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CONTENTS

The changing task of *PLEC News and Views*

Harold Brookfield

PLEC News and Views (PNV) first appeared in July 1993, when the project was one year old. UNU then funded the whole of PLEC with $US 50,000 a year, and although useful supplements were found, it was 1996 before this changed. PNV set out to provide networking information within the project, which in 1993 was composed of five clusters, and to inform selected others about the project. It was intended to carry news, short reports and a correspondence section which never developed. Within two years it was already carrying substantial articles and activity reports by members, as well as full reports on meetings and the accelerating search for major funding.

The papers soon became the most important part of PNV, offering a publication outlet to project authors who did not find it easy to face the formidable review process of the international journals, or who felt that their material was of insufficient consequence for such publication. We were less daunting. Although an early decision was taken not to turn PNV into a refereed journal, the papers were all subjected to a strong editorial process. Some were rejected, and others substantially rewritten. The result was a large number of good papers from most parts of the project. The first paper by a student member of PLEC was published as early as 1995. From among those written up to 2000, 12 were selected for reprinting with or sometimes without editorial change in the project's handsomely praised book *Cultivating Biodiversity* (2002). Three other papers were, by permission, reprinted in regular journals.

Until issue no. 20, in 2002, PNV was printed and mailed to a growing number of subscribers. The printing and mailing bill rose to almost $US 1,000. The end of GEF funding in 2002 made continuation impossible, especially as we also lost the administrator (Ann Howarth) who, in collaboration with Muriel Brookfield as principal editor after 1996, had produced the journal. At the final meeting in New York, it was agreed to

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continue with an electronic PLEC News and Views (ePNV) prepared by Helen Parsons in collaboration with Harold Brookfield. The two also initiated the very different but also electronic information service, PLECserv, which appears twice in most months, and is sent directly to its readers. ePNV, by contrast, is posted on the homepage of our department at the Australian National University (ANU). It is seen by a rather larger number of potential readers than received the old printed copies.

In ePNV articles are the principal content. Most have arisen after correspondence with authors, but a few come spontaneously. Several of the articles have moved away from work specifically associated with the old project. Comments received indicate that ePNV has helped to maintain the PLEC network during the transition to a new and decentralized programme. Its future is, however, uncertain. UNU support, both for ePNV and PLECserv, comes to an end in mid-March 2005. A grant from the Research School of Pacific and Asian Studies, ANU, will keep PLECserv going for several more months, and will permit at least one more issue of ePNV to be published. Beyond that, all depends on the potential funders now being approached.

Researchers win award for article

A. Sirabanchongkran, N. Yimyam, W. Boonma and K. Rerkasem, Faculty of Agriculture, Chiang Mai University, Thailand; K. Coffey and M. Pinedo-Vasquez, Department of Ecology, Evolution and Environmental Biology, Columbia University; and C. Padoch, Institute of Economic Botany, New York Botanical Garden won the *International Rice Research Notes* Best Article Award in the Genetic Resources category, for their article "Varietal turnover and seed exchange: Implications for conservation of rice genetic diversity on-farm." It is one of seven awards with which *International Rice Research Notes* marked International Year of Rice 2004. It was published in IRRN in the December 2004 issue.

Congratulations!

Managing Agrodiversity the Traditional Way

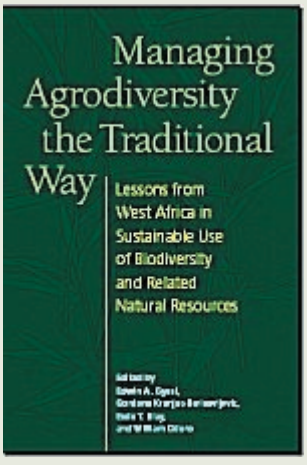
Lessons from West Africa in Sustainable Use of Biodiversity and Related Natural Resources

Edwin A. Gyasi, Gordana Kranjac-Berisavljevic, Essie T. Blay and William Oduro

Drawing on findings of nearly ten years of United Nations University Project on People, Land Management and Environmental Change (UNU/PLEC) multidisciplinary, participatory research work in West Africa (mainly Ghana), this book shows how, traditionally, farmers cultivate and conserve biodiversity while, at the same time, using the land for food production. It highlights PLEC interventions for sustaining agrodiversity for rural livelihoods, as it does lessons for teaching, policy and development planning.

The book would appeal to policy makers and practitioners, and to university students and teachers, including those of agriculture, social science, biological science and others relating to environmental or natural resources management and sustainable development.

- Preface
- Part I: Methodological approaches and knowledge systems: Methodological approaches to the book
- Philosophical foundations of biophysical resource use with special reference to Ghana
- Traditional methods of resource assessment relative to the scientific
- Farmer strategies of managing agrodiversity in a variable climate in PLEC demonstration sites in southern Ghana
- Expert farmers and demonstration sites in conservation of biodiversity
- Part II: Cropping Systems and Related Case Studies: Management regimes in southern Ghana
- Yams: traditional ways of managing their diversity for food security in southern Ghana
- Sustaining diversity of yams in northern Ghana
- Conservation of indigenous rice varieties by women of Gore in the northern savanna zone, Ghana
- Vegetables: traditional ways of managing their diversity for food security in southern Ghana
- The proka mulching and no-burn system: A case study of Tano-Odumasi and Jachie
- Managing the home garden for food security and as a germplasm bank
- Management of trees in association with crops in traditional agroforestry systems
- Preliminary observations on effects of traditional farming practices on growth and yield of crops
- Effects of four indigenous trees canopy covers on soil fertility in a Ghanaian savanna
- Comparative management of savanna woodland in Ghana and Guinea: a preliminary analysis
- Agrodiversity within and without conserved forests for enhancing rural livelihoods
- Part III: Social dimensions of resource management: Aspects of resource tenure that conserve biodiversity: the case of southern and northern Ghana
- Resource access and distribution and the use of land in Tano-Odumase, central Ghana
- The women environmental pace setters of Jachie
- Part IV: Conclusion: Lessons learnt and future research directions



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Papers

Working towards community-based ecosystem management of the Lower Amazon floodplain

David G. McGrath[1], Oriana Trindade Almeida, Marcelo Crossa, Alcilene Cardoso and Márcio Cunha

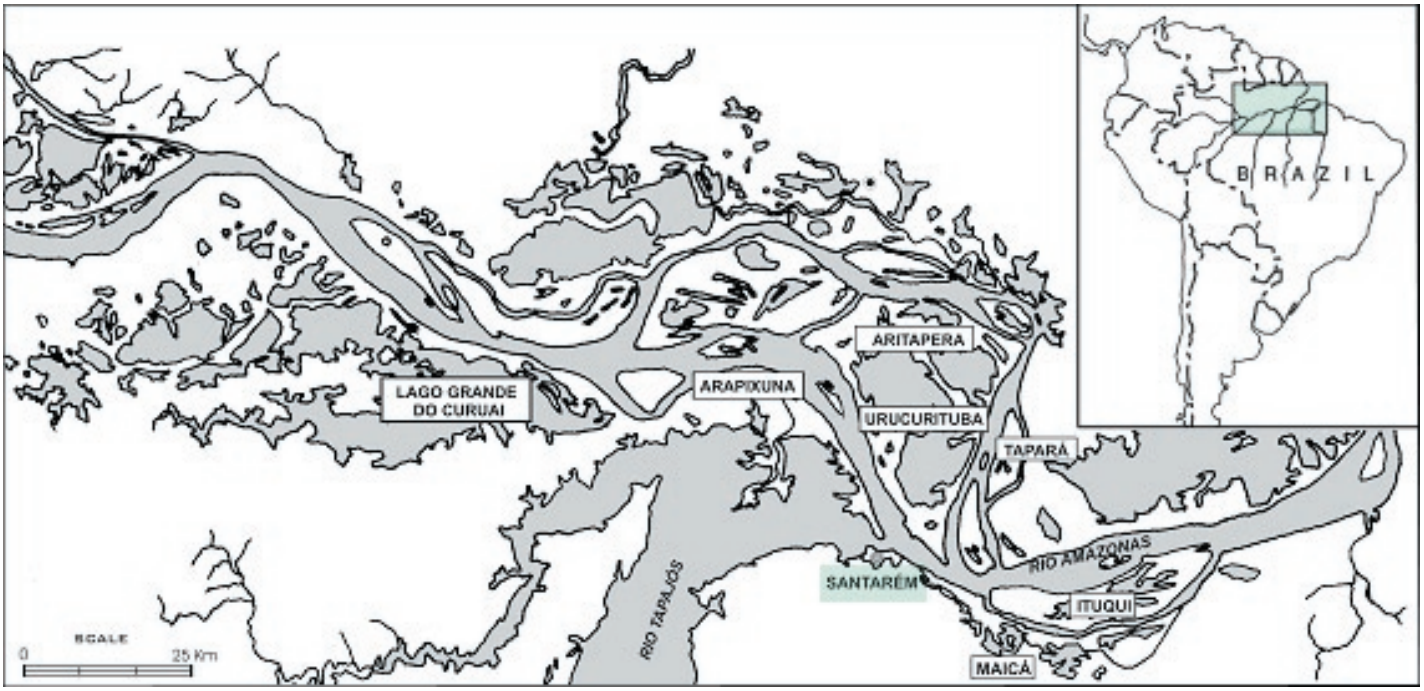
Introduction

During the first phase of PLEC the emphasis was on documenting smallholder use of agrodiversity and developing production and management systems based on the practices and cultigens employed by smallholders. In the second phase the focus has expanded from the farm level to that of the community or region, from the practices and species farmers employ, to the ways in which they individually and collectively manage the regional ecosystem. This approach analyzes farmer management systems within the context of the local/regional ecosystem, to understand how smallholder land use interacts with ecological processes. While agrodiversity tends to focus on production systems, an ecosystem-based approach integrates productive and extractive activities to understand how farmers are consciously and unconsciously modifying the local landscape. As in the study of agrodiversity, the aim is to develop management systems, based on smallholder practices, which optimize local resource production while maintaining the integrity of local ecological processes.

