

Beyond the Farm

A New Look at Livelihood Constraints in the Eastern African Highlands¹

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Abstract

Throughout the highlands of eastern Africa, farming communities face critical challenges in providing for an ever-growing population while maintaining the productivity of the resource base. Most research and extension programs have approached this problem by focusing on the alleviation of farm-level productivity constraints, largely through technological solutions. There is a strong push within national and international arenas to move toward broader units of analysis and intervention, with the aim of enhancing the sustainability of rural livelihoods as well as environmental services emanating from highland areas. Yet little treatment has been given to the issue of farmer motivations for thinking and acting beyond the farm level. Outcomes of a participatory assessment of landscape-level problems of concern to highland farmers of Ethiopia, Kenya and Tanzania shed light on this question and point to contributions that can be made from research and development to support farmers and communities in addressing identified challenges.

Keywords: Eastern Africa, Collective action, Community-based natural resource management, Landscape, Livelihood constraints

Introduction

Throughout the highlands of eastern Africa, farming communities face critical challenges in providing for an ever-growing population while maintaining the productivity of basic resources. Most agricultural research and development (R&D) programs have approached this problem by focusing on the alleviation of farm-level productivity constraints, largely through technological solutions. While great progress has been made in systems thinking through Farming Systems Research and On-Farm Research approaches (Norman, 1980), research is often limited to applied research on specific commodities or components (Hagmann, 1999). This has a profound influence on problem diagnosis and interventions, which tend to be limited to biophysical dimensions and, often, a single disciplinary lens.

As one shifts the focus of inquiry beyond the farm level, the relationship between agricultural production and livelihood, social interactions influencing natural resource management (NRM), and larger landscape patterns and processes become apparent. Due in part to the limitations of the farm-level technology development approach for enabling better integration of components (trees, water, crops, livestock) and actors beyond the level of the farm, participatory watershed management (PWM) has been proposed as an alternative approach. While interpreted in diverse ways, some common aims include:

- To enhance technological innovation by taking into account how linkages among landscape-level components (forest, water, soil) and neighboring farms influence the criteria and incentives for technology adoption (Knox, Meinzen-Dick, and Hazell 2002),
- To enhance livelihood through improved management of the natural resource base supporting agriculture (De and Singh, 1999; Eren, 1977; CGIAR, 2002), and

¹ Paper under review by *Human Organization*.

- To enhance “ecosystem services” emanating from upper catchments (CGIAR, 2002).

This trend has gained significant momentum, contributing to a rather uncritical assessment of the underpinnings of emerging approaches. The failure to critique emerging concepts is critical given the influence of extra-local motives in the formulation of PWM agendas, as reflected (minimally) in the last of these aims. A question recently posed to one of the authors helps to summarize the important conceptual work that remains to be done on PWM: “Why would a farmer to think beyond the farm level?”

This paper illustrates recent experiences in participatory watershed management (PWM) within the African Highlands Initiative (AHI), an eco-regional program of the Consultative Group for International Agricultural Research and Association for Strengthening Agricultural Research in East and Central Africa. Rather than enter into a detailed analysis of the conceptual and methodological foundations of PWM, the current paper presents findings of participatory watershed diagnostic exercises in benchmark sites of Kenya, Ethiopia and Tanzania. The aim of this exercise was to identify natural resource management problems beyond the farm level that concern farmers – thereby defining exactly why, in the highlands of eastern Africa, farmers would want to think and act beyond farm boundaries. The identification of local motives for improved NRM is a fundamental first step toward: a) gaining a more nuanced understanding of bottlenecks to improved livelihood and NRM that go beyond the technological, b) identifying local incentives for improving environmental services and watershed function in upper catchments, and c) developing more strategic approaches to agricultural R&D that acknowledge the complexity of factors influencing rural livelihoods. Following a presentation of local motives for thinking beyond farm level, the paper discusses the implications of findings for institutions seeking to improve livelihoods through integrated natural resource management.

Background

AGRICULTURAL RESEARCH IN EASTERN AFRICA

National Agricultural Research Systems (NARS) in sub-Saharan Africa are strongly shaped by their common histories within Western philosophy and institutions, despite divergent cultural, ecological and political-economic influences. Influences of this common history on current research practice can be broken down into several dimensions: institutional philosophies, institutional structure, research priorities and professional practice. The institutional structure is composed of departmental divisions rooted in particular disciplines, which in turn correspond to particular components of the farming system (soils, annual and perennial crops, trees, livestock, pests and disease, etc.) (Hall and Nahdy 1999). This departmentalized institutional structure reflects a common academic tradition in which phenomena are understood by breaking them down into their component parts and problems addressed according to these discrete components. These philosophical underpinnings tend to legitimize positivist, technicist and reductionist orientations to research, while existing institutional structures foster hierarchy, disciplinary isolation and top-down knowledge transfer (Hagmann 1999; Hall and Nahdy 1999; Sutherland, 1999). While technological and biophysical aspects of agriculture receive strong support, social research is often integrated only to the extent that it is oriented toward enhancing technology adoption. Research is also largely oriented toward specific components of the farming system (crops, soil, livestock, trees) in line with compartmentalized institutional structures (Hall and Nahdy 1999), and toward sub-components that correspond to specific areas of professional expertise. This disciplinary orientation marginalizes systems and agroecological orientations (Munk Ravnborg 1992).

Professional practice is influenced accordingly, with professional identity predicated on the use of knowledge to teach others (as opposed to continuous, collaborative learning) and an emphasis on facts over problem-solving (Hall and Nahdy 1999). These aspects of professional identity foster a top-down approach to technology transfer (Hagmann 1999), in which technologies developed by each department are handed over to an extension system that is responsible for taking these technologies to the farmer. While there is an increase in adaptive on-farm research, in which technologies are field-tested by farmer-researcher teams, farmers continue to have limited input to the early stages of technology development or to defining problems that lie beyond the realm of farm-level productivity.

