[*] Contour farming based on natural vegetative strips: Expanding the scope for increased food crop production on sloping lands in Asia

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In the agriculture of the future, there is a compelling place for agroecologically-based practices alongside practices based on the best available chemical, genetic, and engineering components. This paper explores this issue in the context of the development and spread of a conservation farming system based on natural vegetative contour buffer strips in smallholder production systems in Southeast Asia. Farmers adapted contour hedgerow farming practices into a simpler, buffer-strip system as a labor-saving measure to conserve soil and sustain yields on steeply sloping cropland in Claveria, Mindanao, Philippines. Permanent-ridge tillage systems were also adapted to smallholder farming systems by researchers. Natural vegetative buffer strips resulted in gradually increasing yields, with an estimated benefit of 0.5 t/ha/crop. They were seen to increase land values, facilitate investment in more intensive and profitable cropping systems, and expand the land base for food crop agriculture. They induced an institutional innovation of farmer-led Landcare organizations, which have spread this and other agroforestry practices to thousands of households in the southern Philippines.

1. Introduction

The concept of alternative, agroecological, or low-input agriculture relates to a production system that emphasizes reliance on resources present within the farm (Altieri, 1995; Pretty, 1995). It seeks to minimize the use of purchased inputs by being more management intensive. 'Conventional' agriculture approaches are characterized as those that do not place particular reliance on internal resources or low levels of external inputs. The extent to which alternative agriculture can contribute to increased world food production in the future is an important issue for those making decisions on how to invest in agricultural research, and for those involved in assisting farmers apply that research on the land.

Crosson and Anderson (1999) reviewed the record of the 'conventional' approach, and evidence related to the 'alternative' approach, in the context of trends in world food

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production and future world food needs. They concluded that there are valid concerns about the capacity of the conventional (i.e green revolution) approach to meet increased demand in the future. However, they found that the decline in crop yield increases that has been widely publicized in recent years is more apparent than real. They also noted that environmental degradation has associated with the conventional approach, the intensification process has conserved substantial areas of natural habitat (much of it fragile land) that would have had to have been cleared for production if there had been no green revolution.

The Crosson and Anderson review examined a number of assertions made on the advantages of alternative agriculture. One is the implication of using of resources internal to the farm to increase production in lieu of purchased inputs. They note that alternative agriculture proponents assert that purchased inputs are more costly than on-farm inputs (Gliessman, 1990; Altieri, 1990). Crosson and Anderson conclude that to the farmer it is not the absolute cost of inputs that counts, so much as the relative costs of inputs compared to their respective productivity. They point out that alternative agriculture proponents have not addressed these tradeoffs. Labor is a limiting input, and its opportunity costs are often crucial. Thus, inputs that substitute for labor are often highly desired by smallholders. Foregoing their use may be a real sacrifice.

A second issue is the assertion that using internal resources enables farmers to be less dependent on the uncertainties of the market, and that this will promote greater rural economic and political autonomy, and foster more equitable distribution of economic and political power in the countryside (Francis, 1990; Altieri, 1995). This argument follows similar lines to the macro-economic debate on import substitution versus export orientation.. Countries employing the import substitution approach, however, have not fared particularly well compared to export oriented economies in recent times. A related corollary is that the use of internal resources reduces the farmer's reliance on non-renewable energy supplies. The bulk of the entire world economy now depends on non-renewable energy. Some would question why farmers should bear a special burden to conserve this energy when there is wasteful usage in other sectors.

A third assertion about the superiority of alternative agriculture is that the use of conventional inputs is ecologically unsustainable. This is due to the role of commercial inputs in environmental degradation. The case for reduced use of pesticides through integrated pest management, without any cost in yield, has now been amply demonstrated (Thrupp l996). IPM can make major contributions to the maintenance of yields while reducing human health hazards. Nevertheless, the challenge of increasing food production will necessarily depend on yield-enhancing mechanisms. This makes the case for minimizing the use of commercial fertilizers much less secure. There are compelling questions of how to provide adequate organic nutrient quantities in the broad range of agricultural systems, and of their costs relative to commercial sources. Increased agricultural production requires increased export of nutrients from the farm. There are ecological limits to biological nutrient production and re-cycling of nutrients on-farm. And the relative costs to use organic inputs compared to inorganic sources often become quite high before these limits are reached.