Over the last ten years the Várzea Project of IPAM (Instituto de Pesquisa Ambiental da Amazonia) has been working with floodplain communities, the federal environmental agency IBAMA-Provárzea (Brazilian Institute of Environment and Renewable Resources), the Santarém Fishers Union and other regional organizations to develop an ecosystem based approach to floodplain management that builds on community initiatives in managing local resources (Figure 1) (Almeida and McGrath 1999). The Project focuses on the following elements of an ecosystem management approach:

- research and extension to understand existing patterns of resource use,
- work with smallholders to increase both the sustainability and the economic returns derived from these activities,
- capacity-building activities to strengthen local and regional management organizations,
- educational programs for floodplain school curricula through which teachers and students explore the várzea environment and its use by the community, and
- policy initiatives to develop the legal basis for

Fig. 1. Santarém region, Lower Amazon floodplain, showing location of the Regional Fisheries Councils



1. Dr David G. McGrath, Nucléo de Altos Estudos Amazônicos, Universidade Federal do Pará, Belém, Brazil dmcgrath@amazon.com.br

community-based management of floodplain resources. Now after more than ten years work with communities, we have developed an approach that brings together these diverse elements of the Várzea Program. In this paper we describe the main elements of this management approach.

Ecology of the floodplain and smallholder resource management

The Amazon floodplain or várzea varies considerably over its extent so that any description of the landscape must of necessity be restricted to a particular segment of the river. In the Lower Amazon the predominant features are the presence of large shallow lakes, ranging in size from a few hundred square metres to hundreds of square kilometres, and a vegetation cover that is 90% natural grasslands and 10% forest. From the perspective of smallholder resource management, we can distinguish four main landscape elements: the major river channels, forested natural levees bordering channels, permanent floodplain lakes that occupy much of the floodplain interior, and seasonally inundated grasslands that occupy the transitional zone between levees and lakes. The lakes are actually networks of lakes, varying in size and frequency of annual permanence (Figure 2). The resulting lake systems can cover large areas and have considerable spatial variability in environmental characteristics and resource abundance.

Land tenure typically reflects patterns of resource use. Private property is generally recognized and properties are measured in terms of metres of frontage along the river and extend inland to lakes or canals. This system guarantees each household access to the four main ecological zones. While private properties are recognized, there is a gradient from private to collective property and use inland from the levees to interior lakes. Levees, where virtually all household investments are concentrated, are clearly demarcated. Grasslands, while nominally private property, tend to be treated as commons on which all land owners may graze their cattle. Lakes inland are regarded as the common property of those who own the land around them.

There is a strong seasonal dimension to life on the floodplain resulting from the interaction between flood and precipitation. In the Lower Amazon the river rises gradually from December to June and then falls rapidly from July to early November. The rise and fall of the river coincides with local rainfall patterns, resulting in two seasons: a dry season of falling and low water levels extending from July/August through November/December and a rainy season of rising and high water levels from December/January to May/June. The period of most intense drought occurs in the middle of the low water season, effectively cutting the growing season into two periods, before and after. In terms of planting risk, the key issue is the interaction between when land becomes available for planting, the timing of the October dry season, and when it is inundated again. The height of the levee, vulnerability to drought and frequency and timing of flooding are key factors in developing management systems.

The essential dynamic of the floodplain ecosystem is captured in the flood pulse concept (Junk et al. 1989). Floodplain species have developed feeding and reproductive strategies that take advantage of this seasonal alternation between terrestrial and aquatic phases. Many tree species fruit during the flood season and aquatic macrophyte communities expand over the lake surface as floodwaters rise. Many fish species spawn at this time so larvae can be swept into lakes, which serve as nursery habitats for juveniles. Fish and other vertebrates follow the expanding edge of the water into forests to feed on fruits and nuts. During the low water season deposited sediments fertilize tree growth and turtles and many bird species nest on emerging sandbars, with eggs hatching as floodwaters begin to rise again.

Smallholder management strategies take advantage of the spatial and temporal variation in resource availability (WinklerPrins and McGrath 2000). Most agricultural activities take place on the higher levees bordering the river channel during the low water period. Farmers begin preparing the land in July or August, as soon as it is dry enough to work, and harvest the first crop in October. They may plant a second crop when the rains begin in December to harvest in February before the floodwaters reach the levee. Grasslands inland are used for grazing cattle during the low water season. As floodwaters cover

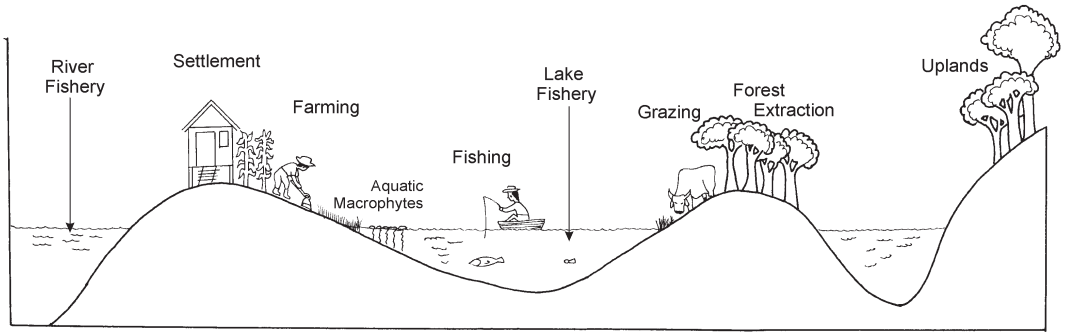


Fig. 2. Environments and land use on the Lower Amazon floodplain

the grasslands in March/April, cattle are either moved to raised platforms on the levee or taken to upland pastures until waters start to recede in July/August. Most fishing takes place in floodplain lakes. River fisheries are most important as the river level falls and schools of fish leave the floodplain and migrate upstream. At low water, fish that remain on the floodplain become concentrated in ever smaller bodies of water facilitating capture.

While the spatial and temporal distribution of economic activities potentially facilitates complementarity, in practice activities often conflict due mainly to unnecessarily destructive exploitation of resources and habitats (Goulding et al 1996). Agricultural fields are usually located in higher areas whose natural vegetation is forest. In the recent past, the expansion of jute farming led to the destruction of floodplain forests in the Lower Amazon and while the intensity of farming has declined, recovery of forests has been limited (Sheikh et al. in press). Extensive ranching is leading to the overgrazing of grasslands and contributing to the degradation of levee forests as cattle trample and browse seedlings and smaller trees (Sheikh 2002). The practice of burning grasslands also contributes to the degradation of forests and grasslands. Cattle and water buffalo occasionally invade fields causing considerable crop damage. These impacts on habitat quality reduce the productive capacity of lake fisheries, compounding the effects of increasing fishing pressure.

While there is a general recognition of the interdependence between the state of lake fisheries and the grasslands and forests, most communities lack institutional mechanisms to protect long-term individual or collective interests in the face of short-term individual gain. Thus people tend to invest in activities where the return to individual investment is most secure (Merry et al. in press). For example, while there is general agreement that lake fisheries are more productive on a per hectare basis than extensive cattle ranching, families will invest in cattle because they own the cow, while the fish belong to whoever catches them first. The result is the paradoxical situation in which the productive potential of the floodplain is both over exploited and underutilized.

Strategy for community-based management

Over the last decade we have worked to develop a more holistic approach to the management of floodplain resources that builds on the interdependence between habitats and resources, the smallholder household economy, and collective interests in the ecological productivity of the system. The basic management unit is the floodplain lake system, which integrates all the major habitats within a given region. It provides a framework for management that makes it possible to evaluate the costs and benefits of different resource management strategies in relation to the productivity and sustainability of the system as a whole. Lake fisheries are a central and also vulnerable element of the system, for the health of lake fisheries depends not just on the direct action of fishers, but also on the effects on habitat of other activities.

Management is based on a global approach that seeks to minimize negative interactions between different resource use activities and promote complementarities to optimize overall production rather than maximize exploitation of one or the other resource. Smallholders tend to employ diversified strategies involving fishing, farming and small and large animal husbandry. Within the household economy, a productive fishery provides a strategic subsidy, contributing animal protein for subsistence, and income for daily purchases, while any surplus can be invested in other productive activities (McGrath et al 1999). Artisanal fishers, unlike professional commercial fishers, tend to make limited demands on the fishery, because once basic needs are met, they devote their time to farming, animal husbandry and other household activities. A high productivity fishery strengthens the viability of smallholder management systems because it enables fishers to minimize the time needed to meet basic needs and dedicate more time to other productive activities.

From an ecological perspective the objective is to maintain the overall health and productivity of the floodplain lake ecosystem. The management strategy is based on the flood pulse and seeks to maintain or strengthen ecological interaction between terrestrial and aquatic habitats and species during the seasonal rise and fall of the river, by maintaining natural flood regimes and conserving forest and grassland vegetation. To reverse habitat degradation a major emphasis is placed on restoring floodplain habitats where appropriate.

Another aspect of community-based management systems is that management activities occur at different spatial scales—individual property, community, and regional lake system—so that each scale is best suited for dealing with specific activities of the overall management system. Most agricultural activity is practiced within individual properties. Cattle ranching takes place at the community level. While fishing may be restricted to lakes close to the community, the local fishery depends on the whole lake system, which is often shared with several communities. These spatial scales are associated with different kinds of property rights that belong to different though usually overlapping groups of stakeholders. Furthermore, the scales are interdependent, for example, decisions made at the level of the individual property (agriculture and forestry) or community territory (grasslands and local lakes) can have implications for the ecological health and productivity of the lake system as a whole.

The basis of floodplain ecosystem management is the organizational capacity to manage local resources and reconcile individual and collective interests in their use. The adaptive management approach, in which the user group develops and implements the management system, adjusting procedures along the way as needed, provides an effective methodological framework for building local organizational capacity. An important element of this approach is the continuous generation and evaluation of information on the performance of the system, providing both feedback to users on the results of management

practices, and also demonstrating to the group that their actions have a measurable effect. This is especially important for managing fisheries because the benefits are often diffuse (marginally more productive fishing effort in the context of great seasonal and inter-annual variation in fishing productivity), while the costs of individual effort expended in meetings and patrols or restoring vegetation, are very concrete and quite constant.

Project activities for ecosystem management

The overall Project strategy described here is a product of more than ten years of work in the region and reflects the history of trial and error learning, captured and missed opportunities, and human and institutional strengths and frailties. Here we describe the main activities undertaken in developing the management intervention strategy for the four spatial scales of project activities, individual property, community territory, lake system, and the regional co-management system.

Management transition

In most extension projects, technical innovations lead to short term gains in production. In contrast, the implementation of a fisheries management regime often results in at least a temporary reduction in total income for most fishers, while total labour expenditures may increase (Figure 3). In many cases this reduction is achieved by banning gillnets, which are the most productive gear, and permitting only cast nets, harpoons and different kinds of hook and line gear. The result can be a large reduction in either income, or a comparable increase in fishing effort or some other activity to maintain previous total income.