THE CHALLENGE: MANAGING NATURAL RESOURCES BEYOND FARM LEVEL

When moving beyond farm-level management to encompass broader dimensions of NRM, the need to expand conventional research domains becomes apparent. The focus on technology adoption has hindered a more nuanced understanding of impacts from technological innovation, which can be both positive and negative (de Grassi and Rosset 2003; Haugerud and Collinson 1990). When taking problem diagnosis to the landscape or watershed level, it is possible to identify important social and environmental impacts of technological innovation that should be understood and taken into consideration in program design. For example, runoff from farms or communal roads can wash out crops of down-slope farmers and lead to the siltation of rivers, while the cultivation of certain trees can retard crop yields on neighboring farms or lead to the depletion of communal water supplies (LeMaitre, Versfeld, and Chapman 2000). Secondly, the emphasis on specific components of the farming system or the integration of these components at farm level predetermines problem definition and the questions that are asked, even when such linkages have a direct influence on farm productivity (as in the above examples). These biases condition scientists to think of rural livelihoods in terms of agricultural productivity alone, despite the critical role played by resource access (land, water, capital), post-harvest processes and off-farm income in rural livelihoods. Finally, existing approaches are ill-suited to address complex trade-offs. If efficient and rational use of natural resources is the goal, it becomes critical to understand trade-offs between components at farm and landscape levels (including allocations of land, labor, capital, nutrient resources on the one hand, and optimization of crop, tree, livestock and water productivity on the other). If equity is a concern, who wins and who loses (social trade-offs) from land use change becomes a guiding question.

Ultimately, the questions asked in participatory problem identification determine the nature of responses, indicating that the mental models and disciplinary biases brought to problem diagnosis within rural communities will influence the envisioned pathways to agricultural development. While this paper is no different in that it sheds light on a particular area of inquiry as of yet marginalized within the arenas of national agricultural research and environmental conservation, it nevertheless illustrates what emerges when daring to move beyond conventional boundaries of agricultural R&D. The challenge then becomes how to move beyond standard disciplinary, institutional and epistemological boundaries to best support local communities in seeking far-reaching improvements in rural livelihoods.

THE AFRICAN HIGHLANDS INITIATIVE

The African Highlands Initiative is an eco-regional program operating 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 in support of improved farm and natural resource management (NRM) among rural communities. Following years of R&D experience at the farm-level, in 2002 AHI expanded its emphasis to encompass broader dimensions of NRM beyond the farm level. While in its preliminary stages, the integrated, participatory watershed management approach that has emerged illustrates important lessons for agricultural R&D in eastern Africa.

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’ or social learning approach to knowledge generation on-site (see Berger and Luckman 1991; Guba 1990; Maturana and Varela 1987), regional staff work to enhance cross-fertilization of ideas between sites and regional integration. While this cross-fertilization helps to strengthen the approach followed as well as the regional research dimension (through the generation of comparable data sets), site-level discussions and scrutiny of approaches ensures sufficient variation so as to enhance comparative learning between sites.

Methodology

THE RESEARCH PROBLEM

The research was guided by one central objective, namely to identify the key biophysical issues requiring a landscape or watershed approach. By pre-testing the methodology in an iterative series of site visits, it was possible to define a set of research questions that could adequately capture the host of issues for which farm-level decision-making is insufficient:

- 1) How have changes in the landscape and land use over time influenced livelihood?
- 2) Are there problems associated with the management of common property resources?
- 3) How do on-farm management practices influence the livelihood of neighboring farmers? How does land management in one village influence livelihoods in neighboring villages?
- 4) What are the sources of NRM conflict in the watershed (among and within villages)?
- 5) What current NRM problems can benefit from enhanced collective action?

DESCRIPTION OF RESEARCH SITES

Research was conducted in four AHI benchmark sites in the highlands of eastern Africa: Lushoto District in the East Usambara Mountains (Tanzania), Vihiga District (western Kenya) and Ginchi and Areka Woredas (central and south-central Ethiopia, respectively) (Table 1). Each site is characterized by high population density, natural resource degradation and declines in agricultural productivity – posing significant challenges to farmers to provide for the growing population while maintaining the productivity of basic resources (water, food, fuel, fodder).

Table 1. Characteristics of AHI Benchmark Sites

Site Attributes	Areka	Ginchi	Lushoto	W. Kenya
Altitude (masl)	1800-2600	>2200	1100-1450	1500-1700
Population Density (/km ²)	400-600	100-200	200-300	600-1200
General land use	Enset, wheat, maize, barley, sorghum, sweet & irish potato, bean, faba bean, pea, grazing in communal areas, horticulture	Wheat, barley, pulses, irish potato, oilseeds, teff, dry season grazing on hillslopes; grazing in valley bottoms	Maize, banana, horticulture, tea, coffee, beans, high-value trees, zero grazed livestock	Maize, beans, vegetable crops, some coffee, tea, sugarcane, and semi-intensive and intensive dairy
Access to irrigation	None	None	Medium (flow is seasonal; strong tradition)	Low (limited to riparian areas)
Livestock trends	Low numbers and decreasing; intensively managed; insufficient	High numbers yet decreasing; access to grazing land good	Small numbers and decreasing; zero-grazed.	Low numbers but stable.
Access to natural forest and woodlots	Medium (tree planting common)	Very limited (few planted; remnant forest at a distance)	Medium to high (many cultivated trees; natural forest protected)	Limited (tree planting common; high population limits access)
Income & Market Opportunities	Limited, with some off-farm opportunities	Medium	Medium to Good (local tea estates & tannin factory)	Medium to Good

(Adapted from AHI, 2001)

METHODOLOGICAL APPROACH

The methodology consisted of four basic elements: a) iterative development of research questions across sites through pre-testing and cross-site sharing, b) the systematic application of research questions through a consultative process of individual and focus group discussions, c) local ranking of issues on the basis of their perceived importance, and d) historical trend analysis with elders. While sufficient methodological parity was ensured so as to enable comparability and reliability of data, AHI's mandate to generate methodological approaches meant that some site-level methodological differences were maintained.

Pre-Testing

The initial stage of pre-testing was found to be essential for the development of a robust set of research questions that could effectively capture the range of issues of concern to local residents, and for which a farm-level or individualized approach to problem-solving is insufficient. The need to pre-test research questions also stems from the rapid popularization of watershed management approaches, which has led to a less than systematic treatment of concepts and methods.

Pre-testing was conducted through a series of site-level discussions with NARS/AHI site teams in Ethiopia, Kenya and Tanzania to develop and field-test preliminary research questions. The objective of such pre-testing was to ensure that important issues were not excluded due to the nature of research questions asked. This proved to be of fundamental importance, as evidenced by the emergence of new watershed-level problems as new questions were added to the research agenda.