The problem may reside in the way agricultural practices are classified into 'alternative' or 'conventional'. It often seems to be more of an ideological divide, rather than a logical one. The dichotomy may not be particularly useful scientifically or practically. Most real-world systems defy such classification, which often seems strained when it is applied to any one system in particular. Several of the papers presented in this volume discuss practices and combinations of practices that adherents might identify as either alternative or conventional, depending upon one's point of view. There are examples of traditional rainfed systems where the only resources originally available to the household were internally based, that are now incorporating some conventional practices as input and product markets penetrate the hinterlands. There are also examples of high-input conventional systems, such as the classic irrigated rice systems, evolving partially toward alternative approaches through less pesticide use.

The debate seems to cloud the key issue, which is finding a combination of practices that best meets the complex needs and objectives of farm families, and of their societies, and the health of the production base. The farmer's objective is to maximize the productivity effect of every available input. In implementing this objective, yields usually are increased, since higher yield is a dominant means of increasing income and family food security.

The dichotomy of the two systems seems overly polarized. Farming systems in many parts of the tropics are increasing in productivity through the use of commercial fertilizers. And the external nutrients that are applied increase the amount of organic matter available for cycling to following crops. Meanwhile, conventional systems are being improved all the time by the application of ecological principles to the management of pests, weeds, and nutrients, and their interactions.

This paper explores the above issues in the context of a particular case of smallholder agricultural systems in Southeast Asia. It pursues the argument that strident distinctions between what is alternative and what is conventional miss the point. In the context of the historical evolution of farming systems, there is a compelling place for agroecologically-based practices right alongside practices based on the best available chemical, genetic, and engineering components.

2. Farming in the uplands of Southeast Asia

The development and diffusion of agricultural technologies for upland smallholder farming systems is a complex challenge. The environments and farming systems for which the practices must be designed are enormously diverse. Farmers who might use them generally have little investment capital and by necessity have short investment horizons. Markets are often remote, transport is difficult and costly, and research and extension services are usually inadequate.

Steep slopes and low inherent soil fertility result in a fragile resource base. In Southeast Asia, sloping uplands cover about 60 to 90 % of the total land areas of each of the countries (Garrity and Sajise, 1992). Soil erosion, as estimated by river sediment load per hectare of watershed, is much more serious in Southeast Asia than in any other region of the world (Milliman and Meade, 1983). The densest populations in the world are transforming these watersheds at a tremendous rate, and exacerbating their degradation.

The uplands of southeast Asia are dominated by strongly acidic soils and hill-slope topography. In the hilly areas, soils are in most cases highly weathered, shallow and infertile. Over 40 % of the arable land in Southeast Asia consists of acidic upland soils classified as Ultisols and Oxisols. Many are strongly acidic (pH < 5.5), and have a low to moderate organic matter content, low cation exchange capacity and base saturation, and low levels of available phosphorus (Maglinao and Hashim, 1993).

The geographic extent of acid upland soils is 186 m ha or 39% of the region's total land area (IRRI, 1986). The acid uplands vary from 33% of total land area in Indonesia and the Philippines to as high as 66% in Laos. Until recently they were not subjected to serious human settlement pressure. Currently, however, these ecosystems are undergoing major transformation in all countries due to greatly accelerated in-migration and rapid natural population increase. Settlement is dominated by small-scale farms that produce cereal crops, mainly maize and upland rice, to meet subsistence food needs. Large areas of these lands have been deforested and converted to short-fallow rotation systems, or to permanent food crop cultivation, with an accelerating pace of ecosystem degradation (Garrity and Sajise, 1992).

3. Evolving Farming Systems in Northern Mindanao, Philippines

A research location in Claveria, northern Mindanao, Philippines, was selected in 1984 as representative of the problem complex of acid upland environments in the region (Magbanua and Garrity 1990). Intensive on-farm research has been done on sustainable upland farming systems for strongly acidic soils. The agroecosystems in the northern Mindanao uplands were under dense humid dipterocarp forest until the early 20th century. Swidden agriculture was practices on a very limited portion of the land. As substantial areas of the old growth timber were harvested by logging companies, small-scale farmers from the central Philippine islands, followed the logging operations. Dry season burning, in association with swidden farming, converted large areas into grasslands. Farmers cultivated upland rice and maize in a grass fallow rotation on the flatter areas. Coffee, coconuts and perennial fruit trees were planted on small areas during the 1950-70 period. The area of these perennials increased from 4 to 30% of the land area between 1967 and 1988 (Garrity and Agustin, 1995). Market tomatoes became an important crop in the 1970s.

