FARMING THE GRASSLANDS

The most common form of vegetation on vast areas of the region's uplands is grass, predominantly *Imperata cylindrica* (known as *cogon* in the Philippines and *alang-alang* in Indonesia and Malaysia) or *Themeda triandra*. These rhizomatous perennials are highly resistant to fire, in addition to being highly inflammable during dry periods. They readily invade abandoned swiddens, cleared forests, and forest openings. A small portion of the current grassland area may be a result of natural disturbances, but the overwhelming area was derived by repeated disturbance by fire (Bartlett, 1956).

Small-scale farming in grasslands is predominantly practiced with animal power. Settlers initially employ a migratory system, shifting their farm area as necessary to sustain crop yields. Greater density of population necessitates fallow-rotating the fields within permanent farm boundaries. As farm size decreases, permanent cropping evolves, in many cases with extremely low comparative returns, as is observed in the densely populated uplands of Cebu, Philippines (Vandermeer, 1963).

Can the productivity of intensive cropping be sustained on a strongly acid soil in *Imperata* grassland? McIntosh et al. (1981) showed that with balanced crop nutrition, an average annual crop yield of 12 to 24 t/ha of rice equivalent could be maintained on a strongly acid soil in an *I. cylindrica* (alang-alang)-infested area in southern Sumatra. The cropping system included as many as five crops per year, including upland rice, maize, cassava, peanut (*Arachis hypogara* L.) and rice bean [*Vigna umbellata* (Thunb.) Ohwi & H. Ohashi] in intercrop and sequential cropping patterns. This was an exceptional level of output for an upland environment, and disputed the concept that *Imperata* grasslands were necessarily waste areas. Productivity levels of this magnitude, however, are unlikely at higher latitudes due to less uniform annual rainfall.

FALLOW IMPROVEMENT SYSTEMS

Farming systems in the grasslands vary over a range of shifting and permanent cultivation systems. The technology appropriate in a shifting cultivation system will differ from that for permanent field cultivation, due to major differences in labor and land-use intensity. As Raintree and Warner (1986) have pointed out, shifting cultivators will maximize their returns to labor rather than to land, and resist inappropriate labor-intensive technologies. Pruned-hedgerow alley farming is a solution suitable to a more intensive stage of permanent cultivation. In shifting systems the management of fallow vegetation is a more relevant issue.

A fallow improvement crop must yield higher nutrient levels and accumulate more organic matter than the natural fallow it replaces. Fallowed fields are usually burned, or subjected to intensive grazing. Farmers acknowledge that these practices are ineffective in regenerating fertility, and this has been corroborated by sampling the nutrient status of grass fallow fields in the Philippines (S. Fujisaka, 1990, unpublished data).

Leguminous cover crops are candidates for enriched fallows, but empirical evidence of their practical utility is sparse. Participatory research with farmers in Leyte, Philippines, found that tropical kudzu (*Pueraria phaseoloides*) was successfully established by broadcasting seed in *Imperata* fallows, and it suppressed the *Imperata* in less than 1 yr. But the practice was only successful when fire can be excluded. Grass fires are exceedingly common in the dry season, and the individual farmer has great difficulty excluding fire from his farm. Communal grazing practices also will be a major constraint to the adoption of managed fallows in many areas.

Systems of fallow enhancement have been demonstrated with leguminous trees. MacDicken (1990) described a planned fallow that evolved indigenously on steep slopes in Cebu. Dense stands of naturally reseeded *L. leucocephala* form the fallow portion of the cycle. When the *Leucaena* is cut, the stems are placed on the contour and staked to create contour bunds. A fallow of 3 to 7 yr is followed by several years of cereal cropping. Stewart (1990) has studied the development of *Leucaena* fallows for use in charcoal production. He found the economic sustainability of the practice to be quite favorable as an added enterprise in the shifting cultivation systems of the Ati Tribal Reservation in Iloilo, Philippines. The substantial cash income generation would reduce the food crop area required per family. It also would enhance the utility of establishing tree fallows to regenerate soil fertility more rapidly.