Individual and Focus Group Discussions

Research was then conducted systematically in each benchmark site through village-level interviews with individuals and focus groups on the basis of important social and biophysical categories (see Table 2).

Table 2. Social and Biophysical Variables Used to Select Interviewees, by Benchmark Site

Site	Variables Used	Rationale
Lushoto	gender, age, wealth, landscape position	Variables likely to influence problem definition, following literature and plot/farm distribution according to slope.
Ginchi	gender, age, wealth	Same as above, yet no clear typology of household or farm location is apparent.
Areka	gender, age, wealth	Individual ownership of vertical strips of land precludes use of a landscape typology, yet a large group of landless laborers provides a fundamental criterion of wealth.
Vihiga	gender, age	Focus group discussions conducted within community fora where use of wealth criteria was considered inappropriate.

Ranking

After conducting interviews at village level, site teams compiled a single list of issues by grouping responses to all research questions and eliminating redundancies. While in some sites these lists were compiled at village level, in others a single list was compiled for the watershed as a whole (across five to six villages). In some sites, the lists were condensed through researcher-led combination of like issues. These lists were then taken back to villages for individual ranking according to the social and biophysical variables outlined in Table 2. Both absolute and pair-wise ranking were tested, for which the relative advantages and disadvantages are well-known (Weller and Romney 1988).

Historical Trends Analysis

Historical trends analyses were conducted with groups of elders in two benchmark sites (Ginchi and Lushoto) to understand the historical context within which observed patterns are embedded. The activity began with a

semi-structured interview, in which elders were asked to identify key changes observed in landscapes, land use and livelihoods over time. Once salient trends were identified, informants tracked the rate of change in key variables associated with these trends on a scale of one to 10 (the number 10 equivalent to the maximum expression of the variable) through four periods spanning approximately 75 years. Where illiteracy rates were high, time periods were matched to critical events that provide a clear reference point for recall.

Results

Results are organized according to categories that emerged from the inquiry rather than the original research questions, due to the authors' intention to identify emerging patterns in the types of issues affecting farmers at this new level of analysis (rather than adhere to the standards of formal scientific inquiry per se). Five new categories of NRM issues were identified for which at least some dimensions of the problem had escaped prior diagnostic activities at farm level. Each category is discussed in turn, with concrete examples of each one. Selected data are presented to illustrate important social differences (priorities by gender, age, wealth or landscape position) or how identified issues evolved over time.

COMMON PROPERTY RESOURCE MANAGEMENT

Common property resources (CPR) in the eastern African highlands are generally limited to water (springs, rivers, wells), grazing land, forest resources, village roads and paths, and in some cases, livestock. Problems affecting common property resources (CPR) and resource management may be classified into those affecting the quantity of the resource and those having a detrimental effect on resource quality.

Resource Quantity

Individual Encroachment on Common Property Resources

Due to land and resource scarcity in highland areas of eastern Africa, every parcel of land is highly valued and encroachment on communal property is common. Encroachment was found to occur on village roads and paths (Areka, Vihiga), communal grazing land (Areka, Vihiga), and springs and waterways (all sites). Encroachment may take several forms, including direct appropriation of the resource and indirect effects from other land management activities (see examples below). Another form of encroachment on communal property is theft of forest products from village forests and woodlots (Lushoto).

Deforestation and the Loss of Indigenous Tree Species

Deforestation was identified as a problem in all sites with the exception of Vihiga. In each of the Ethiopian sites, the problem was expressed as the loss of indigenous tree species and biodiversity. When probing into the reasons behind their concern, some farmers expressed concern about the loss of forest resources (timber, fodder, fuel). Others expressed concern for the loss of ecosystem services (water infiltration and spring discharge, soil erosion control and microclimatic effects) or the substitution of indigenous trees by eucalyptus due to the perceived negative impacts on water discharge and crop yield.

Declining Supplies of Irrigation and Drinking Water

Limited access to potable water was an important concern by farmers in all of the four benchmark sites. Declines in irrigation water was of concern in those sites where traditional irrigation systems are prevalent (Lushoto), and water shortage for livestock a concern expressed by Ginchi farmers alone. Although individuals may have customary or de jure ownership of land surrounding watering points and rivers, water is generally considered by both farmers and government to be common property.

The problem of access has multiple causes. Current land use practices are seen as having a negative impact on spring and river recharge through decreased infiltration, as well as increased sedimentation and water consumption by exotic tree species (especially Eucalyptus, mentioned in all sites as having a negative impact on water). Another perceived cause is land shortage, which has led farmers to increasingly bring marginal lands, riparian areas and spring "buffer zones" under production (Figure 1). Finally, limited access to springs and water stems from social problems, including ineffective management arrangements for domestic and irrigation water. This occurs at both farm and 'catchment' scales. In the first instance, paths to springs on

private land are blocked by individual landowners (Lushoto, Areka). In the second case, paths leading to watering points in neighboring villages are blocked by individuals or the community (Ginchi). Blockage of paths may be seen as an outcome of other problems, as farmers and villages take actions to limit access to a declining resource and limit crop damage caused by stray animals and theft. In some cases, existing conflict resolution mechanisms been effective in reducing conflict and restoring access.



Figure 1. Cultivation of Vegetables near Springs in Lushoto Benchmark Site, Tanzania

Resource Quality

Water Contamination

Contamination of water sources due to cultivation close to rivers and watering points (most sites), use of pesticides in vegetable crops bordering common water sources (Lushoto), and contamination by livestock resulting from failure to fence off human from livestock watering points (Ginchi).

Destruction of CPR

Destruction of common property resources was also mentioned, in particular with regard to fire and water. In some cases, this destruction was seen as unintentional, as with stray fires from agricultural plots. Yet in several cases, destruction was seen as a deliberate means of protest. Examples include setting fire in communal or state forests and destruction of watering points on private property, activities aimed at protesting limited access and restricting communal access to CPR emanating from private property, respectively.

Failure to invest in upkeep and management of CPR

A final category of issues involves insufficient collective investment in the periodic maintenance of CPR, including the construction and maintenance of irrigation canals and dams (Lushoto) and spring protection and management (all sites).

RESOURCE ACCESS AND DISTRIBUTION

The second category of concerns refers to resources that are in short supply in absolute or relative terms. In addition to facing absolute shortages of critical resources, inequitable distribution by gender, age or landscape position intensifies these shortages for some groups.