The area of annual cropland doubled between 1967 and 1988, reaching 41% of the total area (Garrity and Agustin, 1995). The previously scattered cultivated areas had coalesced into extensive contiguous zones of tilled land. During the 40-year period (1949-1988) the area under field crops increased five-fold. In the 1980s maize was the dominant crop, cultivated twice annually with local open-pollinated varieties, unfertilized. Farm sizes averaged 3.0 ha (Mandac et al 1986). The fallow rotation system was evolving into continuous cultivation due to intense pressure for land. The clean cultivated fields tilled with animal power, extending to the steepest slopes (>40%), but there was no evidence of contour farming or significant use of conservation practices. Erosion rates were excessive, typically in the range of 60-200 t/ha/yr (Garrity et al 1993). Extensive farmer surveys established that farmers were clearly aware of the gravity of the situation. They were observing rapidly declining maize yields and were concerned about the consequences (Fujisaka and Garrity, 1989). It was evident that practical conservation farming options were needed for the range of slopes and farmer circumstances. There was much debate in the research team as to whether the serious degradation in land quality would be contained in time to prevent much of the farmland to be ruined beyond productive use.

Trends in land use and farming practices during the past decade have supported a much more positive scenario. There has been widespread adoption by about 1000 farmers of contour farming based on natural vegetative strips. Fertilizer use, which was practiced on less than 10% of the farms in 1984 (Mandac et al, 1986) reached over 90% of farms by 1998. Hybrid maize cultivars replaced local varieties to a similar extent. Maize yields, which had ranged between 1-2 tons/ ha in 1984, had increased to between 2 and 3 tons/ha, depending on land quality and management practices. Equally dramatic was an accelerated shift toward smallholder timber and fruit tree production systems. This was a market-driven phenomenon facilitated by strong productivity increases in maize and other annual crops, enabling large parts of many farms to be released from food production to more profitable, and environmentally sustainable tree-based systems. The next section describes the development and adoption of the conservation buffer strip component of the system.

4. Adaptation and adoption of contour buffer strips

Strategies to effectively control soil erosion by water are based on three major principles (Samson, 1986): Reducing the velocity of run-off water, increasing the infiltration rate of the soil, or dissipating the kinetic energy of raindrops before they hit the soil surface. Measures that employ these principles can be classified as either engineering or vegetative techniques. Engineering (or structural) methods change the characteristics of the slope to reduce the amount and velocity of surface runoff, and include the construction of terraces, dams and canals (Samson, 1986). Soil management practices, including contour plowing and minimum tillage, are agronomic measures. Vegetative techniques are generally less expensive and labor-demanding compared to engineering practices. They maintain a living or dead vegetation cover or barrier to reduce the force of falling raindrops and water runoff. It should be noted that efforts to conserve the soil not only focus on the control of soil erosion *per se*, but also on the maintenance of soil fertility (especially soil organic matter content).

Soil conservation innovations have been widely introduced to farmers cultivating sloping lands in the Philippines. They vary from mechanical methods such as terrace construction to biological erosion control using planted multi-purpose tree and grass hedgerows (IIRR *et al.*,1992). Vegetative soil conservation measures have proved advantageous compared to mechanical methods because of their potential to improve the physical, chemical and biological status of the soil (Sukmana and Suwardjo, 1991), and because they require less labor and capital (PURC, 1990). Among the vegetative measures, contour hedgerow intercropping with leguminous trees has been widely promoted by government agencies and non-governmental organizations (PCARRD, 1997; Nelson *et al.*, 1998b). The technology has become known in the Philippines as the 'Sloping Agricultural Land Technology' or SALT (Tacio, 1991). Although it encompasses a range of components of sustainable farming, the term SALT is often used synonymous with contour hedgerow intercropping. Contour hedgerow farming with leguminous trees has thus become a common feature of extension programs for sustainable agriculture on the sloping uplands. These systems control soil erosion effectively, even on steep slopes (Kiepe, 1995; Garrity, 1995) Extensive data from the IBSRAM Sloping Lands Network trials in six countries have confirmed that annual soil loss with hedgerow systems is typically reduced 70 to 99 percent (Sajjapongse and Syers, 1995).

There are also numerous reports of increased yield levels of annual crops when grown between hedgerows of leguminous trees. However, farmer adoption of these systems is very low. Constraints include the tendency for the perennials to compete for growth resources and hence reduce yields of associated annual crops, and the inadequate amounts of phosphorus cycled to the crop in the prunings. But the major problem is the extra labor needed to prune and maintain the hedgerows. We found that farmers' labor investment to prune their leguminous-tree hedgerows was about 31 days per hectare, or 124 days of annual labor for four prunings (ICRAF, 1996). This increased the total labor for upland rice an average of 64%. Labor for a maize crop increased 90% due to pruning operations. Such an increase in production costs was seldom rewarded by a commensurate increase in returns.

