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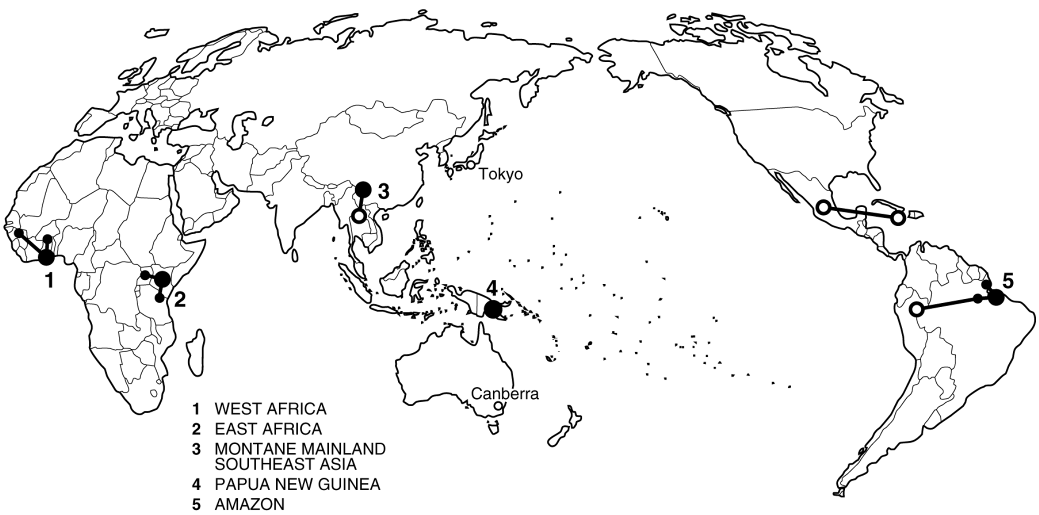

The Clusters of PLEC

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PRINCIPAL SCIENTIFIC COORDINATOR'S REPORT

HIGHLIGHTS OF THE PERIOD APRIL–NOVEMBER 1999

Harold Brookfield

PLEC is now well into its second year with GEF funding, and in almost all parts of the project there is a notable acceleration of progress. This is true of the non-GEF Clusters as well as in those with GEF support. Demonstration sites have now been established in all Clusters, at various stages of elaboration. Within the GEF-supported Clusters, there are now 21 operational demonstration sites, and a further six are in development.[1] In the UNU/PLEC-supported Clusters there are four operational sites, and four in development. Two or three unprofitable sites have been given up.

Following the publication of the methodology special issue of *PLEC News and Views* (No. 13) in April, there have been notable improvements in the recording of both biodiversity and agrodiversity, discussed below. There has been rapid progress in the identification of 'expert farmers' who, in Brazil and Peru, in Ghana and Guinée, and in Tanzania in East Africa, are already working well in farmer-to-farmer training, both formally through field days and workshops, and informally on an individual basis.

Where this has happened there has been very notable progress toward the aim of making the project, in and through its demonstration sites, the property of the farmers themselves. Moreover, a closer bond has developed between the farmers and scientists, the latter learning from the farmers more than teaching them. The standing of PLEC among its stakeholders, including national and local officials and agriculture personnel, as well as the farmers, has been enhanced.

While this has not been a 'new' idea since the time of *Farmer first* (Chambers, Pacey and Thrupp 1989), PLEC is developing a modification of what is sometimes called 'Participatory Research' through a rather direct move into 'participatory action'. There are related international projects concerned with landrace conservation which employ participatory approaches—the biggest is the large NGO-based Community Biodiversity Development and Conservation Programme, and another is the newer International Plant Genetic Resources Institute (IPGRI) initiative on 'Strengthening the scientific basis for *in situ* conservation of agricultural biodiversity on-farm' (Jarvis and Hodgkin 1998). PLEC, looking at on-farm resource management in a more holistic manner, and going directly to farmers' needs, represents a somewhat

[1] A listing of these sites is given in the Demonstration Sites Directory printed at page 38.

diffferent approach, and it appears to be achieving very good early results.

The new trend: helping to restore diversity

Progress is better discussed under principal themes than area by area. One encouraging theme that emerges from some of the reports is the interest shown by farmers in restoring lost elements of diversity into their livelihood systems and environment. Half a century of commercialization, introduction of new crops and improved varieties, and growing problems of decline in soil fertility, has either wiped out or marginalized many locally developed crop landraces, and has led to abandonment of many old practices. There has been extensive erosion of wild biodiversity.

Farmers had come to believe what they have so often been told, that 'modern' ways of production are always superior to their old ways. It has come as a surprise to meet scientists who see both conservationist and production advantages in such old practices as intercropping and planting in association with certain indigenous trees. The same scientists have helped them develop improvements that draw on their own fund of local knowledge as well as on scientific information.