Absolute Resource Shortages

Absolute Shortages of Water for Household Consumption and Irrigation

In all AHI benchmark sites, absolute shortage of water was a primary concern. Only in Lushoto and western Kenya was shortage of irrigation water mentioned as a problem, yet this is due to the greater rather than less seasonal scarcity of water resources in Ethiopia (where water is insufficient in quantity for irrigation to be a consideration). Conflict over domestic water was observed in each site as well, where existing animosities

between neighbors are often manifested as conflict over water during the dry season. Only in Lushoto was theft of and conflict over irrigation water mentioned as a concern. In each site, Eucalyptus was mentioned as a primary contributor to water resource decline. In Areka, of three watering points available to two neighboring villages, all three are surrounded by privately-owned Eucalyptus woodlots. Even in Ginchi, where trees of any kind are in short supply, these impacts are well known. When elders in Lushoto were asked to rank the trends in water resource availability, they indicated a significant decline that set in between 1950 and 1980 due, they said, to the introduction of Eucalyptus (see Figure 2).

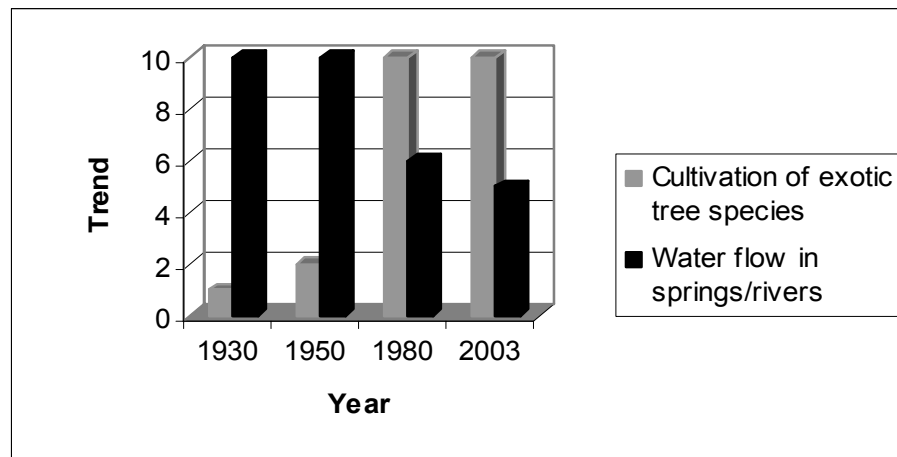


Figure 2. Perceived causal linkages between Eucalyptus and water resource decline, Lushoto benchmark site

Absolute Shortages of Productive Resources

Absolute shortages were also identified for other natural resources, including grazing and cropland, livestock (in particular oxen), and individual or clan property (including land, trees and livestock). Even in Ginchi, where population density is lowest of all benchmark sites (100-200/km²), land shortage due to high population was cited as a major constraint. In Areka, where approximately 40 percent of farmers are landless sharecroppers (Amede, pers. comm.), conflict over labor was cited as a concern. The shortage of oxen for ploughing was most pronounced in Ethiopian sites, whereas the need for improved bulls for cross-breeding with local cattle was stressed in Lushoto. In Lushoto, the land market is booming, with transfers between farmers common and land purchases a key investment strategy.

Two of the major contributors to land shortage are population growth (which some farmers link to improved medical services and reduced infant mortality) and declining agricultural productivity. As stated by a farmer in Dule Village, Lushoto benchmark site:

“In the past, people didn’t cultivate a big piece of land. They were only cultivating small areas due to the high yield. Now one can cultivate even four, five acres but the harvest is very small... Beginning in 1975, during *Ujamaa* [the Socialist regime’s villagization program, then President] Nyerere dictated that people relocate in *Ujamaa* villages to increase access to schools, health services and poverty eradication programs... After this time, population and land pressure increased significantly.”

Absolute Shortages of Forest Resources

Limited access to forest resources was mentioned in all sites, but seen as most severe in Ethiopia. This is in part due to dynamic changes in forest policies over the last century which led to extreme tenure insecurity for land and forests in the country (Yeraswork 1995). While biodiversity loss tends to be a concern echoed mostly by conservationists in the West, the loss of biodiversity was cited as the number one issue by farmers (on average) in the Ginchi benchmark site, and was ranked as one of the top three priorities for all social groups with the exception of youth. While women spend one out of every three days gathering fuel wood from distant forests at the Ginchi site, wood shortage was nevertheless ranked eighth in importance by women and fifth overall. This would suggest that other benefits from trees and environmental services from native forests are

also important reasons behind farmer concern about the loss of indigenous tree species. This was further corroborated through semi-structured interviews, in which environmental spin-offs from deforestation – including erosion, agricultural productivity decline, decreased livestock productivity from shortage of water and fodder, and decreased water quality – were highlighted as key problems.

Relative Shortages (Inadequate Resource Distribution)

Inequitable Distribution of Basic Resources

Distribution of water resources is also a concern, given the highly differentiated access in some sites. Such access is limited either by the seasonality of certain watering points, increasing the distance one must walk to gain access to water, or by limited access to springs on private land – a concern expressed in both Lushoto and Areka. In Ginchi, rather than private ownership, blockage of paths between villages was mentioned as a concern. This is also related to the seasonality of watering points, where decreased access in one village increases pressure on water resources in neighboring villages – as well as attempts to exclude access to a limited resource.

While distances people must walk to access water resources were not measured directly, strong divergences in how people rank declining access to domestic water relative to other watershed-level NRM concerns help to illustrate the patterns in water access by gender, age, wealth and landscape position (Table 3).

Table 3. Relative Importance of Access to Potable Water for Diverse Social Groups, Kwehangala, Lushoto Benchmark Site

Social Criterion	Rank^a of “Limited Access to Potable Water”
Age	<i>Elders: 2.5, Youth: 11.5</i>
Gender	<i>Men: 11, Women: 2</i>
Wealth	<i>High Income: 8, Middle Income: 10, Low Income: 3</i>
Landscape Position	<i>Upslope: 1, Downslope: 12</i>

^a The lower the number or rank, the higher the priority.