Tree legumes and fodder grasses were both tried and adopted by farmers in Claveria during the first years of the research and farmer-to-farmer training project (Fujisaka et al 1994). Farmers that perceived soil erosion to be a problem were much more interested in vegetative barrier techniques that minimised labor (Fujisaka *et al* 1994). We observed that a few farmers independently tried the practice of laying out contour strips that were left unplanted. These were re-vegetated by native grasses and forbs. Researchers found that these natural vegetative strips had many desirable qualities (Garrity, 1993). They needed much less maintenance compared with fodder grasses or tree hedgerows, and offered little competition to the adjacent annual crops compared to the introduced species. They were very efficient in minimising soil loss. And they did not show a tendency to cause greater weed problems for the associated annual crops. Natural vegetative strips (NVS) were also found to be an indigenous practice on a few farms in other localities, including Batangas and Leyte Provinces.

A key advantage of NVS is simplicity in installation. Once contour lines are laid out there is no further investment in planting materials or labor. The vegetative strips do not need to conform closely to the contour; they act as filter strips rather than bunds. Their biomass production, and economic value as fodder, is lower than many other hedgerow options, but labor is minimised. *Vetiver* grass *(Vetiver ziznoides)* fills a similar niche as a low value but effective hedgerow species. But for *vetiver* or any other introduced hedgerow species the planting materials must be obtained and planted out, requiring extra labor.

There are a number of contour farming practices that work satisfactorily. The major advantage of NVS is that they are less costly and less management intensive than other alternatives. In the Asian contour hedgerow vocabulary the NVS system is equivalent to a 'simple SALT'. This translates into wider and more rapid adoption, and less food crop loss due to competition. One limitation of NVS is that they do not enhance the nutrient supply to the crops. In this respect they do not differ from many other hedgerow enterprises, including fodder grasses or perennial cash crops like coffee. Perennials with economic value are an attractive option to many farmers. Farmers who have established NVS are experimenting with a wide range of perennial crops in hedgerows, including many types of fruits, coconuts, coffee, mulberry, and even fast-growing timber species. With continuous cropping, NVS or other low management hedgerow options can only be sustainable with fertilisation. But they have proven to be popular in northern and central Mindanao (Figure 1) and have been adopted by about 1500 farmers in recent years. Their impact on production and the environment are discussed in later sections of this paper.

Figure 1. Natural vegetative buffer strips may rapidly develop into stable agricultural terraces on steep slopes. This photo was taken seven years after the contour strips were laid out by a farmer in Claveria, Misamis Oriental Province, Mindanao, Philippines.

5. Ridge Tillage for Smallholder Systems

As we searched for practical ways to farm contour buffer strip systems to avoid the movement of soil downslope by tillage, we adapted the principles of permanent-ridge tillage systems to smallholder agriculture with animal draft power. The principle of the permanent-ridge tillage system is to maintain alternate strips of untilled and tilled land in a row-cropped field. The untilled strip (the ridge) is where the crop is planted in the same exact row position in each successive season; the inter-row area is where cultivation is practiced for weed control and hilling-up is done. The ridges act as a partial barrier to the surface flow of water, but their major distinction is that they act as a zone of greater infiltration. The no-tillage area tends to accumulate organic matter and macro-pores, due to soil biological activity and root channels. Since primary and secondary tillage operations are not practiced for land preparation between crops, the land is less subject to erosion in the off-season. Labor and expense in land preparation is eliminated. Pre-plant weed control is accomplished by judicious use of a herbicide.

We recently completed a four-year study of permanent-ridge till systems that compared the conventional system with ridge tillage, with natural vegetative strips (NVS), and with a combination of the two (Thapa, Garrity, and Cassel,1998). The annual soil loss was 85.5 tons/hectare on bare, uncropped soil. Ridge tillage reduced soil loss by 49%-58%. Natural vegetative strips reduced soil loss even more: 90-97%. When the two conservation tillage systems were combined, annual soil loss was reduced to an insignificant 0.3 to 1.1 t/ha. Clearly, both systems were effective measures to dramatically reduce erosion. When combined they proved exceedingly effective. The permanent ridges in the ridge-till treatments had high infiltration rates, which reduced runoff from row-to-row in the ridge-till system, and reduced runoff through the grass barriers in the NVS. Kiepe (1995) demonstrated that a much higher infiltration rate in the vicinity of contour hedgerows is the major factor explaining the exceptional ability of contour hedgerows systems to reduce runoff and off-field soil losses.

Mean grain yields of six crops over the three-year period were the same for the conventional system and ridge-till. Thus, ridge tillage maintained maize yields and substantially reducing the amount of labor invested tillage and weed control, reducing production costs, and increasing profitability. We see ridge tillage as a practice that will complement the use of contour buffer strips in the future.