Managed tree fallows may be practical for farming systems without animal power. However, they are not as suitable when draft power is available. Managed tree fallows have been given almost no research attention. Fire exclusion will be a dominant concern in their successful implementation.

SMALL-SCALE FARM DIVERSIFICATION

The most plausible model of sustainable independent small-holder farming in the uplands is one of diversification into mixed farming systems. Given the exceptionally high production and marketing risks in the uplands, and generally low marginal returns, the farm family must engage in a number of enterprises to provide nutritional and income security (Chambers, 1986). These enterprises seek to take maximum advantage of the complementarities among income-generating activities (e.g., leguminous trees for fodder, green leaf manure, and fuelwood; cattle for draft, cash income, and manure.)

The upland farm family must place primary emphasis on subsistence food crop production. But the land-use systems that result from pursuing these needs are the least sustainable alternatives. The issue is how to enable the farm enterprise to move profitably along a trajectory that will continually increase the area of perennial plants, and decrease the area devoted to annuals. The gradual expansion of home gardens, ruminant livestock production, and plantation and timber tree crops, will contribute to this end. Figure 5–4 presents a generalized model of the evolutionary development of a small-

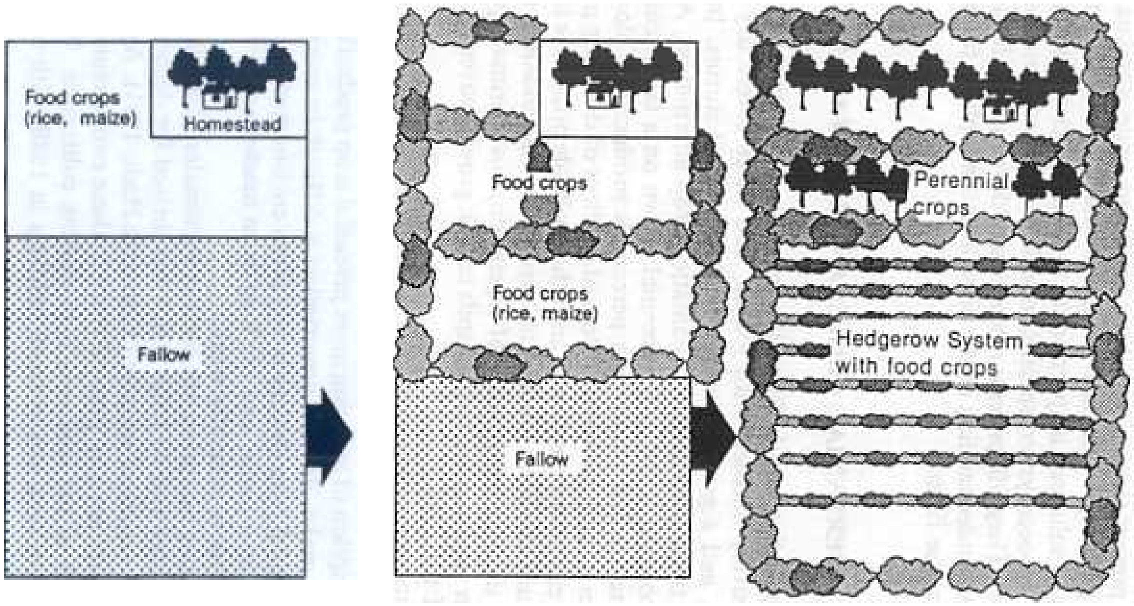


Fig. 5-4. Model of the evolutionary development of a small-scale upland farm on sloping land.

scale upland farm that illustrates this trajectory. The nature of the fallow vegetation, the food crop system, and the evolving enterprise mix will be highly specific to the particular agroecosystem. The model, therefore, emphasizes the tendency toward greater on-farm diversity, toward conservation farming systems to enable sustained food cropping, and toward an ever-enlarging area under commercial perennial vegetation.