Because of the lower productivity of farming, fishers may expend even more effort to achieve their original household income if they choose to compensate for lost income by increasing labour in farming. As the fishery recovers, productivity will increase, eventually achieving the expected levels of the managed lake system, so that overall productivity, combining both fishing and farming, is higher than in the original case where fishing provides all household income. However, achieving a more productive fishery depends on the degree of community compliance with the new management regulations. This is the risk that households must face: will their sacrifice be compensated by a more productive fishery in the future or will free-riders simply take advantage of the situation to reap windfall benefits, condemning the management effort to failure?

To be effective, a strategy for implementing a new management regime must go beyond a concern with the fishery *per se* to consider the other main dimensions of a fully functioning management system. This includes implementing appropriate resource use rules, diversifying productive alternatives, modifying farming and ranching practices to reduce destructive impacts on habitats and resources, and restoring forests and grasslands to enhance recuperation of the productive capacity of the floodplain. All of this depends on strengthening the organizational capacity of the user group to develop, implement and enforce the management regime, so members have confidence that rules will be enforced and free-riding controlled. This depends in turn on the regional/national policy and institutional context in which the management system develops and the quality of the support this legal-institutional context provides for community-based resource management.

Individual property level management

The island lake system is subdivided into individual properties all of which cut across the main ecological zones of the floodplain. The main habitat affected by unilateral family land-use decisions is the forested natural levee. The relative extent of forest and farmland depends on total planted area and cropping frequency. The planted area includes house gardens, annual and perennial crops, and pasture with native or planted grasses. Forest extraction is largely limited to fuelwood gathering.

Annual and perennial crop production

With some important local exceptions, agricultural production in the region is low and only a small fraction of the available levee is currently being exploited for cultivation. Much is cleared land used as pasture or secondary forest. A major objective of the project is to diversify household income by increasing agricultural income. Here two concerns are to reduce risk of crop loss from drought and increase flood season agricultural income. Over the course of the project we have tested four main production systems: traditional annual crops (corn, beans, watermelon and squash), irrigated vegetables (tomatoes, green peppers and cabbage), perennials (bananas and assorted fruit trees) and raised planting boxes to produce flood-season vegetables (tomatoes).

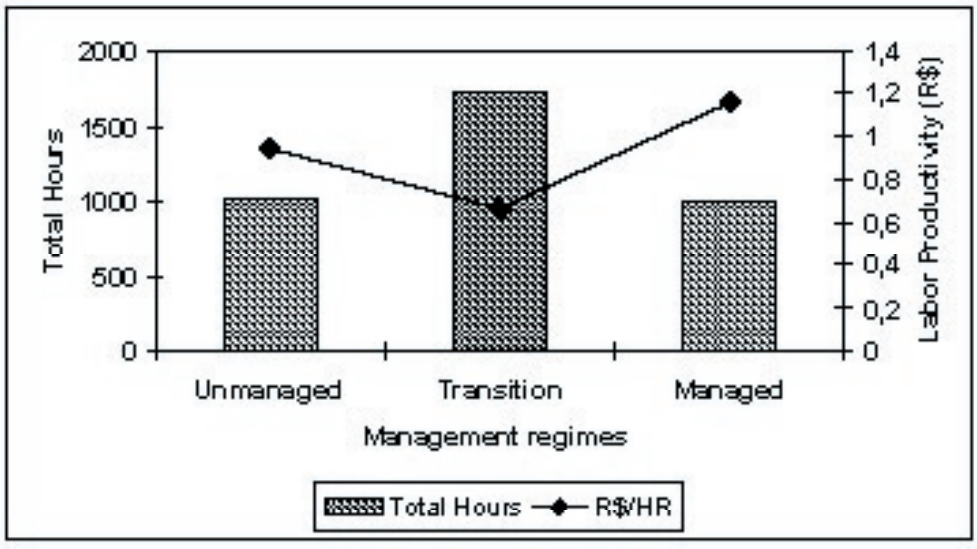


Fig. 3 Effect of fishery management on hours worked and labour productivity

Community farming activities are organized in associations and community seed funds, with overlap in membership around 100%. The seed funds are a potentially effective mechanism for accumulating capital for investment in farming activities. However, the tendency of the groups is to cut the repayment increment above the sum borrowed so low as to preclude any significant growth of the fund. This limits its potential as a mechanism for generating funds for larger capital expenditures.

Initial efforts revolved around roças experimentais where a group of farmers in collaboration with the project extensionists, tested different crop varieties and planting treatments, later using those that seemed most promising. We tested traditional annual crops and irrigated vegetables. Experiments, following a local method of producing vegetables with pump irrigation, were intended to permit farmers to cultivate crops through the dry season. Farmers eventually abandoned this approach. Two problems they cited were lack of sufficient land for adequate rotations resulting in weed and pest infestations and difficulties in marketing.

Work with traditional annual crops has proved more successful. In the five communities, annual crop production has grown despite some problems with pests. Perennial crops are an alternative especially for higher levees where the frequency and duration of flooding are lower. Though involving a smaller numbers of farmers, perennials, especially bananas, has been promising fairly high returns. We plan to expand the number of farmers and to include other fruit tree species, such as papaya and soursop, that do well and are sought after by local frozen pulp processors.

Producing flood season vegetables in raised planting boxes, was tested in two communities over the past year and proved quite successful, providing a significant income source for these families during a period when income from other sources is limited. In years when even the highest levees are inundated, this system could be a critical source of income.

Forest management:

In 1998 a farmer in Aracampina planted 100 pau mulato (*Calycophyllum spruceanum*) seedlings in a small area behind his house. Initial results indicate that growth rates are comparable to those observed by Pinedo and colleagues on the tidal várzea of Amapá. We are now talking with other residents of Aracampina interested in forming a group to plant a large enough area of pau mulatto and other species to sustain a community sawmill, similar to those studied by PLEC in Amapá (Pinedo Vasquez and Rabelo 2002).

Community level management

Community level initiatives involve management of lake fisheries, collective agreements for managing cattle on community grasslands and restoration of floodplain habitat.

Managing lake fisheries

Here we have concentrated on developing management systems for one species, the pirarucu, a large (up to 2.5 m) species of great commercial and cultural value whose sedentary behavior makes it well suited for management in floodplain lakes. The management of this charismatic species serves as a vehicle for developing lake management systems that eventually incorporate other species.

The project began as a participatory research project on the ecology and management of pirarucu involving researchers and local pirarucu fishers. An important initial objective is to overcome the problem identified earlier regarding smallholders' perception of the relative security of managing cattle and fish. Through the use of simple field-based population monitoring techniques, fishers can develop a concrete understanding of the dynamics of their local pirarucu populations comparable to their understanding of that of community cattle herds. Two characteristics of the pirarucu facilitate this association. They surface to gulp air at regular intervals and they form couples that care for their young during six months of the year.

The evolving monitoring system has three main components. Teams of fishers have been trained in a participatory census methodology based on wildlife census techniques so they can estimate reliably the number of adult and juvenile pirarucus in a given lake (Castello 2004). Second, they monitor breeding couples to obtain an estimate of the reproductive potential of the lake. Third, records are kept of all pirarucu caught in the lake including size (weight), date, location and gear used. Based on the information generated, communities develop management plans.

The number of fish in managed lakes has increased steadily over the last three years. One interesting observation from monitoring reproductive behavior is that lakes with little or no surface vegetation do not have breeding couples, evidence of the positive linkages between habitat quality and lake productive potential. The association recently completed an evaluation of the status of pirarucu populations in all the floodplain lake systems of the municipality and identified promising communities for expanding the pirarucu management project. Teams of fishers are also visiting communities in the Peruvian Amazon and other parts of the Brazilian Amazon to teach monitoring techniques and assist local fishers in developing lake management systems.

One means of fostering collective interest in a community fishery, is to organize collective fishing trips where the proceeds are invested in benefit of the community. Participants catch a predetermined number of pirarucu, sell the catch and invest the funds in community projects. Any surplus can be divided among the families that have participated in management activities over the course of the year. To promote management and organize marketing,

an association of pirarucu fishers was formed with 78 members from seven communities.

Managing turtle nesting beaches

In addition to lakes and grasslands, another important resource are the turtle nesting beaches adjacent to communities. Three species of river turtles are widely hunted for their meat and eggs and populations have been steadily declining. Three years ago Grupo Renascer[2] of Aracampina mobilized the community to protect a nearby nesting beach. Over the last three years the number of turtles nesting has increased from 122 to 395 with all three species showing steady increases.

This increase cannot be attributed to greater reproductive success, as the species takes more than two years to reach maturity. It must be the result of other turtles being attracted to protected beaches. A similar process may explain the increases in pirarucu populations in managed lakes. If this is the case, it represents an additional and powerful positive feedback for management as it increases the rate of response beyond the productive capacity of the local population.

Managing cattle on floodplain grasslands

The other major common property resource of the floodplain is the seasonally inundated grasslands of the floodplain interior where cattle are grazed during the low water season (Sheikh et al. in press). Ranching has been a major source of conflict between floodplain resource users. Together a group of governmental and nongovernmental organizations is developing a legal mechanism called a "Term of Adjustment of Conduct" (TAC), to provide a legal basis for collective agreements that define rules for raising cattle and water buffalo on the floodplain. Concerns addressed in these agreements include defining the period when cattle may be grazed in community grasslands and stipulating procedures for compensating farmers for damage suffered when cattle invade fields. To date some 54 agreements have been created. While enforcement is patchy, TACs do provide the most effective legal mechanism available for controlling the major cause of environmental degradation and a major source of risk for floodplain smallholders.

Restoring foodplain forests and grasslands

A third element of the Project involves restoring floodplain habitats, especially forests and grasslands. Between 1999 and 2003 a group of 13 farmers of the community of Aracampina, the Grupo Renascer, undertook a pilot reforestation project on an island in front of the community. The aim was to improve the quality of fish habitat in a lake on the island by planting species that produce fruit or nuts consumed by fish. A second objective was to identify a group of species that can be used successfully for reforesting lake margins. After four years, sections of the lake margin are successfully reforested and trees are producing fruit that are used by fishers to catch fish in the understory during the flood season. Based on this experience, the Renascer group shifted efforts to major lake levees on the main island behind the community where most fishing is concentrated. Here they initiated two projects: reforestation of the margins of a central canal that provides habitat for fish during the dry season, and replanting canarana grass in a fenced area close to the community to provide a nearby source of grass for cattle during the flood season. Grupo Renascer is also working with other communities in the region to restore their forests and grasslands.

Regional management

The basic management unit is the regional lake system, the network of lakes linked together by canals to form a more or less continuous body of water over a large part of the annual flood cycle. It integrates all the main habitats and resources, as well as the resource use activities of the local population and can encompass from one to dozens of communities and ranches.