In Tanzania, for example, a major problem has become vulnerability of yields to moisture stress. The length of the growing season has tended to become shorter since the 1970s, a trend proven by examination of the long-term data. Farmers using conservation tillage and applying animal manure in an efficient manner have weathered these problems better than others. Some farmers with limited land have developed crop rotations, improved livestock management, and are practising agroforestry. Others have diversified their activities into a range of economic enterprises on very small areas of land. With the encouragement of PLEC scientists, they have set out to train others in their ways of managing resources.

The active involvement of farmers in the surveys of agrodiversity, agro-biodiversity and wild biodiversity has also had productive consequences. Farmers have become more aware that certain species of value are growing scarce. They recall that a wider range of services was obtained from biodiversity in the past than in recent times. They have also realized that the *in situ* conservation of valued species is still entirely possible, sometimes by importing germplasm from nearby areas where it survives, into areas from which it has disappeared.

Exhibitions of rare and endangered species, of fauna as well as flora, have been organized at workshops and other occasions to make the situation more widely known among the local population. This has happened especially in Ghana and Guinée, and in Ghana farmers have gone on to demonstrate the food—indeed, gastronomic —value of some of these species, especially through the November 1999 'show' at Sekesua-Osonson that is described in Box 1. PLEC nurseries, initially set up to propagate introduced species at farmers' request, now also include indigenous species in need of multiplication.

Neither the climatic nor the economic environment ever remains constant, and PLEC planning with farmers has always to recognize this ongoing uncertainty. A boost in the market for one crop or animal may lead to distortions in land use, creating new problems that have to be solved in the face of climatic conditions that are never 'normal'. This has happened in Mexico, where an enlarged project (described below at p.33) promptly encountered such variability. Finding that the maize monoculture evolved during the last half-century yielded economically poor results in a high altitude environment, Mazahua farmers sought PLEC help in re-establishing a more

BOX 1

DEMONSTRATING THE VALUE OF AGRODIVERSITY IN GHANA

A show of traditional foods based on endangered or rare biotic species was hosted by the Southern Ghana Association of PLEC farmers on 5 November 1999, at Sekesua, Upper Manya Krobo, Ghana. A programme (here put into the past tense) set out the objective of the show.

Sustainable conservation of agrodiversity requires demonstration of its value, notably as a source of food for human subsistence. Thus the show planned by PLEC farmers for Sekesua-Osonson demonstration site in southern Ghana, aimed to demonstrate the value inherent in agrodiversity by displaying the diversity of meals that could be prepared on the basis of local crop-diversity. It emphasized rare traditional dishes based on rare traditional food items, and built upon a maiden mini-show of a similar character mounted by Sekesua-Osonson PLEC farmers as part of a regional workshop held by WAPLEC (West African Cluster of PLEC) in Ghana in September 1998.

Also, through an exhibit of endangered species, the show sought to sensitize the public to the threats posed to biota, and to the wider ecological and socio-economic implications of the threat. Finally, through guided visits to focal points of applied PLEC field work within Sekesua-Osonson demonstration site, the show sought to popularize awareness of practical measures that may be encouraged at grassroots level to stem threats to agricultural and biological diversity, and to enhance environmental quality. Activities included:

- visits to focal points of PLEC agricultural and biological diversity conservational work;
- exhibit of endangered species, traditional dishes and the food items used for preparation of the dishes;
- savouring/sampling of the exhibited dishes;
- sale of food items and forest products;
- poster display of general PLEC concerns and purpose, and of activities in demonstration sites;
- open discussion of agro-environmental issues;
- plays, games and video show for children;
- awards to individual PLEC farmers and farmer groups outstanding in agrodiversity conservation and sustainable farming; and,
- traditional music, dance and other cultural display.

Among those who attended the show were the regional Minister in the Government of Ghana, and PLEC visitors to the Cluster, Professor Michael Stocking, Mr Liang Luohui and the PNG Cluster leader, Mr John Sowei. The three latter went on to visit the groups and demonstration sites in northern and central Ghana, and Liang also visited the Guinée sub-Cluster.

diversified pattern of cropping, involving restoration of inter-planting and the re-establishment of discarded landraces. An 'abnormal' set of climatic conditions in 1999 made it difficult to establish some chosen crops.

In Peru, an exceptionally high flood in the El Niño year of 1998 wholly changed the floodplain environment, creating a new set of conditions to which farmers' planning had to adapt. Farmers may wish to strengthen or restore diversity, but it has to be an adaptable diversity. This does not make the PLEC task impossible, but it greatly increases the challenge. Scientific understanding of conditions has to incorporate farmers' historical memory, and the working out of 'sustainable' and conservationist solutions has to be done in the context of continual uncertainty. Simple 'land-use planning', as the term is commonly understood, is not enough.

New approaches, new methods, new mind-sets

The second major theme to emerge from the first 18 months of GEF-funded PLEC work is the growing role of the farmers themselves, and an important re-orientation of the approach of the scientists. At the start of PLEC work, which varies from seven years to only one year ago in different areas, the scientists came in with their own questions. Where they offered returns to the farmers, these were in the form of recommendations, or science-directed interventions. This approach has not yet gone, and a place for interventions will remain throughout the life of PLEC, but increasingly they are interventions sought by the farmers, based on their own evolving knowledge and experimentation.