Unequal Inheritance and Property Rights

Given the rapid increase in population density in the highland areas of eastern Africa and the tendency to sub-divide land among one’s male children, total landholdings are declining rapidly. This is a primary concern for youth, who were alone in identifying this as a concern during focus group discussions in western Kenya. While it is also clearly an issue for women, whose limited customary rights to land are increasingly restricted under social, economic and political change (Kevane and Gray 1999; Shipton 1988), “non-recognition of women’s property rights” was mentioned as a concern in Lushoto only. Yet the failure to discuss this in other sites is more likely a result of the limited voice of women than the absence of the problem, a hypothesis that is supported by the greater participation of women in group interviews and community fora in Tanzania relative to other sites (in particular Ethiopia). Unequal inheritance of livestock was also mentioned as a concern in Lushoto. While land fragmentation was also mentioned by Tanzanian farmers, it is unclear whether the concept of fragmentation refers to plot size or plot distribution.

TRANS-BOUNDARY EFFECTS

The third set of issues involves declines in agricultural productivity stemming from trans-boundary interactions between neighboring farms and villages, and other resource disputes involving boundaries. These issues may be classified into six categories: failure of neighboring farmers to cooperate in water drainage, pathogens crossing farm and village boundaries, negative impacts resulting from the cultivation of certain species near farm boundaries, direct destruction of crops from the activities of neighboring farmers, boundary disputes, and upstream-downstream interactions.

Water Drainage

In every benchmark site but most notably in Ginchi, failure of neighboring farmers to cooperate in water drainage is considered a major problem. In Kenya, of most concern is runoff from village roads due to the force with which water enters farmers' fields. In each case, down-slope farmers are the most negatively affected, requiring collective action among farmers residing or cultivating in upper and lower parts of the landscape.

In Ginchi, outcomes of such runoff include the loss of seed, fertilizer and soil, as well as increased conflict among farmers. In Lushoto, these problems are aggravated by the prevalence of black wattle (*Acacia mearnsii*) on hilltops and sloping land, a tree with a secure market (a district-level processing plant for the extraction of tannins) yet which forms a relatively impenetrable layer of leaf litter that exacerbates runoff from upslope fields. According to one elder, the use of iron sheets to replace thatch as roofing material has also contributed to the problem. In Lushoto, soil fertility decline and erosion on hillsides is seen as the strongest causal factor behind the decline in soil fertility in valley bottoms (where cash crops are grown) due to the speed at which water now declines from the hillsides and the deposition of soils of poorer quality in the valley bottoms (Figure 3).

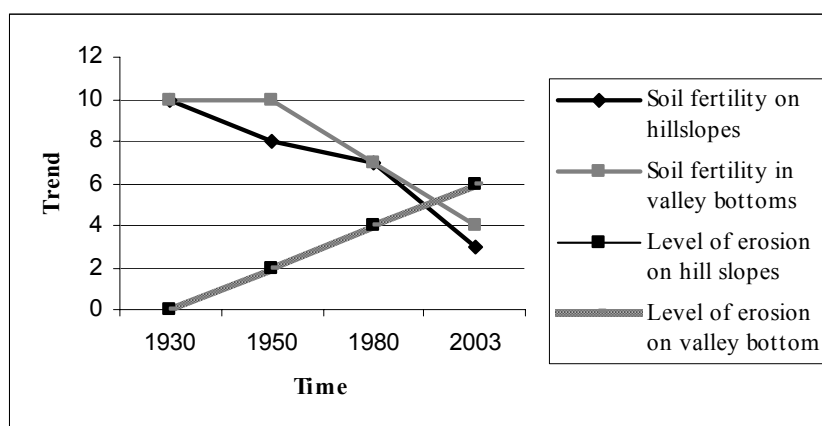


Figure 3. Perceived linkages between hillside and valley bottom erosion, Lushoto benchmark site

Pathogens Crossing Farm and Village Boundaries

When asked about trans-boundary effects between neighboring farms and villages, farmers identified the effects of crop and livestock pests and disease, weeds, rodents and wild animals as problems. The one exception was Ginchi, where the higher altitude and the larger per-family landholdings may be helping to minimize such problems. In Kenya, an increase in fungal infestation in all crops was cited, yet few issues (with the exception of declining water resources) compared with the importance of witch weed (*Striga hermonthica* and *S. asiatica*) in limiting crop production. Given that the incidence of witch weed is intimately associated with soil fertility indices (Kanampiu 2002), overall agro-ecosystem decline is playing an important role.

When women in Areka were asked to list the primary constraints on agricultural production and income, six out of the 14 issues mentioned were related to pathogens and pests. These included coffee berry disease (*Colletotrichum coffeanum*), mole rats (*Tachyoryctes* or *Heterocephalus* spp.) in root crops such as enset and sweet potato, porcupine (*Hystrix cristata*) in all crops, sweet potato butterfly (*Acraea acerata*), and black fly and *Trypanosoma* spp. in livestock. Of these, two (the black fly and sweet potato butterfly) were considered to be more acute in dry months, and saw climatic change (in particular a decline in rainfall) as an important causal factor. Collective action among neighboring farmers is considered essential in combating black fly, rodents and porcupine.

Boundary Trees

In most benchmark sites, Eucalyptus was mentioned as a major concern regarding its impact on both water and crops. These observations are not unique to farmers in eastern Africa. Similar perceptions have been

documented in India and Thailand (Phantumvanit, Panayotou, and Jetanavanich 1990; Shiva 1991), and in the fields of water resources management (LeMaitre, Versfeld, and Chapman 2000) and social forestry (Shiva 1991). In each site, Eucalyptus was always the first problematic boundary tree mentioned by farmers, and in some cases the only one. In Lushoto, black wattle (*Acacia mearnsii*) and *Acrocarpus* spp. were also mentioned, while in Areka avocado, banana, coffee and sugar cane were each mentioned as suppressing crop yield when planted by neighbors on boundary lines. Given the smaller land size in Areka, this would suggest that the smaller the landholdings, the greater the effect of such trans-boundary interactions. This problem is therefore likely to be exacerbated in the future, as population grows and landholdings further decrease in size.