The regional lake system is the scale at which lake fisheries management takes place. There are two aspects of management. The first has a regulatory objective, and seeks to insure that all members have more or less equal access to the fishery and that fishing pressure is within sustainable levels. The second has an economic objective, in which a group of fishers manage a local fishery to generate income from it. The pirarucu management experience is an example of the latter. In this section we describe an example of the former, development of a co-management system for floodplain fisheries of Santarém.

Background

The present co-management system, developed out of the regional grassroots movement to take control over access and use of lake fisheries and limit commercial fishing pressure in floodplain lakes. Beginning in the early 1980s, floodplain communities throughout the region began developing collective agreements, called acordos de pesca, to define rules of access and use of local lake fisheries. In the 1990s IBAMA in collaboration with the Municipal Fishers' Union, local NGOs and floodplain communities, sought to develop a co-management system for regional fisheries that incorporated these fishing agreements into the formal structure of fisheries management.

This effort focused on three main questions: stakeholder representation, institutional structure, and policy framework. The first problem with the prevailing system was that there was no mechanism for insuring that all stakeholders participated in the development of agreements. Agreements tended to be drafted and voted upon only by those in favor of reducing fishing pressure. Second, there was no explicit inter-community institutional structure responsible for formulating and implementing inter-community fishing agreements. Third, there was no legal basis for community fishing agreements so actions

2. Literally means the reborn group, referring to reforestation and not spiritual transformation.

taken to enforce measures were illegal unless also covered by existing fisheries regulations.

A number of modifications were introduced. Regional Fisheries Councils were created for each of the main lake systems of the Santarém floodplain. These are intercommunity councils composed of representatives from each of the communities located within the territory of a regional lake system. The Council is responsible for organizing the formulation of a fishing accord. At the same time, IBAMA revised existing fisheries management policy to define criteria and procedures for legalizing community agreements. Finally, IBAMA implemented a program to train Volunteer Environmental Agents (VEA) for each community who are responsible for organizing local enforcement of fishing agreements. There are now 7 Regional Fisheries Councils (8 if the Santarém urban Council is included) with a total of 135 communities and a population of 35-40,000 people, covering approximately 266 km^2 of Amazon floodplain (Figure 1). With these changes a regional system was created in which Regional Fisheries Councils formulate lake management agreements. IBAMA evaluates the agreements and if approved transforms them into law. The Regional Fisheries Councils, together with Environmental Agents, are responsible for implementing fisheries agreements at the community level.

Ecological performance

A recent study indicates that these lake management regimes are having a significant effect on the productivity of local fisheries (Almeida 2004). A comparison of fishing activity in lakes with and without functional fishing agreements found that fishing activity in the two types of lakes was essentially the same. However, on average fishing in managed lakes was 60% more productive, although there is considerable variation in the difference among the 9 matched pairs of communities. Since there is no significant difference in fishing activity, the reason for the difference in productivity seems to be due to the exclusion of large commercial fishing boats in lakes with fishing agreements. This study shows that lakes can be effective management units for floodplain fisheries.

Two telemetry studies of the behavior of the pirarucu suggest a more complex situation. In the first study, four pirarucus circulated within the same lake system for over two years until radio batteries gave out. In the second, 24 pirarucus were fitted with radios, 12 each in two different lakes almost 40 km apart. Those in one lake left the lake and circulated through the floodplain, eventually entering the lake of the other group, before slowly making their way back to the lake they where they were tagged. This study suggests that while there is as yet no evidence of long distance migratory behavior, pirarucu in the Lower Amazon may circulate from one lake to another within a larger region of floodplain. Thus, while individual lake systems are useful as management units, populations of even highly sedentary species may circulate through larger sections of floodplain than that of individual lake systems.

Organizational performance

Organizational performance is more problematic. Problems with co-management policy (criteria and kinds of actions permitted) and the performance of different stakeholder groups (IBAMA and communities) jeopardize the institutional sustainability of the co-management system. With regard to policy, constitutional constraints prohibit the closing of lakes to outsiders and charging user fees. This creates a situation where outsiders and free riders have access to all the benefits of community management, and also eliminates the most effective way of financing management. The policy also limits the powers of VEAs in enforcing agreements. To compound matters, IBAMAs support for co-management has been weak with little presence in the field. Its agents are also accused of ignoring citations brought by VEAs, thereby undermining their authority in the community. The result is that some 50% of VEAs have dropped out and there is considerable grumbling that things were better before when communities could take enforcement into their own hands. However, construction of the co-management system has been a process of adaptive learning and IBAMA and Provárzea have shown themselves to be committed to supporting refinements of the system to improve performance and institutional sustainability.

Integrating scales through the floodplain land tenure system

The challenge now is to effectively integrate the scales of management, creating mechanisms through which Regional Fisheries Councils can enforce rules at different levels. In this way, Councils can insure, for example, that land use at the property level is consistent with the quality and extent of vegetation cover needed at the regional lake system scale, that community policies with regard to cattle address the needs of farmers and fishers, and that actions taken by communities and large land owners are consistent with the ecological integrity of the lake system as a whole.

One of the key differences between this and many other regional management experiments is that it is taking place outside the context of a government reserve. The floodplain is legally government property. Only use rights can be recognized and land-use regulations are quite stringent. However, the government has never asserted ownership. Nor has it ever sought to enforce land-use regulations. Residents consider the land they occupy to be their property. Land is routinely bought and sold, though without legal titles. Consequently, land use has developed according to the norms of private property and regional market opportunities in which individual landowners are free to make more or less unilateral land-use decisions. With no government authority to make final decisions on land and resource use, individual land owners cannot be coerced into entering collective agreements and complying with provisions that they consider to infringe their interests.

While the floodplain is not a reserve, it does have many characteristics of a reserve. The most promising strategy

for institutionalizing local collective control over private land-use decisions and strengthening links between scales, is to take advantage of its semi-reserve status and make recognition of rights to land conditional to lake system management plans (Benatti et al. 2003). While formal private property rights cannot be recognized, the federal government can create a concession system for use rights in which maintenance of individual concessions depends on compliance with regional land-use plans. We are now working with the three main federal agencies responsible for regularizing floodplain use rights to develop a viable proposal that strengthens collective control over land-use activities. In this way the main zone in which private property rights are recognized, levees bordering the channels where settlement and forests are concentrated, can be brought under the effective control of the Regional Fisheries Councils.

Prospects

Over the last ten years this multi-institutional collaboration of stakeholder organizations, including floodplain communities and associations, municipal fishers unions, government agencies, NGOs and foreign donor organizations, has embarked on a major regional experiment in the community-based management of floodplain lake ecosystems. It has been greatly facilitated by remarkably stable regional economic conditions, resulting in little conflict or polarization among floodplain stakeholders. But while the basic framework for management at regional lake, community and property levels has been constructed, it is far from consolidated. As this paper shows, significant structural adjustments are necessary, and much work must be done at community and property scales to consolidate this regional management structure.

Unfortunately, there is little time available for achieving this consolidation. The stability of the last decade is over and the region is in the early stages of a major transformation. Soybeans are now being planted in sight of the Amazon River. Cargill, the multinational grain company, has constructed a port facility in Santarém harbour. Agroindustry is moving into the Lower Amazon and brushing aside the protestations of those who claim the Amazon is not appropriate for mechanized, chemical intensive commercial agriculture. Government and business interests are negotiating the paving of the precarious dirt track that links Santarém to the soybean heartland of western Brazil.

Sooner or later, pressures on the floodplain will intensify, mechanized agriculture, aquaculture and intensive ranching could, individually or together, rapidly transform the Lower Amazon floodplain, as has happened to many other floodplains of the world. How this process plays out will depend in large measure on the capacity of the smallholder-community co-management organizations described here to control destructive pressures and take advantage of economic opportunities that these regional changes may offer. Much depends on how quickly the changes needed to consolidate the fragile management system can be accomplished. While the future is by no means certain, a process of collective, adaptive learning has been put in place through which progressively more effective management systems can be developed. This collective learning capacity may be more important than any given management system, for successfully adapting to the coming regional transformations.

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Agrobiodiversity and the economic cost of agrochemical use among smallholder farmers in the Rio Grande Valley, Jamaica

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Introduction

This study focuses on the PLEC-Jamaica demonstration site located in the Lower Rio Grande Valley in the parish of Portland, Jamaica. The site covers an area of 10.4 square kilometres with a population of 1023 people distributed among five communities−Fellowship, Toms Hope, Berridale, Golden Vale and Coopers Hill. Population density is 99 persons per square kilometre, which, in the context of rural Jamaica, is fairly low. However, owing to the predominantly steep terrain, physiographic density is relatively high, indicating fairly intensive cultivation of land in this predominantly smallholder farming area.

The study is based on a survey of 57 small-scale agricultural plots and examines the impact of agrochemical use on the physical, social and economic landscape. The study builds on the PLEC project and its strategy to promote sustainability in smallholder farming. The agrobiodiversity status and the agrochemical use provide a backdrop against which agrochemical costs in small-scale farming can be better understood (Thomas-Hope, Spence and Semple, 1999).

The use of agrochemicals in the smallholder farming systems of the Rio Grande Valley is inversely associated with the level of agrodiversity as it reflects the level of biodiversity on the farms. Thus the economic cost of agrochemical usage is inversely related to levels of agrobiodiversity.

Status of agrobiodiversity at the PLEC demonstration site

The biophysical description of the Rio Grande Valley watershed highlights diversity as a characteristic feature, and the PLEC studies within the demonstration site confirmed this legacy of agricultural diversity (Ferguson, 1998; Mines and Geology Division, 2000). High diversity is particularly evident when one examines the smallholder farming systems, where farmers cultivate and support a wide variety of crops and other plants for their food, nutritional, cultural and economic needs.

Assessments of agrobiodiversity at the PLEC-Jamaica Rio Grande demonstration site attempted to capture most aspects of the biophysical, crop and land management diversity that characterized small farming (Thomas-Hope, Semple and Spence, 2000). The assessment supported the main tenets of the PLEC project, that diversity is a feature of agricultural systems which is often overlooked in biodiversity assessments, but which must be better understood in the process of biodiversity conservation.

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The assessment identified current land-use stages and field types (Zarin, Guo and Enu-Kwesi, 1999), farm management regimes, and crop and associated cropping systems and land management practices (including planting, land preparation, soil management and crop management). This analysis of the farm systems at the Rio Grande site focused on the cultivated, wild, and semi-domesticated plant species found on farms in order to highlight local trends in:

- the dynamics of agrobiodiversity and biodiversity, particularly impacts of land and crop management decisions and tenure arrangements on diversity;
- the environmental and socio-economic impacts of change on diversity; and
- models of tree and field crop combinations found on small farms.