6. Contribution to future food production and food security

Earlier it was stated that maize yields in Claveria had ranged between 1 to 2 tons/ ha in 1984, and that they have increased to between 2 and 3 ton/ha currently. This increase resulted from a number of interacting changes in crop and land management. Particularly noteworthy are the shift to hybrid maize from local cultivars, and the increasing use of lime and nitrogen and phosphorus fertilizers. In order to isolate the production effects of contour buffer strip systems, Nelson et al (1998a) modeled the long term trends in maize yields for several alternative buffer strip systems compared to maize produced under the same set of conventional management practices but without the strips. This was done based on an extensive set of on-farm experiments conducted by Agus et al (1998). Yields began to diverge significantly after about five years, and by the 15th year yields in the buffer strip systems were about 0.5 t/ha higher than in the open field system. Yields of the three buffer strip systems (natural vegetative strips, planted grass strips, and leguminous tree hedgerows) were almost identical throughout. The main driver of the differences between the buffer strip systems and open-field farming was a much steeper decline in soil carbon and nitrogen in the open field system. This was due to accelerated soil erosion. These effects were estimated assuming a constant application of 60 kg/ha of nitrogen fertilizer.

Contour buffer strips were found to result in a gradually increasing advantage in yield, due to reduced degradation in the soil resource base. But the situation is significantly more dynamic than captured by the results of the model. More favorable soil moisture conditions are typically observed in contour buffer strip systems. This effect was not factored into the calculations, and would be expected to have increased the short-term yield advantage of vegetative strips. Also, farmers tend to shift their management practices and choice of enterprise after they install contour buffer strips. Much higher rates of nutrient application (inorganic and organic) are typically observed on maize and other crops grown in fields where the buffer strips have been installed. Farmers attribute this to greater confidence that their fertilizer and manure investment (labor and cash) will not be eroded away. Also, it is common for farmers to switch to higher value crops or crop cultivars. These changes may be expected to result in much greater cumulative production and income in fields with buffer strips than the direct effects of 0.5 tons/ha per crop that were noted above.

What are the implications if these more farmer-friendly contour buffer strips were adopted on a wider scale in Southeast Asia? Assuming that adoption were to occur on 2% of the 186 million hectares of strongly acid upland soils, with aggregate production effects estimated to be on the order of one ton per hectare per year, an annual production advantage of some 3.6 million tons of maize may be expected. Assuming a per capita consumption of 100 kg/person/year, this would provide the basic food needs for 36 million people.

7. Contribution to environmental protection

Until recently, fallow rotation was the only feasible way for most upland farmers to produce annual crops. Now, with yield-conserving practices (contour buffer strips and reduced tillage) and yield-enhancing practices (fertilizers and new varieties) continuous intensified production is possible. These gains are obtained on sloping soils; soils that would not be expected to be productively farmed to annual crops without conservation structures. The gains also provide the opportunity to release land for other more profitable and environmentally suitable enterprises. Alternatives include vegetable production systems, perennial horticultural trees, timber production, and livestock systems, all of which tend to have relative comparative advantage on sloping uplands.

Since contour buffer systems are adapted to a wide range of food and perennial crops, the NVS solution is fairly broad-based and generalizable. Indications are that they are effective for an indefinite period of time. It is conceivable that in the far distant future the upland areas of Asia will see a decline in rural populations. When this occurs, the intensity of land use may decline, and some areas that are farmed with terraces will be able to be transformed from food crops into tree crops. In limited areas this is already being observed. Perhaps from the perspective of food production, a shift to woody perennials may be considered deleterious. But from the standpoint of rural income, and the evolution of environmentally favorable land use systems, such a trend may be quite positive.

Natural vegetative strip systems do not fix and cycle nitrogen, as is attributed to hedgerows of leguminous trees. However, in the phosphrus-limiting environments of the Asian uplands, tree-based hedgerows are themselves not effective in cycling adequate amounts of P to meet crop demand. They are therefore unable to sustain crop yields (Garrity, 1993). The importation of nutrients through manure and/or fertilizers containing adequate amounts of crop-available P, is therefore essential in maintaining or increasing yields.

The NVS practice is a technical innovation that opens up new possibilities that enable sustained farming on quite steep slopes, thus expanding the land base of food crop agriculture. Adopters of NVS were recently surveyed, and one of the questions asked was whether they perceived that the installation of the buffer strips increased the value of their land. All respondents strongly believed that it had. When asked for their estimate of the amount that they expected their land values were elevated by NVS, their answers ranged between a 35 and 50 % increase (Stark, M, 1998, personal communication). The future for contour hedgerow systems appears to be favorable to the shift toward low labor alternatives like NVS, with soil fertility being maintained by nutrient importation. This is not different than in most other types of agricultural systems, except that NVS systems make sustainable annual cropping possible on steeply sloping lands otherwise prone to severe erosion.