At present there is very little predictive understanding of these evolutionary pathways. This has resulted in much confusion and wasted effort directed to solutions inappropriate to farmers' circumstances. Much more detailed agroecosystem-specific models are needed than the one given here (Fig. 5-4). They will provide research and development institutions a clearer predictive understanding of the directions that upland farming systems will follow in the future.

PERENNIAL CROPS: AN UNCERTAIN FUTURE

Proceeding north from the equator the climate generally becomes progressively harsher, with longer, and more severe dry seasons, cooler winters, and a greater threat of severe tropical storms. In the Equatorial regions there is an array of plantation crop alternatives. Above about 10° N lat, coconut is the only perennial grown on a large scale. Above about 15° there are few major cash perennials produced on sloping lands. This produces a south-to-north ecological gradient of declining perennial crop alternatives that progressively limits the available protective land-use options. Northward along this gradient also are ecological conditions that are associated with slower establishment of vegetation, lower primary productivity, and a greater tendency for upland soils to lack ground cover for substantial portions of the year.

Since perennial crops have generally proven to be an ecologically sustainable land use on tropical sloping uplands, while food crops have not, the prescription of inducing more perennial crop production by small-holders is easy to make. But this prescription is difficult to successfully implement. The perennial crop choices in any given environment are limited, prices are often highly volatile, and the long-term market outlook for most tropical commodities is generally weak.

A major exception has been in Peninsular Malaysia, where the small-holder rubber and oil palm sector has thrived for decades, mostly independent of government support (Vincent & Hadi, 1991). Approximately 3 million hectares are now planted there to these two perennial crops, while less than 0.1% of the land area is in shifting cultivation. Forty-six percent of the oil palm area was in small holdings in 1988, with a similar percentage for rubber.

What were the factors that induced a uniquely successful small-holder plantation sector in Malaysia? Several factors appear to have contributed. There was an excellent fit between the ecological requirements of these two crops and the climatic environments and marketing infrastructure developed due to the presence of a large industrial plantation sector. And there was long-term political stability, rapid industrial development, and a low rural population density.

Many of these advantages are lacking in the uplands of the other countries in the region. Coconut (*Cocos nucifera* L.) is a dominant plantation crop in the Philippines and Indonesia. They occupy much of the steepest nonarable land at lower elevations in these countries. The livelihood of millions of the poorest families, and the economic future of many parts of the uplands, is heavily dependent on the coconut industry. But there is a serious threat of economic collapse with the decline in international demand for coconut oil, due to preference for substitute vegetable oils with a lower saturated fat content.

The tropical perennials have received very little international research attention, but if agricultural sustainability is dependent on a shift toward perennials, a stronger case should be made for greater emphasis on them. For example, the demise of coconut farming may result in both an economic and ecological catastrophe, as more families are dispossessed, and more steep land is put in food crop farming. There must be a more determined effort to find substitute uses for coconut oil.

The need for more funding for product development research that will bolster the competitiveness of traditional and nontraditional tropical crops is evident. Current trends point toward greater substitution for tropical products through genetic engineering, and other technologies. This may tend to further undermine the markets for tropical crop commodities in the future. There also is potential for the development of novel tree crops that open up new opportunities for the tropical environment, or that have a comparative advantage in providing unique future products that the industrialized world will value. But greater private and public sector support for the development of perennial crop enterprises will be essential. This effort must be linked with the improvement of food crop production methods, in order to release land and labor to pursue other cash-generating activities.

ELEMENTS OF A STRATEGY

This paper has reviewed some of the technology issues that are central to the sustainability of small-scale farming in the sloping uplands. However, a comprehensive strategy for evolving sustainable land-use systems will involve three main elements: (i) tenure, (ii) delivery, and (iii) technology (Fig. 5-5). Tenure encompasses populations and their relationship to the land. Delivery involves the mechanisms which government institutions and the private sector employ to deliver policy and varied infrastructural support to facilitate and guide the process of change. Technology covers the technical solutions, and the institutional capabilities to develop them. Technical solutions are unlikely to be suitable unless they are researched and implemented within the context of the complex interconnections with these other dominant elements.