Land management diversity at the Rio Grande demonstration site

Within the sampled farm units, there were five dominant land-use stages (Thomas-Hope and Spence, 2003). Within each land-use stage, the identified field types varied as a function of farm management and reflected a complex mix of different types of cultivated and non-cultivated crops, trees and shrubs adopted by each farmer. Within the land-use stages, field types ranged from one to eight, with agroforest and edge land-use stages showing the highest variations in field types. A total of 235 different species of plants were identified on the farms, including roots and tubers, vegetables, legumes, cereals, fruits, condiments, ornamental and medicinal plants and timber trees. Approximately 70 per cent of the plant species were used by local residents. Uses included food, building material, erosion and flood water control, mulch, medicine, spices, stimulants and fencing material.

Field types on some farms changed frequently, primarily as a function of the farmer's crop and land management decisions. For example, one farm was initially characterized as having three dominant land-use stages with six field types. This farmer occupied flat lands on the floodplains of a river where he intercropped plots of banana, coffee and coconuts with a variety of vegetables, including pumpkin, cucumber, cabbage, pack choi and peppers. This farmer's decision to farm this mix of crops was based primarily on the access to markets, access to technical assistance and the availability of suitable land with proximity to water sources. Subsequent visits with this farmer showed that changes in markets and other socioeconomic pressures had led to a change in his cropping system. He had converted his vegetable intercrop to banana monoculture (banana orchard land-use stage). This case highlighted the dynamic nature of management at the demonstration site, and the need for long-term monitoring to accurately capture the occurrence of diversity and the impacts of change.

Land-use stages and field types

The results of the agrobiodiversity assessments indicated that species occurrence and abundance varied according to land-use stages and field types. The agroforest, house garden and edge land-use stages were the most commonly observed within the demonstration area, constituting over 80 per cent of the total sample units. These land-use stages also displayed the highest diversity of crop, fruit trees, shrubs and other valuable plants as the species richness[2] index reflects (Table 1). The Margalef Index of abundance showed that the agroforest, edge and house garden land-use stages, respectively, showed a higher abundance index than that of the orchard. Margalef Index values for the dominant land-use stages ranged from 20 to 58, while that of the banana orchards were as low as 6. The land-use stage has implications for the abundance of species found on farms. Where other plants were intercropped within banana fields generating the agroforest or house-garden land-use stage, the abundance index increased dramatically, sometimes as much as a factor of three. The fallow stage areas not actively managed due to their susceptibility to flooding also showed high species diversity.

The higher diversity in the agroforest, house garden and edge land-use stages can be attributed to the intensive management practices employed by farmers as physical and economic coping mechanisms. These strategies allow for the diversification of agricultural production, facilitating better market access, which subsequently assist in fulfilling the needs of the farmer and household for food and cash. The management practices associated with the coping mechanism allow for variation in cropping types and patterns from farm to farm, further increasing agrobiodiversity. These approaches to crop production, land management and livelihood security formed the basis of the 'good practice' models developed by the PLEC farmers and scientists and demonstrated by expert farmers.

Table 1. Species richness as a function of land-use stages

Land-use stage	Incidence of the land-use stage	Average species richness
Agroforest	9	26
House garden	6	27
Edge	20	16
Fallow	1	26
Orchard	3	12

Variation in diversity is a function of farmer management. The sampled area showed species richness that ranged from 7 to 59, with the variation following the observed trends in the land-use stages discussed above. The agroforest land-use stage showed the highest variation in field types, with over 9 field types identified. Species richness in the field types within this land use stage ranged from 13 to 59. On farms where there was an emphasis on a mixture of banana, root crops, vegetable, fruit and lumber trees, there was greater organizational diversity and the species richness index was above 25. The field type with the highest species richness (59), was found on a farm divided into a number of subplots with various crops planted for sale in the local market. This farm also showed the highest level of species abundance within the agroforest and edge field type. The farmer's management practices reflected the relationship between market orientation and the level of diversity as this farmer sells all his produce locally. Conversely, banana farmers targeting export markets receive technical support from the Banana Export Company (BECO) which promotes a reduction in diversity to facilitate greater efficiency and reduced production costs. For example, banana farmers producing for the export market clear the banana orchard to reduce 'wastage' of nutrient inputs through uptake by other plants, and to reduce the incidence of disease from trash. This approach promotes a reduction in diversity and is reflected in the uniformity in field type. The single field type within this banana plantation/orchard land-use stage showed the lowest species richness values, which ranged from 7 to 19, with an average of 12. Most farms had species richness of 20 and above.

The field types of the house garden land-use stage showed less variation than other field types. Assessments of the observed field types also showed that the edges had a significant contribution to make to diversity, and in many instances the edge contained crops, fruit trees and medicinal plants not commonly grown in the main farming area.

Crops and cropping systems

Diversity within the demonstration site was also examined at the level of the crops and crop management systems. Land-use stages and field types of the demonstration site are dominated by the banana. Within the farms sampled over 75 per cent of the farmers indicated that a second major income generating crop was cultivated, and 61 per cent of farmers also farmed a third income generating crop. Commonly observed secondary and tertiary crops are plantain, yam, breadfruit and dasheen. Some farmers also include vegetables such as tomato and legumes. Thirteen different types of vegetables were observed on the sampled farms. These included cabbage, cucumber, pumpkin, tomato, cauliflower, okra and calaloo (leafy green). Legumes are both widely cultivated and consumed in the Valley, but farmers grow limited varieties, mainly kidney beans, string beans, gungo peas, cow peas and broad beans.

Table 2 shows the diversity of crops in each land-use stage and highlights the non-cultivated species that commonly thrive in each land-use stage except orchards. Diversity increases where non-cultivated species are allowed to thrive, namely in edges and house gardens. It must be emphasized that this diversity is directly a function of the farmer's management practices for weed/wild plant control and crop and plant choice. The occurrence of medicinal and ornamental plants varied, particularly at the field type level, and was found to be more prevalent in the edge land-use stage. Data analysis also highlighted the facts that:

2. A count of the number of species in a particular sample

Table 2: Crops and cropping systems common to the dominant land-use stages at the Rio Grande Demonstration Site

Land-use Stage	Most common crops	Most common trees (cultivated or promoted)	Medicinal or other useful plants
Agroforest	Banana Plantain Dasheen Sweet Potato Yam Peas/Legumes Vegetables Pineapple	Grow/Fence Stake Ackee Coconut Mango Apples Coffee Citrus	Mint spp. Bird Pepper Aloe Vera Susumber
House garden	Banana Plantain Dasheen Sweet Potato Yam Peas/Legumes Vegetables Pineapple	Grow/Fence Stake Ackee Coconut Mango Apples Coffee Citrus Soursop Sweet sop Guinep	Ornamental Plants Mint spp. Bird Pepper Aloe Vera Susumber
Edge	Yam Banana Plantain	Nutmeg Apple Mangoes Citrus	Grasses Mint spp. Growstake Hogmeat Aloe vera
Orchard	Banana	Apple	A few aggressive wild plants e.g. Hogmeat, Marigold, and Guinea Grass
Shrub Dominated Fallow	Dasheen Coco Yam	Coconut	Bachelor Button Mongoose Weed Milk Weed Watergrass Rat Ears Cowfoot Marigold Guinea Grass

- despite socioeconomic, cultural and political pressures, agrodiversity is flourishing within the demonstration site;
- coping strategies are reflected in the land-use stage variations observed; and
- substantial diversity has been noted in cultivated and non-cultivated species, in management practices and techniques, and in land use.

Agrodiversity and agrochemical use

Issues related to agrochemical use and their environmental impacts are well documented and the desirability of farming systems to become less reliant on agrochemicals is constantly promoted. The PLEC approach of encouraging agrobiodiversity within small-scale farming systems provides a strategy for reduction in agrochemical use through greater biological diversity and diversity in farm management practices. This study arose from the need to better understand the nature of farmers' agrochemical use within the demonstration site (Smith, 2003). The study sought to establish:

- the types of fertilizers and pesticides used by farmers;
- the factors which influenced the farmers' use of agrochemicals;
- the types of crops and plants present on farms; and
- the relationship between agrochemical use and levels of agrobiodiversity in different land-use stages.

The objective of this assessment is twofold: to understand variations in agrochemical use in relation to crop types; and to investigate interrelationships between agrochemical use and agrobiodiversity.

As is common across Jamaica, use of agrochemicals by farmers at the PLEC demonstration site was prevalent, with over 82 per cent acknowledging the application of chemical fertilizers and pesticides to their crops. In addition, more than 80 per cent of the farmers thought agrochemical application was a key part of crop production. Within the agroforest and house garden land-use stages there were less agrochemical inputs compared with the banana orchard/plantation land-use stage. Since agroforests and house-gardens represent higher levels of agrodiversity than the orchard/plantation land-use stage, there is clear indication that increased agrodiversity coincides with lower demands for agrochemicals. For example, farms that fell within the orchard land-use stage routinely used more than one and as many as five types of fertilizers. The routine use of pesticides and the number of pesticides applied was also higher for this land-use stage. Seven different types of fertilizers and 20 types of pesticides were used by farmers

Table 3. Pesticide use at the PLEC Demonstration Site

Agrochemical (common name)	Crops	% of agrochemical users
Insecticides		
Mocap	Bananas	52
Furadan	Bananas	37
Rugby	Bananas	19
Decis	Vegatables	4
Dipel	Vegatables	4
Xentare	Vegatables	4
Sevens	Citrus	4
Primacide	Bananas	4
Fungicides		
Anvil	Bananas	4
Benlate	Bananas	15
Calixin	Bananas	52
Cocide	Vegatables	4
Tilt	Bananas	74
Spray Oil	Bananas	74
Manchocide	Vegatables	4
Ridomil	Vegatables	4
Herbicides		
Roundup	Weeds	4
Gramaxone	Weeds	93
Diquat	Weeds	19
Karate	Weeds	7

Table 4. Fertilizers use and general frequency of use. at the PLEC demonstration site

Fertilizers	Crops	Frequency	Function	% Farmers
Sulphate	Vegetables Plantain Bananas, Peppers Coffee Variety of young plants	once	Promote young plant growth	78
Potash	Vegetables Plantain Bananas Dasheen Coco	once	Promote shoots in bananas	33
Miracle Gro	Vegetables	once		7
15:5:35 All purpose	Banana Dasheen Coco Plantain Vegetables A mixture of crops	Every 10 weeks	Promote growth	78
Urea	Banana Plantain	once	Promote young plant growth	11

throughout the demonstration site (see Tables 3 and 4). While the relationship between land-use stage and pesticide use cannot be easily assessed, it was noticeable that pesticide use was more prevalent in some cropping systems than others. For instance, 67 per cent of pesticide use was in the traditional export crops banana and coffee.