8. Induced Institutional Innovation: The Farmer-led Landcare Movement

There is a sound basis for assuming that watershed degradation does not have to be an inevitable consequence of using sloping land for agriculture. Small holders can engage in farming and management of natural forest resources in both a productive and resource-conserving manner. Awareness of this has focused attention on evolving demand-driven, community-based approaches to watershed resource management, in which those who occupy the land actively participate in management and sustainable utilization of their local watershed resources for multiple purposes.

In Asia, much attention has been given to the role of local organizations in forest management and management of other common natural resources. This is exemplified by the progress in Joint Forest Management in India, Forest Users' Groups in Nepal, and Community-Based Forest Management in the Philippines (Poffenberger and McGean, 1996). But local organizations may also be a means to mobilize knowledge to solve problems in agriculture through improved land husbandry. Particularly in countries where decentralization of power and fiscal responsibility is occurring, and democracy is becoming institutionalized down to the village level, leadership skills in the farming population are maturing. These skills provide a basis for the evolution of organizations led by farmers that address practical ways of overcoming their problems in creating a more sustainable agriculture.

Among the organizational models for enhancing local initiative in attacking land degradation, one of particular interest is called 'Landcare'. Through this approach local communities organize to tackle their agricultural problems in partnership with public sector institutions. The distinguishing characteristics of Landcare groups are that they voluntary, self-governing, and focus on problem-solving resources within the community.

Farmer enthusiasm in Claveria to get involved in diffusing NVS and other agroforestry practices led to the formation of village-level organizations to share knowledge of the practices. Groups formed in several villages during 1996, creating interest in further expansion by others within the villages and municipalities of northern and central Mindanao. The approach developed into a dynamic movement that now has about 200 self-governing groups, with several thousand members, in six municipalities. The local government units were impressed with the energy of this movement, and are now supporting the effort financially, with active involvement of the village leaders. Early in 1999 the Claveria municipal council passed legislation making it mandatory to establish contour buffer strips on all sloping fields in the municipality of Claveria. A recent survey (Keil, 1999) found that more than 90% of the sample households supported the implementation of this legislation.

Experience in the Philippines (300 groups) and Australia (4500 groups) suggests that such an approach may provide a means to more effectively share and generate technical information, spread the adoption of new practices, enhance research, and foster farm and watershed planning processes. The groups exhibit some characteristics similar to the farmer field schools made popular in integrated pest management. Landcare groups, however, are more formalized and aim at a broader range of land degradation and sustainability issues. Some distinguishing features of Landcare groups are:

- They develop their own agenda and tackle the range of sustainability issues considered important to the group.
- They tend to be based on neighborhoods or small sub-watersheds.
- The impetus for formation comes from the community, although explicit support from outside may be obtained.
- The momentum and ownership of the group's program is with the community.

Farmer-driven approaches show promise of being more effective and less expensive than current transfer of technology approaches. The Landcare organizations became the basis for a successful grassroots approach to finding new solutions to upland agricultural problems, partnering with local government, pulling in outside technical and financial resources, and diffusing new information throughout the community (Garrity, 1999).

The Landcare movement has now attracted the attention of the national government. The national watershed management strategy has now been based on Landcare as a foundation upon which to build an effective community-based approach to sustainable agriculture and natural resources management. This has provided the opportunity to scale-up Landcare principles and experiences to other parts of the Philippines. The experience suggests that there is potential for enhancing this grassroots approach elsewhere in Southeast Asia.

There are signs that institutions like this could help transform extension systems. Extension agents move from role of teacher of individual farmers one-on-one, to that of being a facilitator to whole farmer groups (Campbell, 1994). Conservation farming based on contour buffer strips was one practice that popularized through Landcare. Another was nurseries for growing new species of fruit and timber trees to diversify the farm enterprise. The agenda of the groups is determined by the members, so a wide range of issues are taken up by different groups, including dairy and beef farming, cut flower production, and problems in vegetable crop farming, among others.

Landcare groups have also gained significant influence at the local political level. Local governments are actively and enthusiastically assisting the movement with budgetary allocations and solid political support. At the community level, Landcare has proven to be a powerful force for evolving initiatives that protect the whole watershed. The collaborative structure of Landcare is fostered through mutually supportive relationships among the farmers' organizations, local government, and technical support agencies in research and extension.