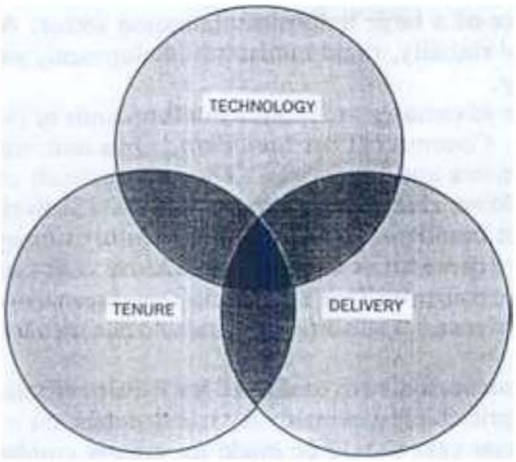


Fig. 5-5. Development of sustainable land-use systems in the sloping uplands will depend on integrated solutions in three key areas.

Future success in bringing sustainable land use to the uplands will be fundamentally dependent on major changes in the way public lands are managed. Most governments in the region have been incapable of managing the public domain entrusted to them. To harness the energies of the upland populations in creating sustainable land-use systems, and ensure success in reforestation and forest remnant conservation, governments must establish a new political relationship with the upland populations. They must proceed to recognize the boundaries of lands held by the indigenous occupants, and move to recognize their full ownership rights. The dominant issue is empowerment of the upland people: Giving them a fair stake in the land.

Any strategy to address the sustainable management of upland resources also must include a strong program to reduce the rate of population growth. The poorest households in the rural uplands have the highest birth and mortality rates. Governments must redirect health programs to ensure greater investments in village-level health work and paramedical personnel, with family planning support and education an integral part of this effort. This will necessitate strong and sustained international support. Demographic targets, and effective organization to meet them, must be highlighted as fundamental components of such support.

THE RESEARCH MODEL

Agricultural research basically follows two strategies (van Otten & Knobloch, 1990)—the commodity strategy, which selects specific commodities and attempts to expand their production; and the resource-base oriented strategy, which aims to find a production system that can best use the available resource base. The resource-base oriented strategy tends to aim at dealing with marginal land situations, because the more difficult the resource base, the greater the need for a resource-base approach in research (Plucknett et al., 1987).

Upland agricultural systems contrast starkly with the less heterogeneous lowland rice systems, that have historically received overwhelming attention. Interrelatedness and complexity are fundamental conditions of the land-use problems of the sloping uplands. Quick-fix, single-factor solutions have proven clearly inadequate. The government agriculture departments in the region have only recently begun to give significant attention to the task of understanding upland agricultural technologies. Reorientation of both the research and extension approach is underway, involving more decentralization to local levels. The farming systems research and development model is being adopted for upland technology generation, with strong emphasis on farmer participatory research.

Chambers (1986) argued that normal professionals have neglected the gaps and linkages between the central concerns of their different disciplines. This is best shown diagramatically in Fig. 5-6. The professions, and government departments, tend to preserve their specializations, focus narrowly, and overlook the linkages which are often important for resource-poor farmers. Agroforestry is an example of a more integrative approach to exploiting critical linkages, where both agronomists and foresters are concerned with the interactions between crops and trees. Much of the research success in the future will be related to exploiting these linkages.

It is at the interface between forestry and farming that many of the future research and development challenges will be encountered. For the upland farming populations to become effective partners with government in conserving, managing, and replanting forests, while meeting their basic subsistence food production needs, a deep understanding of the constraints, and workable solutions is needed. Only teamwork will generate it.