For Eucalyptus, negative impacts on crops can result from a number of factors, including shade, competition for soil moisture and nutrients, and allelopathic effects (Florence 1986; Shiva 1991), although the severity of these impacts may be species- and climate-dependent (Saxena 1994). Some species are also known to be toxic to soil fauna that play a critical role in decomposition (Kale and Krishnamurthy 1981). In Areka, Eucalyptus was also mentioned as a culprit in reducing availability of cropland due to high population pressure in this site and the effective area occupied by Eucalyptus, whose negative impacts extend 10 to 20 meters into neighboring fields by local estimates. Competition between food and Eucalyptus production has also been documented in India, where the poor have been disproportionately affected from restricted land use options and reduced land productivity resulting from the cultivation of eucalyptus on neighboring farms (generally by wealthier or absentee landlords) (Shiva, 1991).

Destruction of Crops from Stray Fire and Livestock

Destruction of crops from stray fire and livestock were mentioned in Lushoto alone. Despite a by-law requiring zero grazing, animals are often left to roam across farm and village boundaries, destroying crops. Stray fires were identified as a problem on neighboring fields during land preparation, and within village forests.

Resource Disputes Involving Boundaries

Boundary Disputes

Boundary disputes were cited as a problem in every site except for Western Kenya. In Lushoto and Ginchi, farmers expressed this problem as insufficient respect for land boundaries and theft of agricultural produce. In both Ethiopian sites (Areka, Ginchi), conflict over paths through neighboring farms and villages are examples of this problem. The latter results not only from neighboring villages trying to gain access to limited water resources, but from crop damage resulting from failure to control livestock along the way.

Upstream-Downstream Interactions

Lushoto was the only site in which the conventional upstream-downstream watershed interactions were cited as a problem. Farmers expressed this in terms of the drying up of valley bottoms. This is exacerbated by the cultivation of Eucalyptus in valley bottoms – not by individual farmers, who utilize such land for the cultivation of cash crops, but by a tea factory. It takes on increasing importance due to the high value placed on such lands for the cultivation of cash crops during the dry season when market prices for such crops are high.

LINKAGES BETWEEN PRODUCTIVITY AND COLLECTIVE ACTION

The fourth set of issues includes areas in which collective action could significantly enhance farm productivity or livelihoods, either through increased access to productive resources (natural capital, labor) or through cooperation to conserve resources that are under threat (for example, biodiversity and traditional ecological knowledge).

Collective Action to Increase Access to Productive Resources

Collective Action to Enhance Farm Productivity

Areas requiring collective action are classified as watershed issues because the tendency to address agricultural productivity constraints by working with individuals, or with groups of farmers who nevertheless make

individualized decisions on land use, tends to preclude the identification of needs at this level. Effective identification requires more targeted research questions and an expanded scope of interpretation.

The first example involves access to productive resources that would be difficult to access or manage through individualized efforts. Organizational strategies aimed at improving access to inputs (high quality seed and fertilizer, capital) may be needed due to the inability of individual farmers working in isolation to circumvent intermediaries (for greater control over input quality or price), credit programs that offer credit only to groups, or resource complementarities among members of groups seeking to access credit. In Lushoto, for example, small groups of women of mixed wealth are jointly accessing credit from micro-credit programs. The collateral provided by wealthier farmers entitles them to a greater proportion of the loan, making the arrangement favorable to both groups. A second example involves cooperation for accessing and managing physical capital (i.e. water pumps, community bull centers, seed multiplication plots) (Lushoto). While such issues were raised only in Lushoto, problems in other sites (low productivity of animals, feed shortage, livestock disease, limited nutrient resources) might be addressed through a similar intensification of livestock systems.

Collective action can also enhance farm productivity through improved management of trans-boundary interactions, as outlined above. To decrease the impact from pathogens and rodents crossing farm boundaries, for example, farmers in Lushoto suggested cooperation in the timing of fallow, in crop rotations and in the use of quality seed to control crop diseases. In Areka, farmers suggested the need to improve cooperation in controlling wild animals, erosion and run-off, and in carrying out the labor-intensive work of uprooting eucalyptus (in spots where its eradication is proposed). In Ginchi, concerns which are on the surface individual or farm-level (soil fertility decline, feed shortage, fuel wood shortage) in reality have strong collective action dimensions due to seasonal communal grazing on individual cropland and open access to dung (Figure 4).



Figure 4. Cow dung deposited during communal grazing periods in Ginchi, Ethiopia, is treated as an open access resource despite individual ownership of land. With extensive deforestation and increasing distance to forest remnants, dung is used as fuel. Open access to dung hinders the ability of individual landowners to make technological innovations aimed at restoring the fertility of outfields, demonstrating the need for collective action in negotiating solutions.

Finally, cooperation is required in overcoming social problems that reduce farm productivity such as theft. Theft of fodder, trees, seedlings, fuel wood and crops were documented in Lushoto. Some crop theft was attributed to soil transport (erosion) across farm boundaries; what is one farmer's loss is another's gain, contributing to a belief that another farmers' harvest is in part one's own.

Collective Action for Labor Sharing

Traditional labor sharing groups that help to ease the burden of agricultural tasks are common in agrarian societies, as indicated by their presence in Latin America (Noguchi 2003), Africa (Admassie 2002; Mowo et al.

2004) and Asia (Stark 2000). Farmers in Lushoto and Areka suggested that an increase in such practices is needed to enable investments in labor-intensive activities such as farmyard manure application, terrace construction, fodder collection, compost making and land preparation in general.

Cooperation in the Conservation of Important Resources

Conserving Biodiversity

Another area in which collective action was deemed critical was in biodiversity conservation. While biodiversity loss was mentioned as a problem in Lushoto, this idea was most pronounced in Ethiopia – where loss of diversity in food crops (enset, maize) and forage species was of greatest concern among Areka farmers, and the loss of indigenous tree species in Ginchi. The loss of important food and forage species was perceived as being linked to broader processes of environmental degradation, including the added stress placed on some species or cultivars during conditions of drought and soil nutrient depletion.

Conserving Traditional Ecological Knowledge and Practices

Another area in which cooperation is required is in bridging intergenerational disputes about appropriate land management practices. In Lushoto, this was expressed as the need to reconcile traditional with modern religious beliefs on NRM. This concern has emerged as a result of the rapid marginalization of traditional natural resource management practices and beliefs, which according to some farmers is attributable to modern schooling and the influx of exogenous religious institutions. One group of elders from the Lushoto benchmark site stressed the need to reconcile traditional with modern beliefs on appropriate management of natural resources, given the perceived jump in crop pests following the abandonment of a traditional pest control practice called *hande* (Figure 5). While youth claim this practice to be superstitious, researchers from CIAT found the local botanical used in this practice (*Tephrosia* spp.) to be more effective than any other in controlling cutworms in the laboratory (Matosho, pers. comm.).