The relationship between land-use stages, biodiversity and agrochemical use was measured through SPSS cross-tabulations. Only three land-use stages, home gardens, agroforest and orchard, were included in the analysis because agrochemicals are not normally applied to edges and fallows. Both home gardens and agroforest are characterized by high levels of biodiversity while orchards of mainly bananas, have significantly lower levels. Table 5 shows the relationship between land-use stage and total pesticide use at the PLEC demonstration site. The R-value of 0.6 suggests a significant relationship between agrobiodiversity and the level of pesticide usage. Pesticide use was greatest in the orchard land-use stage where the level of species diversity was lowest. Home garden and agroforest land-use stages which are characterized by significantly higher levels of species diversity had comparatively lower levels of pesticide use. A similar pattern is demonstrated for fertilizer use (Table 6). In high fertilizer use of more than 350 kilograms of fertilizer per season, coincided with orchard land-use stage in nearly 77 percent of the cases. This is in contrast to about 16 percent with house gardens and about 7 percent with agroforest.

Table 5: Percentage distribution of total pesticide use (kg) per season

Land-use Stage	Low (up to 17 kg)	Medium (18 to 46 kg)	High (more than 46 kg)	Total
House garden	15.4		17.9	15.5
Orchard	73.1	100	75.0	75.9
Agroforest	11.5		7.1	8.6
Total	100	100	100	100

R=0.610

Table 6 Percentage distribution of total fertilizer usage (kg) per season

Land-use Stage	Low (up to 182 kg)	Medium (183 to 350 kg)	High (more than 350 kg)	Total
House garden	6.9	41.7	11.8	15.5
Orchard	82.8	58.3	76.5	75.9
Agroforest	10.3		11.8	8.6
Total	100	100	100	100

R=0.577

Economic cost of agrochemical use

Agrochemical use has economic as well as environmental implications. Characteristically, record-keeping on revenues and expenditure by small-scale farmers in the Caribbean

is virtually non-existent, making a cost-benefit analysis of agrochemical use impossible. Farmers considered fertilizers as an absolute necessity especially for the export banana production because it contributed to increased yields and improved appearance. Implicit in the information in Tables 5 and 6 is that the associated cost can be calculated based on the relationships between land-use stage and pesticide and chemical fertilizer use. A summary is shown in Table 7.

The total cost of agrochemicals (pesticides and fertilizers) among the land-use stages is a reflection of the number of farmers in the study for each land-use stage as well as the mean application per farmer. This has environmental implications in terms of potential for water pollution. The mean cost of agrochemicals by land-use stage allows cost comparisons between the land-use stages. For both pesticides and chemical fertilizers, orchards are characterized by the lowest levels of agrobiodiversity and the greatest mean cost per farmer for these inputs, while agroforest incurs the least mean cost. Given similarities in species richness between house gardens and agroforest, a closer agrochemical cost relationship was anticipated between these two land-use stages. However, the agrochemical-cost relationship between house garden and orchard is closer than between house garden and agroforest. This may be related to the fact that the agrobiodiversity of house gardens includes some commercial crops such as vegetables and root-crops on which agrochemicals are traditionally applied. The agroforests at the PLEC site are primarily comprised of food trees that do not have a tradition of agrochemical application or even active cultivation.

Table 7. Estimated cost of agrochemicals by land-use stage at PLEC Site

Land-use stage	Total pesticide cost($J)	Mean cost ($J)	Total fertilizer cost ($J)	Mean cost ($J)
House garden	162,938	18,104	97,400	10,822
Orchard	921,836	20,950	550,000	12,500
Agroforest	69,106	13,821	42,800	8,560

Note: US$1 = J$61.00 (approx)

Conclusion

The relationship between agrochemical use and land-use stages at the PLEC demonstration site raises significant issues. High levels of agrobiodiversity are associated with a reduction in the amounts of agrochemicals required, while reduced agrochemical use on plots is associated with greater biodiversity. Maintaining high production and low biodiversity on plots in general increases the need for the use of higher pesticide, herbicide and fertilizer use which has the effect of reducing both species variability and abundance on those plots. Orchards have the lowest levels of agrobiodiversity, and have correspondingly higher levels of agrochemical use than house gardens and agroforests. As a result, farmers involved in the cultivation of orchard crops incur significantly greater expenses for agrochemical inputs than the more biodiverse land-use stages.

Because farm households have multiple income sources, and profits from farming are not recorded by the farmers, it was not possible to isolate the specific impact of agrochemical costs on incomes from farming. Thus the variation in economic levels of the farm households could not be explained in terms of the differential levels of agrochemical use. However, the inverse relationship between biodiversity and agrochemical use and the associated cost to the farmer is shown to be considerable. Further, the relationship between fields under orchard/ plantation crops highlights the coincidence of reduced levels of biodiversity and increased agrochemical usage associated with the cultivation practices of crops principally intended for export. This raises concerns both for the environmental sustainability and the economic viability of small farms engaged in traditional forms of export production in the Jamaican small farming systems.

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The farmers of Baihualing, western Yunnan, China

Dao Zhiling and Guo Huijun

Introduction

Southwestern China's mountainous and upland areas are of great ecological and cultural complexity, and home to a large number of ethnic minority groups. They are also among the poorest areas in China. An increasing number of programs aimed at poverty alleviation and infrastructure are implemented to push economic development. At the same time, protection of the rich and fragile ecosystems receives a lot of attention. Rapid changes in farming practices in these areas result from individual household decisions under the Household Responsibility System and expanding influences of the market. Many farmers successfully take these opportunities and innovate or adapt their farming systems and techniques to the new social landscapes.

During 1993 to 2002, PLEC-China Cluster in Yunnan Province worked closely with farmers on agrobiodiversity conservation in Baihualing village, in a valley draining to the Nu Jiang (Salween river) from the Gaoligongshan State Nature Reserve. PLEC aimed to promote the positive innovations of farming and use of natural resources that have improved local livelihoods without damaging rich biodiversity, and to develop these villages as model demonstration sites for wide replication.

Baihualing administrative village covers 1810 ha, with a population in 2000 of 2180. The village lies between 850 and 2000 m, and the upper part borders the State Nature Reserve of Gaoligongshan (Gaoligong mountains). Main land-use stages are upland, paddy, home garden and forest. All of the farming lands are allocated to and managed by individual households. The main crops are paddy rice, maize, sugar cane, coffee, walnut, chestnut, pea and potato. The main sources of income are sugar, livestock, off-farm employment and cash crops (Table 1).

During GEF/UNEP/UNU-PLEC project implementation from 1995 to 2002, most demonstration activities were organized by the Farmers' Association for Biodiversity Conservation (FABC). The farmers' association was co-funded by MacArthur Foundation and UNU-PLEC in 1995. It is a self-organizing, self-managing, self-developing and self-serving organization. Expert farmers for demonstration were selected through household-level agrobiodiversity assessment (HH-ABA, Guo et al. 2000). Ten expert farmers were selected from among farmers in most of the eight natural villages within Baihualing administrative village to share and extend their experience and techniques on agrobiodiversity management.

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One of most important demonstration activities is agroforestry management. Several training courses on techniques of growing fruits, such as grafting, pruning, prevention and cure of plant diseases, were organized to help farmers expand areas of coffee, longan, orange, chestnut, walnut and persimmon as alternatives to sugarcane. The expansion and diversification has increased farmers income and reduced the risk arising from market fluctuation. The tree crop cultivation increased nine times and production increased 10.6 times from 1997 to 2000. Up to now, some 330 ha of Baihualing farmlands are managed in agroforestry systems, much of it still immature, but already contributing 15 per cent of the village cash income in 2001 (Table 2).

Table 1. Percentage contribution of different income sources to household cash income in Baihualing village (2001)

Income source	Percentage contribution to income
Sugarcane	41.9
Coffee	2.9
Cardamon	4.6
Walnut	5.1
Chestnut	2.6
Vegetables	0.1
Grains	2.5
Off-farm	15.5
Transport	10.5

The purpose of PLEC is not only to absolutely increase biodiversity in certain land types or fields, but also to demonstrate expert farmers' innovative knowledge and skill on agrobiodiversity conservation and sustainable rural development which will help to increase biodiversity on all levels, landscape, ecological, species, and variety (genetic) level in a certain area. The 10 expert farmers were among those who sustained a high level of agrobiodiversity and total biodiversity on their land. Table 3, which employs the Margalef diversity index, shows the diversity levels achieved by five farmers, two of whom (Zhang and Wu) are among the experts. The cash incomes of these two, though not derived wholly from agroforestry, are much above the average in the community. Mr. Wu knows how to use many wild plants, but also introduces some useful wild plants into his agroforestry system. He cultivates a medicinal orchid (*Dendrobium candidum*) on walnut and chestnut tree stems and rocks.

Table 2. Area and production of main tree cash crops in 1997 and 2000 in the Baihualing village

Crops		Walnut	Chestnut	Coffee	Longan	Persimmon	Orange
Area (mu)	1997	35	50	82	10	4	43
	2000	150	130	1272	480	4	42
Yields (kg)	1997	500	600	1200	1	80	172
	2000	3200	4400	18500	120	93	970

Note: Area: mu (1/15 ha.); Yields: kg.

Data are from the village statistics; most of cash crops are still young seedlings. PLEC data suggest that the village statistics underestimate the area now under tree crops, which now totals more than 5,000 mu.

Expert farmers bring along other farmers. Through training workshops and farmer-to-farmer training, more and more farmers have joined PLEC activities. As expert farmers of Baihualing commented when we visited a demonstration:

> there are many advantages with the farming systems of perennial/annual crop diversity. They reduce production and market risk compared with monoculture. And few people must lead the development of diversity, and other conservative people would then see benefits of new ways of farming and follow.

Farmers can undoubtedly get benefits from their diverse farming systems. In Baihualing since 1995, 461 farmers have been trained in grafting, pruning, pest control, tree crop cultivation and environmental protection through workshops on biodiversity conservation and practical rural skill. Brought along by expert framers, more and more farmers introduce tree crops into both uplands and paddy fields.

