerindians, Tavy in Madagascar). While a dispute can usually be settled through arbitration or through a court process, conflicts can only be resolved by a change in perceived underlying injustices or inequalities. Gender problems are not usually seen to be associated with conflicts, especially in patriarchal societies: but women are often influential behind the scenes and the lack of involvement of women can lead to domestic disputes, and project failure. Conflict analysis begins with determining the nature of the conflict and certain boundaries (geographical, temporal etc), identifying the actors and key stakeholders. Conflict Mapping can help to separate 'needs' or 'interests' from 'positions' (e.g. the extent of resource use, now and in past and future). There are many kinds of mapping methods, including sketching (based on use of twigs, string, etc), GIS, and 3-D modeling. Mapping can be especially useful for understanding multiple access rights, peripatetic communities, and remote (unmapped) zones. While much attention has been paid to manifest, violent conflict, the overarching conflict in NRM is fought not with knives or guns but with pens, word processors and websites. Due to the influence of the 'development machine' on fundamentals such as land tenure, the role of local leaders, and the boundaries of protected areas, conceptual conflicts can be traced to local 'manifest' conflicts. The battlegrounds of NRM conflict are not only the rural areas of the developing world, but also the conference rooms and libraries of the global environmental management and development sector.

A Framework and Process for Operationalizing INRM: Experiences, Challenges and Implications for the Future

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The African Highlands Initiative (AHI) has been aimed at solving land degradation and poverty issues through more effective approaches and building capacity to use these approaches. Through a facilitated and consultative process involving stakeholders, AHI has formulated an Integrated Natural Resource Management (INRM)[1] *framework and a process that can provide orientation for research and development organizations to achieve effective natural resource management and improve livelihoods. The framework, its elements and implications for individuals, organizations and partnerships, along with experiences to date are discussed. Stakeholders have pointed out through analysis that the most limiting factor for development is not technology alone, but rather that weak functional integration of research, limited application of research for development, and limited genuine involvement and competence development of beneficiaries are also major deficits. In other words, social and institutional deficits and strategies to ensure functional contributions of research to development are key at this point in time. Thus, it is reasoned that paradigm shifts are required in work and relationships: scientist-driven, reductionist research to be augmented with client-driven, team based systems research where one approaches technical aspects of the system from social organization and institutional perspectives; studying the system from outside to understand it towards working within the system to change the system (using action research); farm level intervention towards considering multiple levels of analysis and intervention (watershed, district, policy); and a training or teaching (more top-down) approach to a more equitable learning and adaptation approach, where partners (grassroots, NGOs, private sector) knowledge base is more 'equal', and building of skill base and ability to adapt through experience and learning is the thrust.*

These shifts require new negotiated roles and responsibilities which question tradition, challenge existing institutional culture and associated behaviour, and ways of working. In particular, the question of 'researcher's role', their commitment towards making an impact in often un-enabling institutional environments, and the type of contribution through science are looming issues. How and when can the framework and processes be best applied? What are strategies for and ways to manage necessary institutional change so as to move into the new R4D paradigm? What are the strategies and means by which the necessary institutional and individual competence is needed to carry out new ways of working? How can other R&D actors and organizations be brought on board?

[1] INRM is an approach tackles the complex of NRM and livelihood issues by: integrating multiple sources of expertise and perspectives using collaborative, strategic partnerships and team work; promoting facilitated dialogue and improved inter-institutional links with development organizations, policy makers and the private sector; working at multiple levels and scales with a wide variety of actors so as to differentiate and solve problems for various strata and conditions; utilizing a range of participatory methods that foster stewardship of natural resources, are inclusive of women and the poor, value local knowledge, and build local capacity; and use experiential learning and systematic monitoring for continuous progress for innovation and application of the approach. The new term for this is Integrated Agricultural Research for Development (IAR4D).

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