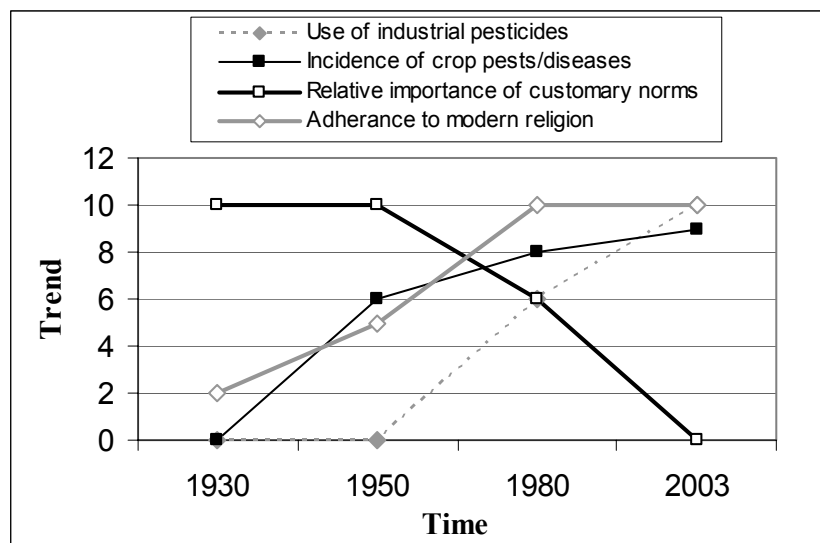


Figure 5. Perceived linkages between crop pests and the decline in traditional NRM practices, Lushoto benchmark site

LINKAGES BETWEEN LIVELIHOOD AND COLLECTIVE ACTION

The final category includes areas in which collective action is currently needed to enhance income or livelihood more broadly, including organizational strategies aimed at improving income or food security or optimizing the management of existing resources.

Organizational Strategies Aimed at Improving Income and Food Security

Organizational Strategies for Improved Market Access

The need to cooperate to improve access to markets for agricultural produce was mentioned in Areka and Lushoto benchmark sites. This was mentioned in particular for coffee, for which market prices have been in steep decline for more than a decade.

Organizational Strategies for Improved Food Security

In Areka, a region of chronic food deficit, the issue of food security is weighing heavily on the local population. While the inability to repay debts after crop loss was mentioned in Lushoto, such issues featured much more prominently in Areka than in any other site. Some of the problems mentioned included early harvest (due to the need for both food and income), dependence on food aid, and pressure to sell crops when the price is low (due to storage pests and manipulation of prices by buyers in times of need). While collective action was not mentioned as a solution, cooperation in post-harvest storage infrastructure to extend the shelf life of produce and rotational credit functions *within local communities* could assist in alleviating the problem. This is particularly true in areas where predatory buyers lend money to farmers in exchange for low farmyard prices.

Organizational Strategies Aimed at Optimizing the Management of Existing Resources

Pooling Resources

The need to pool limited local resources for income generation or labor saving was given significant attention by Lushoto farmers. This activity was perceived as most useful for establishing joint enterprises, purchasing labor-saving grain mills, addressing labor shortages exacerbated by HIV/AIDS, and supporting one another in times of need.

Improving Institutions and Governance of Resources

A final area of interest and concern was in improving institutions and governance. A priority in this area was the strengthening of farmers' organizations and leadership, the latter to address the tendency toward favoritism in law enforcement and governance. Other examples include improved modes of penalty enforcement and conflict resolution (Lushoto), and improved cooperation in the maintenance of community infrastructure (water lines, dams, buildings) and environmental conservation (spring protection, afforestation) (Areka, Lushoto). The strengthening of social capital was also emphasized with regard to better management of village income (Lushoto), and distribution of household assets (for example in Areka, where limited access to cash crop income among women was stressed).

Discussion

The host of issues emerging through a systematic, multi-country look at factors hindering livelihoods and agricultural productivity beyond the farm level clearly illustrates the need for new forms of support for agricultural development and rural livelihood improvement. In addition to looking at component integration at broader spatial scales (watershed, landscape), between neighboring farms, and between individual and common property to understand the interactions between farm and off-farm management, it will be critical to consider solutions lying outside the sphere of technology. Each of the issues raised is discussed in turn, along with the implications for agricultural R&D programs.

COMMON PROPERTY RESOURCE MANAGEMENT

While the principles of managing common pool resources are similar to those governing individual property (clear definition of ownership and users, reward expectation, etc.), guidelines particular to effective CPR management are now coming to light (Meinzen-Dick et al. 2002; Ostrom 1990; Wittayapak and Dearden 1999). The literature on CPR is growing rapidly, contributing a wealth of information for practitioners on the essential building blocks for improved management regimes. Some of these include clear rules and guidelines for managing the resource (including resource upkeep and resource access), means to ensure compliance with such rules, and a clear definition of boundaries of both the resource and the beneficiary population (Pandey and Yadama 1990; Wittayapak and Dearden 1999). Such elements help to ensure trust in the actions of other users,

a critical element to avoiding the tragedy of the commons scenario – where it becomes rational to exploit the resource when individuals act outside of agreed upon norms.

The ingredients to enabling improved management of CPR are largely absent from the conceptualization of current agricultural R&D programs. Support programs would reach far beyond the conventional disciplinary and sectoral boundaries of extant agricultural R&D programs, extending into the areas of law, governance, environmental protection, and institutional development. While a sound biophysical understanding of the magnitude of change required to enhance the productivity of any given CPR is required, this is only a first step in achieving effective systems of governance of these resources.

RESOURCE ACCESS AND DISTRIBUTION

To enhance access to natural resources, it will be important to understand the biophysical mechanisms of resource decline and the extent of actions required to enhance resource productivity; foster institutions for improved natural resource governance; understand farmer investment strategies (i.e. improving upon existing resources vs. acquiring new ones); and understand the impacts of land use policies. To improve the distribution of resources and related benefits, a more nuanced understanding of major bottlenecks to improved livelihood (and related pathways out of poverty) is needed, as well as of the causes in resource inequality and trends in resource distributions over time. Such a diversity of interventions is summarized in Table 4.