9. Conclusions

This paper reviewed evidence that natural vegetative strips are a land-conserving technology that have the potential to make a substantial contribution to tropical food production in the coming decades. But where do natural vegetative strips fall on the spectrum of ‘conventional’ versus ‘alternative’ agriculture? They may be seen as an alternative agricultural practice in the sense that they are an innovation based wholly upon resources internal to the farm. And they are an embodiment of the application of agroecological principles to the challenge of evolving simple, practical, no-external input solutions for soil conservation. But it may also be claimed that NVS reinforce conventional approaches, as they tend to indirectly stimulate the use of commercial fertilizers and commercial cultivars.

NVS are neither an ‘alternative’ or ‘conventional’ approach. They may be employed by farmers practicing low-input, biological farming, or by farmers practicing high-input conventional agriculture. They are conducive to the use of fertilizers, reduced tillage, organic matter recycling, green manures and cover crops, and other manurial practices. And they are one example of many that are discussed in the companion papers of this volume that cannot be defined unambiguously as alternative or conventional.

It is likely that agreement will not be reached on how much alternative agriculture can increase the world's food supply. But it is likely that most would agree that there are many fruitful pathways by which the application of agroecological knowledge to the development and refinement of farming practices will contribute to this goal. And that there is scope for combining ecological knowledge synergistically with much of the proven experience generated through advances in chemistry (fertilizers, pesticides), genetics (new varieties) and engineering (tools, equipment).

In this context, it is important to stress that human capital is a fundamental resource in creating and adapting solutions to the myriad farming environments of the tropics. In particular, the potential of farmer-led organizations, such as Landcare in the Philippines, has not been given the attention it deserves for transforming both agricultural extension and research.

We must move beyond the ideological clash of 'alternative' versus 'conventional' to explore the rich common ground they share. Then we can fully attack the central issue, which is how to guide decision-makers toward a greater balanced investment in the full range of solutions to increase agricultural production and sustainability.

10. References Cited

Agus, F, Garrity, DP, Cassel, DK, and Mercado, A. 1998. Grain crop response to contour hedgerow systems on sloping Oxisols. Agroforestry Systems 42:107-120.

Altieri, M A. 1990. Agroecology and rural development in Latin America In M Altieri and S Hecht, Agroecology and small farm development. CRC Press, Boca Raton.

Altieri, M A.1995. Agroecology: The science of sustainable agriculture. Westview Press, Boulder.

Campbell, A. 1994. Landcare: Communities Shaping the Land and the Future. Allen and Unvin, St Leonards, New South Wales, Australia. 344 p.

Crosson, P and Anderson J R. l999 Technologies for meeting future global demands for food. Paper presented at Conference on " Sustainable agriculture: evaluation of new paradigms and old practices". Bellagio, Italy.

Francis, C.1990. Potential of multiple cropping systems In M Altieri and S Hecht, Agroecology and small farm development. Boca Raton.

Fujisaka, S and Garrity, D P. 1989. Developing sustainable food crop farming systems for the sloping acid uplands: A farmer-participatory approach. Proceedings of the SUAN IV Regional Symposium on Agroecosystems Research. Khon Kaen University, Khon Kaen, Thailand, pp. 182-193.

Fujisaka, S, Jayson, E, and Dapusala, A. 1994. Trees, grasses, and weeds: species choice in farmer-developed contour hedgerows. Agroforestry Systems 25:13-22.

Garrity, D P. 1999. Participatory approaches to catchment management: Some experiences to build upon. Proceedings of the Managing Soil Erosion Consortium Assembly. International Board for Soil Research and Management, Bangkok, Thailand. (in press).

Garrity, D P. 1993. Sustainable land-use systems for sloping uplands in Southeast Asia In Technologies for Sustainable Agriculture in the Tropics. American Society of Agronomy Special Publication 56, Madison, Wisconsin, P 41-66.

Garrity, D P.1995. Improved agroforestry technologies for conservation farming: Pathways toward sustainability In Proceedings International Workshop on Conservation Farming for Sloping Uplands in Southeast Asia: Challenges, Opportunities and Prospects. International Board for Soil Research and Management, Bangkok, Thailand. Proceedings No 14, pp. 145-168.

Garrity, D P, and Sajise, P E. 1992. Sustainable land use systems research in Southeast Asia: A regional assessment In Sustainable Land Use Systems Research and Development. Rodale Press, Emmaus, pp 59-76.

Garrity, D P, Kummer, D M, and Guiang, E S. 1993. The Philippines In Sustainable Agriculture in the Humid Tropics. National Research Council, Washington, DC, pp. 549-624.

Garrity, D P and Agustin, P C.1995. Historical land use evolution in a tropical acid upland agroecosystem. Agriculture, Ecosystems, and Environment 53:83-95.