In Baihualing village, about 400 households took part in PLEC activities on cash crop breeding, cultivating, grafting and pruning between 1998 to 2001. And 2200 mu (147 ha.) farm land have been managed by agroforestry. On the other hand, more and more farmers consciously protect wild animals and plants in the nature reserve around the village. Mr. Li Dayi, a typical Lishu hunter in the past, began to cultivate a native timber tree (*Phoebe puwenensis*) in 1983 after the land allocation to individuals. He experimented for two years to get seedlings of this timber tree. He began to cultivate it around his house and upland sides. And then he planted this timber tree in his 30 mu of upland (15 mu rented from another farmer). He also planted other species including *Toona ciliata* and *Cunninghamia lanceolata*. He also supplies different kinds of tree crop seedlings for other farmers and teaches them how to cultivated every year. His new seedlings are Chinese fir, walnut and *Punica granatum*. He bred 50,000 walnut seedlings, 5,000 *P. granatum* seedlings and 5,000 Chinese fir seedlings from 2000 to 2001. A hunter has gone.

Both the farmers' association and the expert farmers still organize and effectively take part in different activities in the thirty months after PLEC phase 1 finished in 2002. The Farmers Association for Biodiversity Conservation and PLEC's expert farmer demonstration activities are recognized by more and more people from outside. They make their contribution within the village, and also contribute significantly in the other villages nearby and far away. Several have been invited to teach their technology on land management and economic tree plantation. Mr. Li Dayi and Mr. Chen Shihou were invited to teach in a training course in a Christian church in August 2004. The participants attending came from the three prefectures of Nujiang, Baoshan and Dehong. Mr. Chen Shihou and Mr. Lijiahu were invited to guide fruit tree cultivation and management in other villages several times. In 2004 more

Table 2. Species richness indices of different households of agroforestry systems in Hanlong

Farmer	Species	Individual	Useful species	Useful individuals	Useful species rate(%)	Useful individual rate（%）	DMo Total-bio	D`Mo Agro-bio
Zhang	63	952	16	57	25.4	6.0	0.066	0.281
Peng 1	29	625	10	139	34.5	22.2	0.046	0.078
Peng 2	21	501	8	42	38.1	8.4	0.042	0.190
Xiong	50	968	17	178	34.0	18.4	0.052	0.096
Yang	49	1322	21	186	42.9	21.6	0.037	0.113
Wu	55	837	18	46	32.7	5.4	0.066	0.391

than forty thousand walnut seedlings were bred by Mr. Li Dayi. Half of the seedlings were sold to people in other villages and half were given free to Baihualing villagers. Encouraged and guided by Mr. Li Jihu and Mr. Chen Shihou, more than 10 ha of orange plantation and 10 ha of Japanese persimmon plantation were developed. Mr. Wu, one of the most active expert farmers, is not only the first farmer using agroforestry system but also the first farmer to open a farmer guest house in the village. His guest house, built opposite his living house in 2001-02, was opened in early 2003 and has already received more than 200 visitors. A new crop, *Morus alba* (mulberry) has been introduced into Baihualing village by the farmers' association in late 2004. Some expert farmers are inaugurators of cultivation. All of the tree crops mentioned above are cultivated in agroforestry systems. Mr. Yang Zhixue has developed an intercropping system of chestnuts, peach, maize, peas on steep uplands. The productivity of the agroforestry systems is much higher than the former cropping patterns, with the mixed crop producing 504 yuan/mu compared with 180 for maize and beans intercrop, 240 chestnut monocrop and 120 maize monocrop (Table 4).

Mr. Wang Yousheng (former village head of Baihualing) is delegate of People's Congress of Baoshan City. He is going to press the government to pay more attention to NGOs such as Gaoligongshan Farmers Association for Biodiversity Conservation, which play important roles in environmental protection and rural development.

PLEC ideas and its approaches for agrodiversity and agrobiodiversity development and conservation are not only to be extended in certain demonstration sites. In China PLEC demonstration sites, not only were the targets achieved during project implementation, PLEC ideas and methodologies have been continued and extended both in the village and out side by important partner-demonstration expert farmers.

Table 4. Comparisons of productivity between monocropping and agroforest in Hanlong village

Farming Type	Crop	Yield (kg/mu)	Value (yuan/mu)	Total Value
Agroforestry	Chestnuts	45	360	
	Maize	120	96	
	Beans	40	48	504
Mixed Crops	Maize	150	120	
	Beans	50	60	180
Chestnut monocrop	Chestnuts	30	240	240
Maize monocrop	Maize	150	120	120

Note: 15 trees/mu, 5 –year age ; local market price

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A group of Baihualing farmers

Land, women and opportunity in Northern Ghana

G.Kranjac-Berisavljevic' and Abubakari Seini[1]

Introduction: the power of tradition

Women's engagement in agricultural and income generating activities in Ghana is often inhibited by unequal access to land and credit, lower levels of education and the difficult task of providing income under unfavourable conditions. This scenario leads to many other related social problems, such as high rural urban migration of young women, low levels of literacy, poor access to health and other social amenities.

The Dagbon (Dagomba) traditional land-holding and power system is heavily slanted toward men.[2] As in most of the ethnic groups in Northern Ghana, the current generation keeps the land in custody for future generations. Land rights are related to the sequence of arrival and settlement and the social organization of the clans that constitute the community. Land use is only given as a right to the household by the chief, or the earth priest (Tindana). In some areas of Northern Ghana, the eldest member of the founding clan was considered as priest of the Earth-god (Tindana), to become the political and spiritual head of the settlement.

British colonial rule in Northern Ghana was established in 1900 and this affected the traditional tenure system to some extent. The importance of Tindana was greatly reduced and most of their powers handed over to chiefs (Kasanga and Kotey 2001). There are only a few areas now under the traditional rule of Tindana. The colonial government passed various decrees, placing rights to the native lands under the control of the Governor, and subject to his disposition; no title to the occupation and use of any land was valid without his consent (Kasanga 1992). Until recent times, land acquisition for any purpose under the traditional arrangements did not involve cash payments, because the traditional view is 'you cannot sell land'. Only land for residential and industrial purposes is now sold for cash in urban communities.

The traditional land holding system divides land among clans, under the clan heads, all controlled by the chief or 'Naa', who is in turn responsible to the overlord/king of Dagbon (Yaa-Naa). For administrative purposes, the Power or Authority (Nam) of ownership and supervision has been entrusted to various Paramount Chiefs, and land ownership has been structured and stratified in a Nam (power) hierarchy.

Paramount chiefs delegate their Nam to Elders, Sub Chiefs and Community Chiefs (Kpanbalba). Most sub chiefs and community chiefs have jurisdiction over a certain land area. The boundaries of these land areas are well known, and the land is passed on from generation to generation. Clan heads in every community or village hold the trustee ownership for members of their clan. Within each clan, the head usually further subdivides the land at the household level; the yilyidana or 'landlord' is then responsible for allocating land within the family unit. Such 'landlords' are always men; women cannot own land in Dagomba society, apart from some exceptions described below.

Acquisition of Nam and the right to use land

Nam, and through it, jurisdiction over the land, can only be acquired through a few entry points: Paramount chiefs acquire Nam from the Yaa-Naa. There are definite criteria for eligibility and subsequent procedures for the selection and enskinment (inauguration) of paramount chiefs. On being successfully enskined, the paramount chief gains jurisdiction over all lands that fall under the Nam of the paramouncy. Village chiefs, Elders and sub-chiefs acquire their Nam over the lands through their respective paramount chiefs, in a similar procedure as the paramount chiefs. Ownership of land by clan heads (Dogrikpema) is achieved as 'falli' or legacy. Usually, the oldest man in the clan would hold the 'dang tingbani' (family land) in trust for the clan. He will give various plots/farms to clan members for their use. Every household head is given a piece of land by Dogrikpema to till and to feed his household. Ownership of the land under the jurisdiction of the Tindana is determined through practice of traditional religion. The spirits or gods are said to move to the Tindana through manifestation of signs (Gbaabu). These signs appear in the Tindana. Kalli, or spiritual rites, are subsequently performed for him/her to take over the relevant responsibilities, irrespective of the age, which is an important factor in Nam acquisition through clan structure.

Male individuals from other areas can also acquire land if it is available. Kana-ko, or migrant farmers, have to identify a piece of land which suits their purpose. They then buy cola nuts for presentation, obtain the services of an intermediary from the local community and ask for (suhi) the piece of land from the head of the clan or village chief. Such ownership is only temporary.

Land ownership and women

Although most village and sub chiefs are men, there are some notable exceptions. Certain Dagbon lands are the preserve of women who rule them as sub chiefs and Tindanas. These include the following communities: Gundogu, Kuglogu, Shiling, Kpatuya, Vokpiya, Yimah'gu,

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2. The Dagomba are one of the largest ethnic groups in Northern Ghana. Their society is patrilineal and highly stratified. An integrated farming system, described in detail in the early 20th century, remains changed only in detail.

and Nangbogu have female chiefs; in Nakpanzoo chieftaincy alternates between male and female; Tindan-Pag'yilli and Katariga have female Tindana. All rulers are Princesses of royal blood, female relatives to the Yaa-Naa and Tindana. By their descent, the female sub chiefs command the respect of the communities and other paramount chiefs. Nam acquisition over their subjects is regarded as the same as if they were males of royal ancestry.

The presence of royal princesses and female fetish priests in no way affects the situation of ordinary women in Dagomba society. They do not have access to land in any situation. Ordinary women always depend on their male relatives. Their farms, on which they contribute labour, are never theirs to own. The exceptions given to the female chiefs and priests only emphasize the generally unfavourable situation regarding women's chances to own the land.

Women's opportunities

There are only limited opportunities for women to increase income through participation in agriculture due to restricted access to land because of traditional tenure systems. Rural women do not work only in farming. They dominate in many of the rural non-farm activities that grow most rapidly as rural economies undergo structural transformation, such as food processing, tailoring, and trading. They also have major stakes in many of the declining non-farm rural occupations including basket making, mat making, ceramics, and weaving. Women in many cases may be seen as key actors in the transformation of rural economy.

While the traditional system excludes women from land ownership, there are opportunities for industrious women to venture into farming on lands which are not any more under traditional tenure or on which purely male crops such as yams are grown. Some examples include lands earlier acquired by the colonial government or obtained for project development after Ghanaian independence in 1957. Women are found cultivating rice on the irrigation projects, and they take active part in the urban and peri-urban vegetable production. Lands cultivated with non-traditional crops are also a possible domain of women; there are some females among the small-scale mango and cashew farm owners in the region. However, their representation is not comparable to that of men, even though there is no restriction to their access to land in this case.