Table 4. New Areas of Research Required to Identify Strategic Interventions

Area of Intervention	Specific Information Gaps Guiding Research and Subsequent Interventions
Biophysical	<ul style="list-style-type: none"> - Biophysical mechanisms in resource decline - Extent of corrective actions required to restore resource productivity - Capability of natural systems to supply existing or projected demands
Institutional	<ul style="list-style-type: none"> - Causes and trends in resource inequality - How to most effectively strengthen farmer organizations - Weaknesses in existing governance mechanisms for natural resources
Policy	<ul style="list-style-type: none"> - Causes and trends in resource inequality - Impacts of current policies (i.e. land tenure and energy policies) on livelihood and environment - Impact of local and national policy formulation and enforcement mechanisms on compliance
Social	<ul style="list-style-type: none"> - Causes and trends in resource inequality - Bottlenecks to improved livelihood and current pathways out of poverty - Traditional knowledge on environmental management and cause-effect relationships - Investment strategies and impacts (i.e. intensifying vs. extensifying land use, and the impacts on resource availability and quality) - Capacity of different types of farmers to integrate options aimed at reversing resource decline

TRANS-BOUNDARY EFFECTS

Conventional approaches to agricultural R&D are also insufficient for addressing negative trans-boundary interactions between neighboring farms. Addressing such concerns will require: a) knowledge of the biophysical mechanisms involved (i.e. to control crop and livestock pests and disease, rodents and wild animals); b) strategies for the more optimal integration of trees into the landscape so as to enhance the magnitude and social distribution of benefits while minimizing negative effects on crops and water; and c) strategies for enhancing hydrological function for the benefit of upstream and downstream users. There are also implications for collective action in terms of the degree and timing of cooperation so that pests or pathogens can be effectively controlled (Munk Ravnborg et al. 2002). Solutions must therefore include existing and new

areas of biophysical research, ethnoscientific research on perceived cause and effect relationships, and technological solutions to intensify use systems and reduce pressure on existing resources. Finally, social and policy interventions required to enable the necessary changes in management practices, resource governance and cooperation will need to be both understood (using conventional research) and worked through (using action learning approaches).

LINKAGES BETWEEN PRODUCTIVITY AND COLLECTIVE ACTION

Given the range of constraints that could be addressed through enhanced cooperation between farmers, a clear intervention in this realm would be on social and organizational strategies to enhance farmer cooperation, minimize conflict and make better use of existing resources. Issues of leadership, transparent organizational and financial management, and institution-building are stated by farmers as urgent needs in this realm. Yet for conserving important resources that are currently under threat, more is needed. For local knowledge to be respected and revitalized in its relevance to contemporary decision-making, factors contributing to its erosion must be addressed. For this, schools and religious institutions must be brought on board and integrated into systematic efforts to document and understand (from both scientific and ethnographic standpoints) the functional value of such knowledge for environmental management. The same can be said for biodiversity conservation; only through the identification of root causes of biodiversity loss can effective strategies be developed for its conservation and lasting impacts achieved.

LINKAGES BETWEEN LIVELIHOOD AND COLLECTIVE ACTION

Finally, it will be necessary to look beyond agricultural productivity and natural resource management altogether if we are to address livelihood constraints more broadly. A clear understanding of the bottlenecks to savings and investment, through systematic research, will be required to identify key leverage points for improved livelihood. Secondly, institutions of governance will need to be rejuvenated in a general sense for cooperation to be enhanced in all aspects of life. This might include awareness-building on the critical importance of establishing and complying with norms in improving livelihoods, establishing more representative and participatory policy-making processes with enhanced local ownership, and integrating traditional with modern conflict resolution strategies so that widespread support for enforcement is enhanced while alleviating the burden on local leaders (often close relatives of those breaching norms) in policy enforcement.

Conclusions

While existing agricultural R&D institutions have many of the critical building blocks for enhancing agricultural productivity, farmer empowerment and livelihoods more broadly, this paper demonstrates clear gaps in institutional capacity and investments. In addition to technology development from national agricultural research systems and civil society engagement (for which non-governmental organizations are often most skilled), institution-building is needed to enhance farmer cooperation, NRM and social access to basic resources. This calls for social capital enhancement among farmers in terms of increased ability and willingness to co-operate for achieving common goals, and the development or strengthening of norms and networks for collective action. Also sorely needed are user-friendly tools to make explicit the trade-offs between gains to different system components (at farm and landscape scales) and between local users themselves, for whom differential benefits accrue from alternative land use scenarios. Policy research is required to understand the social and environmental impacts of existing policies, and to understand the direction and magnitude of change required to improve negative trends. Finally, R&D institutions themselves must embrace the important task of understanding their own histories, how such histories have conditioned the nature of questions asked about rural livelihoods, and the nature of change required for a more strategic and truly empowering engagement with rural communities.

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Acknowledgements

The African Highlands Initiative (AHI) expresses its gratitude to the Department for Research and Development of Tanzania (DRD); Ethiopian Institute of Agricultural Research (EIAR); FOFIFA of Madagascar; Kenyan Agricultural Research Institute (KARI); National Agricultural Research Organization of Uganda (NARO); International Centre for Tropical Agriculture (CIAT); World Agroforestry Centre (ICRAF); Tropical Soils Biology and Fertility Institute of CIAT (TSBF-CIAT); International Maize and Wheat Centre (CIMMYT); International Potato Centre (CIP); International Institute of Tropical Agriculture (IITA); Ministries of Agriculture and NGO partners operating in AHI Benchmark Sites of Ethiopia, Kenya, Tanzania and Uganda for the technical, facilitation and partnership roles they have played in our effort to develop tools and methods in Integrated Natural Resource Management together with local communities.

AHI is very thankful to the donors which tirelessly financed the regional and global engagement of AHI in improving our development and natural resource management research endeavours, namely the Swiss Development Cooperation (SDC); International Development Research Council (IDRC); Ministerie van Buitenlandse Zaken (the Netherlands government); Cooperazione Italiana (Italian government); the Rockefeller Foundation; the European Commission; the Consultative Group on International Agricultural Research (CGIAR); the Department for International Development (DfID); the Collective Action and Property Rights Programme of the CGIAR (CAPRi); the International Potato Center (CIP) and ECAPAPA.