Farming-systems research evolved as a framework for a more comprehensive, multidisciplinary attack on the complex constraints in agroecosystems (Harrington et al., 1989). Ecosystem-based research should aim to target a

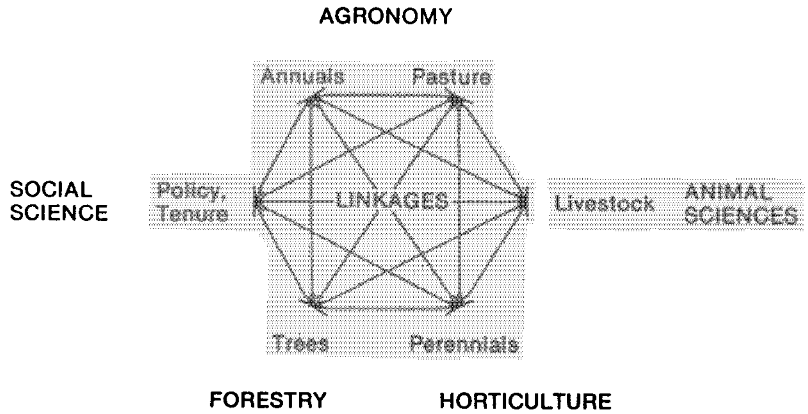


Fig. 5-6. Linkages among enterprises on small-scale upland farms that require interdisciplinary focus.

broader continuum that includes forest management and agriculture. Such work needs a methodology that provides foresters and agriculturists a common framework within which to interact.

Hart and Sands (1990) have proposed a strategy that may provide a starting point—sustainable land-use systems research (SLUSR). It focuses on the land-use system, targeting the land management unit, within the context of its biophysical and socioeconomic environments (Fig. 5-7). The research methodology of SLUSR is based on the farming systems methodology. It directs strong emphasis to the ecosystem as the starting point of problem analysis and design.

Research relevant to the sloping uplands will involve more emphasis on the parallel streams of on-farm research (Fig. 5-8): Conventional researcher-managed work will continue to be essential, but much more emphasis will be given to farmer-participatory research, including farmer-initiated experimentation. Research directed to the sloping uplands will be carried out largely at on-farm laboratories at representative sites, rather than at experiment stations. These sites will provide an explicit focal point for the disciplines to concentrate their respective skills. The Southeast Asian region needs a more complete network of key upland research sites where teams can focus their efforts in a critical mass. These key sites need sustained support, with a budgeting structure that keeps team members working together.

Although new technology will be a central focus of research, in the current climate of policy change two other areas need much greater field research emphasis: (i) land tenure issues, particularly the effects of different tenurial instruments on small farm viability and sustainable land management; and (ii) community organization and implementation of participatory management, emphasizing process-oriented research on effective grass-roots organization.

CONCLUSIONS

The complex issues of sustainable land use in the upland ecosystem are common to all the countries in Southeast Asia. The problems transcend national boundaries, and will require stronger international mechanisms to provide efficient research and development support to the respective nations. There are a number of institutions and networks that are concerned with components of upland resource management, and a regional assessment of the current work relevant to sustainable land-use systems has been made (Garrity & Sajise, 1991).

The key to eventual success in the uplands is in understanding the interrelatedness of the problems across sectors, and in developing the capacity to strengthen the efforts of each country to conceptualize, plan, and implement interventions appropriate to the unique realities of the ecosystem. This will require a new sloping upland ecosystem-based approach in international research. Such a focus does not fall wholly within the mandate of any of the International Agricultural Research Centers. In fact, a credible model