Garrity, D P. 1999. Participatory approaches to catchment management: Some experiences to build upon. Proceedings of the Managing Soil Erosion Consortium Assembly. International Board for Soil Research and Management, Bangkok, Thailand. (in press).

Gliessman, S. 1990. The ecology and management of traditional farming systems In M Altieri and S Hecht, Agroecology and Small Farm Development. CRC Press, Boca Raton.

ICRAF, 1996. Annual Report for 1995. International Centre for Research in Agroforestry, Nairobi, Kenya.

IIRR (International Institute for Rural Reconstruction), DENR (Department of Environment and Natural Resources), FF (Ford Foundation). 1992. Soil and water conservation (SWC) technologies and agroforestry systems. In: Agroforestry Technology Information Kit (ATIK). No. 1. IIRR, Silang, Cavite, Philippines.

IRRI. 1986. Area and distribution of acid upland soils in Southeast Asia In Annual Report for 1985. International Rice Research Institute, Los Banos, Philippines, pp. 214-215.

Kiepe, P. 1995. No runoff, no soil loss: Soil and water conservation in hedgerow barrier systems. Wageningen Agricultural University, Wageningen, Netherlands.

Magbanua, R D and Garrity, D P. 1990. Agroecosystems analysis of a key upland farming systems research site. Proceedings of the 1988 Acid Upland Design Workshop. International Rice Research Institute, Los Banos, Philippines.

Maglinao A R and Hashim, 1993. Management of sloping uplands for sustainable agriculture in Southeast Asia, In: Soil Management Abstracts. Vol. 5, No. 4. Bangkok, Thailand: IBSRAM: 111-127

Mandac, A M, Flinn, J C, and Genesilda, M P. 1986. Developing technology for upland farms in northern Mindanao, Philippines. Phil J Crop Science 11:69-79.

Milliman, J D, and Meade. 1983. World-wide delivery of river sediment to the oceans. J Geol 91:1-21.

Nelson, R.A., Cramb, R.A., Menz, K. and Mamicpic, M. (1998a): Gliricidia, napier and natural vegetation hedgerows. In: Menz, K., Magcale-Macandong, D. and Rusastra, I.W. (eds.): Improving smallholder farming systems in Imperata areas of Southeast Asia: alternatives to shifting cultivation. Canberra, Australia: ACIAR: 95-112.

Nelson, R.A., Cramb, R.A., Menz, K. and Mamicpic, M. (1998b): Cost-benefit analysis of alternative forms of hedgerow intercropping in the Philippine uplands. Agroforestry Systems 39: 241-262.

Poffenberger, M and McGean, B (eds.). 1996. Village Voices, Forest Choices: Joint Forest Management in India. Oxford University Press: Oxford, UK. 356 p.

PCARRD, 1997. Developments in agroforestry research, Los Banos, Philippines: PCARRD

PURC, 1990. Soil erosion control measures for the uplands. Manila, Philippines: PURC

Pretty, J.1995. Regenerating Agriculture. Earthscan, London.

Sajjapongse, A and Syers, K.1995. Tangible outcomes and impacts from the ASIALAND management of sloping lands network In Proceedings International Workshop on Conservation Farming for Sloping Uplands in Southeast Asia: Challenges, Opportunities and Prospects. International Board for Soil Research and Management, Bangkok, Thailand. Proceedings No 14, pp. 3-14.

Samson, B.K.1986. Upland development technologies. *In*: Fujisaka, S., Castillo, R. and Sajise P.E. (eds.): Man, agriculture and the tropical forest: change and development in the Philippine uplands. Winrock International, Bangkok, Thailand: 119–167.

Sukmana and Suwardjo, 1991. Prospects of vegetative soil conservation measures for sustainable upland agriculture Indonesian Agricultural Research Development (IARD) Journal 13 (1 & 2):1-7

Tacio, H.D. 1991. The SALT System: agroforestry for sloping lands Agroforestry Today (Jan.-Feb.): 12-13

Thapa, Garrity, and Cassel, 1998. Assessment of Tillage Erosion Rates on Steepland Oxisols in the Humid Tropics Using Granite Rocks in Soil Science Society of North Carolina Proceedings, Vol.XLI.9 pp.

Thrupp, L.A. l996. New partnerships for sustainable agriculture. World Resources Institute. Washington DC.

Keil, A. 1999. Soil degradation and conservation in the uplands of the humid tropics: a general introduction and a case study of the adoption of and experiences with contour hedgerows and natural vegetative filter strips in Claveria Philippines, BSc thesis. Witzenhousen, Germany: University of Kassel.