Constraints on improvement

According to the Core Welfare Indicators Survey, carried out in Ghana in 1997 (Statistical Services, 2001), Northern Region has about 77% its of population living in rural areas, and perhaps the highest incidence of rural poverty in the entire country, as well as the lowest literacy rate (16.8%). Access to social amenities, such as potable water and health services as well as education is very limited.

In many communities in this part of the Northern Region less than 5 per cent of female children attend school. In the community of Jegbo-Ghulahigu, in Tolon/Kumbungu district, a PLEC Project Field Survey in 1999 was told emphatically that no girl attends school. Tolon/Kumbungu district, together with Savelugu/Nantong district, have the highest number of young females migrating to the southern cities of Kumasi and Accra to become load carriers. The situation is creating many problems, bringing social imbalances, reducing the active population and generally causing degradation of life quality for the affected communities.

The PLEC Project has been working with farmers in the Tolon/Kumbungu district since 1996 in about 19 rural communities, with the centre of activities at the Bognayili-Dugu-Song Main Demonstration site. There are about 250 male and 250 female members engaged in activities such as stone bunding, agroforestry, preservation of local yam landraces, and compost making. Researchers and farmers are partners in the development of activities and emphasis is always given to creating value from biodiversity through support for the farmers' initiatives.

The case of spinning and weaving

Cotton spinning and weaving is an important traditional occupation for women in Northern Ghana. These activities do not require scarce inputs such as firewood or water, and are carried out in the dry season when there is less work for women on the farm. Locally woven cloth is used to make traditional smocks, with a high value in the market as garments for ceremonial occasions, and as tourist attractions. On average, it takes about 3 weeks for one woman to spin enough thread to weave a single smock. The thread is then given to a different person, to weave using a traditional narrow loom, while a third person dyes the cloth using local herbal preparations. The narrow strips of cloth are joined before sale. All the parts of the operation, especially spinning and weaving are on the verge of disappearing, due to lack of interest, the high migration rate of young females and the competition of imported garments.

Improved tools and equipment are essential to expand the productivity of rural women. A project developed by a University of Development Studies research team with a grant from Ghana Education Trust fund aims to improve the spinning and weaving industry of a local women's group. The main goals are to manufacture an improved loom prototype capable of using local hand-spun yarn and make it available for use by interested groups. An existing wide loom produced by the Intermediate Technology Transfer Unit (ITTU) uses imported yarn. No effort has been made by any agency to adjust the loom for locally woven cotton thread. This is what the northern Ghana PLEC team intends to carry out in its planned work.

A second problem concerns the lack of organization in local garment manufacture. The local garment goes through several, specialized operations during its manufacture, all at different locations and by different people. The research

team believes the garment process can be simplified and made more efficient, thereby improving the income of the producers which will give opportunities for income generation to women living in the areas where very few other resources are available.

Many small appropriate technology projects supported by voluntary agencies have successfully introduced simple yet effective devices that are affordable, require little maintenance, and are easy to use. However, experiences of PLEC and other projects have shown that reaching rural women with technology improvements is not necessarily simple. Accepted technologies have generally been those that improve or upgrade traditional techniques, because this ensures social acceptability, and accustomed practices, tastes, beliefs, and taboos are not disrupted. Successful technology projects for women involve the beneficiaries in the identification and development of improvements and the propagation of improved technology through a package comprising group formation, training and credit. None of this is easy.

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Dagbon women, children and a school girl cooking in the family compound

Dagbon men returning from cultivating yams

News

PLEC-CAMP farmers association: Sekesua-Osonson report, August 2004

Mr. Emmanuel Nartey

Activities in PLEC-CAMP (Collaborative Agroecosystems Management Project) Sekesua during July and August focused on training of farmers in beekeeping and snail-raising. In Apimsu and Akumesu more than 100 hundred participants attended, and in other communities like Dawatrim and Etwento 45 people attended. Even though all the participants could not be assisted with beehives, they were made to understand that everything relies on their own initiatives. Support could come from areas other than the Heifer Project once they have acquired the knowledge. A decision was taken at the end of training at Apimsu and Akumesu that only those who have the ability to purchase hive stands will be assisted with pass-on hives. This is a measure to protect the hives from termites. The participants came to understand that snail raising takes only a little money to start and they resolved to start their housing immediately.

During the training at Apimsu, most of the participants who trap grasscutters for domestication realized they need to try different methods of catching them. A plan for a pen was drawn and the Association would help in the construction. The pen could serve as transit for onward placement to those who are prepared to keep grasscutters.

At Akumesu, most of the land along the streams is good for cultivation of fruit trees and yams. This became evident when participants visited an expert farmer's land to learn how biodiversity could be promoted.

The group at Akumesu resolved to visit the Plant Genetic Resources Centre, Bunso, to learn further the potential that could be promoted on their lands.

At Nsutapong, 5 farmers growing yellow yam were identified during a meeting held with PLEC-CAMP leaders to help them form a farmers' group. The yellow yam farmers have adopted the use of organic manure to improve their yield. A visit to their farms showed that the taste of organically grown yams is maintained, while those grown with chemical fertilizer do not cook well sometimes, and if they do, the taste and colour changes.

The Presidential Initiative on Cassava has been inaugurated in the Manya Krobo District, among 5 others that will form the Densu Starch Company. The other Districts are Yilo, Asuojaman, Fantiakwa, Akuapem North and Suhum Kraboa Coaltar Districts. The factory will be sited at Apesewa near Nkurakan in the Yilo District. Farmers are being mobilized to start large-scale cassava production to feed the factory when it is established. The areas earmarked for cassava production in Manya Krobo is around Asesewa and Sekesua. PLEC-CAMP farmers are involved in the production but are starting to sensitize members on degradation. The farmer leaders encourage members to practice alley cropping when the production reaches full gear. Even before that, the farmers are being encouraged to map out areas for crops like cocoyams and shade yams alongside other threatened species. By so doing, most of the indigenous knowledge could be applied to ensure its continuous existence.

It has been found that the only way to sustain indigenous knowledge in ecosystem conservation among farmers with limited land holdings is the initiation of farmers' field schools. To ensure the success of these approaches, PLEC-CAMP farmers have identified on-farm and off-farm income generating activities, which could lead to sustainable land use:

- The conserved aboretum at Bormase owned by E.O. Djeagbo is being used as an apiary using hives with metal stands, and this adds value to arboretum.
- Shade yams are being conserved on the lands of Odorkor Agbo in addition to beehives.
- A compound owned by Emmanuel Nartey improved with the raising of snails, grasscutters, mushrooms, and home gardens, and the adjoining land use in the conservation of yams and beehives.
- Regina Aku's snail pens at Bormase and other spots within the demonstration area are potential study sites.

Farmers from the newly organized areas come to the spots listed, to know at first hand how to start one of those ventures. This makes it easy for participants to understand lessons during training. Schools are visiting the aboretum to learn about the importance of conserved lands.

The Manya Krobo Cultural Advisory Board has recommended the initiative and has advised the District Assembly and the Traditional Council to make it mandatory that genetically modified plants do not take over indigenous plants entirely even though they promote bumper harvests.

During a Board meeting of the Cultural Advisory Board at Odumase in August, a lecturer of the University of Ghana, Prof. Ayernor, was full of praise on the way PLEC ideas are playing meaningful roles in the small land-holding families. He advised that farmers contact PGRC for assistance in obtaining cost cultivars.

A report on PLEC activities was given to the Cultural Advisory Board and members are to advise the whole District on indigenous food preparation and promotion at Hotels and cultural gatherings.

PLECserv reaches 50 issues

PLECserv provides an introduction to recent articles or other publications of interest to people working among developing-country farmers, and concerned about development and conservation. PLECserv, can be found at **http://c3.unu.edu/plec/index.html**. Recent titles are:

41. Village-level development initiatives depend on social networking. Sept. 22, 2004. (Bin Wu and Jules Pretty, 2004. Social connectedness in marginal rural China: the case of farmer innovation circles in Zhidan, north Shaanxi. *Agriculture and Human Values* 21: 81-92.)

42. Promoting wood as a crop in Haiti: an effective model. Sept. 28, 2004. (G.F. Murray and M.W Bannister. 2004. Peasants, agroforesters and anthropologists: a 20-year venture in income-generating trees and hedgerows in Haiti. *Agroforestry Systems* 61: 383-397.)

43. Guatemalan small-scale producers lead export production of vegetables and fruit. October 13, 2004. (Sarah Hamilton and Edward F. Fischer 2003. Non-traditional agricultural exports in highland Guatemala: Understandings of risk and perceptions of change. *Latin American Research Review* 38(3): 82-110.)

44. Escaping one set of problems in Bangladesh: creating others. October 28, 2004. (A.M.S. Ali. 2004. Technological change in agriculture and land degradation in Bangladesh: a case study. *Land Degradation and Development* 15: 283-298.)

45. Globalizing fresh fruit production: life at the bottom end of the supply chain. November 10, 2004. (Andrienetta Kritzinger, Stephanie Barrientos and Hester Rossouw 2004. Global production and flexible employment in South African horticulture: experiences of contract workers in fruit exports. *Sociologia Ruralis* 44 (1): 17-39.)

46. Carving out livelihoods in the Misquitia region. November 24 2004. (Kendra McSweeny. 2004 The dugout canoe trade in Cental America's Misquitia: approaching rural livelihoods through systems of exchange. *Annals of the Association of American Geographers* 94(3): 638-661.)

47. Making policy: science and myth in environmental policy on a Himalayan scale. December 2004. (P.M. Blaikie and J.S.S. Muldavin. 2004. Upstream, downstream, China, India: the politics of environment in the Himalayan region. *Annals of the Association of American Geographers* 94 (3): 520-548.)

48. Remittances from migrants are big business: can they achieve social goals? January 19, 2005. (Luin Goldring. 2004 Family and collective remittances to Mexico: a multi-dimensional typology. *Development and Change* 35(4): 799-840.)

49. Market-led agrarian reform: a low-cost way of achieving true redistribution? February 03, 2005. (S.M. Borras Jr. 2005. Can redistributive reform be achieved via market-based voluntary land transfer schemes? Evidence and lessons from the Philippines. *Journal of Development Studies* 41: 90-134.)

50. Planting like your neighbours: maize diversity in southern Mexico. February 16, 2005. (Perales, H.R., Benz, B.F. and Brush, S.B. 2005. Maize diversity and ethnolinguistic diversity in Chiapas, Mexico. *PNAS* 102(3): 949-54.)

People Land Management and Ecosystem Conservation (PLEC) involves a collaborative effort between scientists and smallholder farmers from across the developing world to develop sustainable and participatory approaches to conservation, especially of biodiversity, based on farmers' technologies and knowledge within the agricultural systems of the farmers.

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