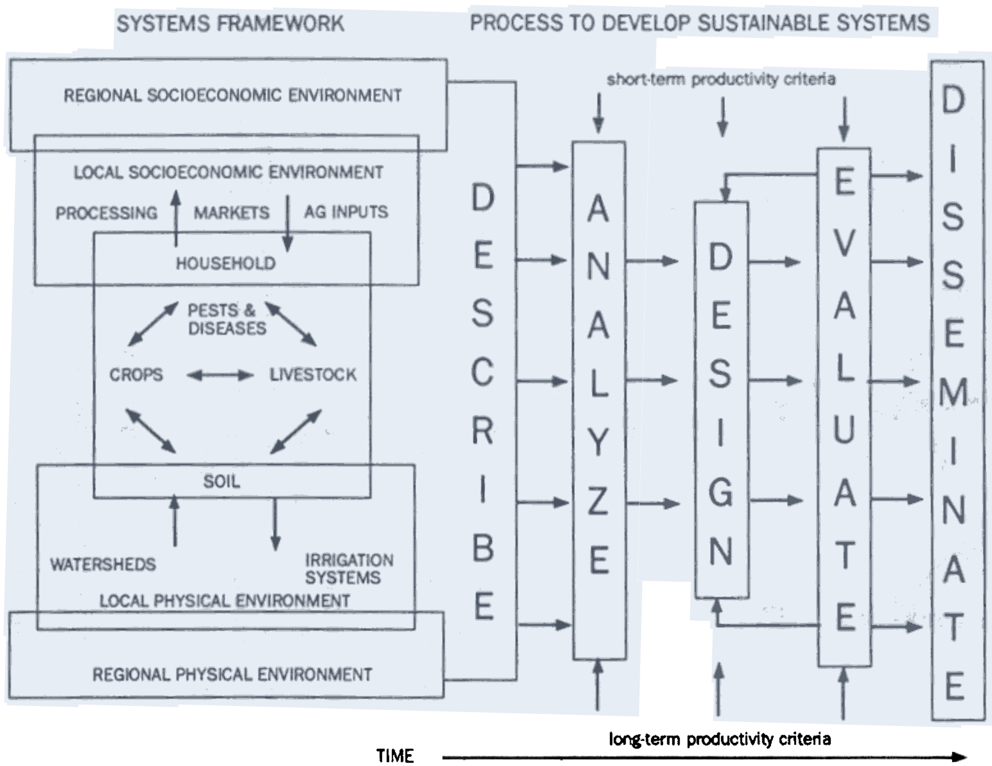
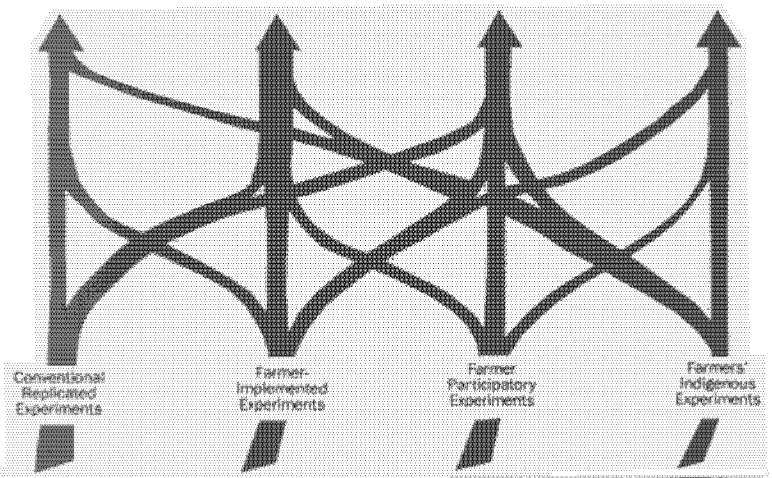


Fig. 5-7. A research and development process that could be used by a multidisciplinary team as a guide in the development of sustainable land-use systems (Hart & Sands, 1990).



Who designs:	Researcher	Researcher (with farmer input)	Farmer (with researcher or extension advice)	Farmer
Who manages:	Researcher	Researcher (with farmer)	Farmer	Farmer
Who implements:	Researcher	Farmer	Farmer	Farmer
Examples:	Fertilizer trials Variety trials	Cropping pattern tests	Hedgerow farming systems	New crops or cultivars

Fig. 5-8. Four major streams of on-farm experimentation, with interactive information flow over time.

For this approach does not yet exist in the developing world, and cannot be recognized in the institutional settings of the developed countries. Such a model needs to be conceptualized and developed on an international basis, and adapted to the diverse ecological and institutional settings encountered in the Southeast Asian nations.

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