The role of farmers' associations, pioneered since the preparatory phase in Brazilian Amazonia, Ghana and China, is increasingly to take charge of the experimental work and to determine the scientists' agenda. Already, this change is having throughput to the approach to farmers' knowledge and experimentation taken by those members of the agriculture service who have been involved in PLEC work.

In Ghana, a methodology workshop held at Kumasi in March 1999 reviewed these and other changes. The chairman of this meeting, Emeritus-Professor Ebenezer Laing of the Department of Botany in the University of Ghana, offered a challenge to the assembled scientists at the end of this meeting. It is reproduced in Box 2, page 8. Important changes in the whole approach are involved. With experience from Amazonia and as a member of PLEC's Demonstration Activities Advisory Team (DAT), Miguel Pinedo-Vásquez further develops this important question at page 11. In addition, an excellent definition of a demonstration site by A.S. Abdulai et al. appears in a paper at page 19.

Advances in survey methodology

A good deal of the initial work done on biodiversity and agrodiversity inventory yielded only indicative results and, since the issue of the 'guidelines', some work has been done over again on a sounder scientific basis. While this has led to delays, it has also led to much more useful work in which agrodiversity survey and biodiversity survey have become closely integrated. This has happened even in Cluster areas which contributed members to the Biodiversity Advisory Group.

At its second meeting in May 1999, the Biodiversity Advisory Group developed a standard format for recording, details of which were sent to all Clusters in June. The purpose of the standard format is to provide inputs to a common database. A particular feature is the separation of utility data from species data, to avoid potential problems of intellectual property rights. A summary form of the report is printed below at page 7.

The Chinese, who innovated early with their 'Agro-biodiversity Assessment' or ABA (Guo et al. 1996), have innovated further following a visit by Christine Padoch in April 1999. More closely linking the three tasks of biodiversity assessment, agrodiversity assessment, and identification of the more expert farmers, they have developed a 'Household Agro-biodiversity Assessment' (HH-ABA). This method, still being developed in the field, was presented to an Asian-region Conference on Sustainable Agriculture, held in Thailand in October. A fuller presentation, after further elaboration, will be published in the next issue (No. 15) of *PLEC News and Views*.

Methodological papers in this issue

There are two specifically methodological papers in this issue, and a third paper with strong methodological content. At page 7, the June report of the Biodiversity Advisory Group (BAG) is printed in summary form. It concerns a system for data entry. At page 11 is a first paper from the newly-developed Demonstration Activities Advisory Team (DAT), offering advice arising from experience in Amazonia and Ghana, and from the first field visit of the team to Papua New Guinea in August. It responds also to certain minority views that have been expressed since the team was formed in May. Third, the paper by Abdulai et al. at page 19, substantially supplements the DAT paper from an experience in northern Ghana, in the early part of 1999.

Some confusion over terminology has become apparent during 1999, so at page 17 the editors have brought together the main terms proposed by DAT and BAG, and in the agrodiversity guidelines of Brookfield, Stocking and Brookfield (1999). Readers may find this summary useful.

'VIVE WAPLEC; VIVE LE PLEC': GUINÉE, SEPTEMBER 1999

The workshop at Pita

The 4th WAPLEC regional Workshop was held at Pita on the Fouta Djallon, in Guinée, from 6 to 8 September. The whole day of 6 September was devoted to formal meetings. About 70 people attended, including several local farmers. Near-simultaneous translation between French and English was provided. After an opening ceremony, formal papers on work done were presented by the Guinéen and Ghanaian participants.

The Guinéen papers were followed by addresses by PLEC farmers, Mamadou Alliou Kane (Missidè Héïré), Mody Oumar Barry (Tioukognol), and a spokesperson for the women's dyers group at Missidè Héïré. The farmers' contributions very clearly set out what the people are doing in association with PLEC, and how they are re-investing income from one enterprise in support of the next enterprise in their plans. The success and popularity of the composting and manuring enterprises described in Fofana et al. (1998) was stressed. The project was described by the farmers as a pilot for Guinée as a whole. It is, they said, different from others in that it goes to the root of the farmers' life and livelihood.

The second day (7 September) was spent in the field, at the cooperating Puelh (Fulani) and Djallonké villages of Missidè Héïré, Dianguel, Tioukoungol, Dar ès Salam, Lari and Goloya. Virtually the whole population of these communities participated, demonstrating enthusiasm for PLEC. The title above arises from the children's part in a well-planned traditional and modern welcome for the visitors at Missidè Héïré.

PLEC work on the Fouta Djallon began in 1995, leading to a very competent, but unpublished, preliminary-phase report on the Kollangui-Hadia area, completed in December 1996. After this phase the PLEC group moved in 1997–98 into a group of related villages lying further east which we visited. A substantial range of demonstration activities has been undertaken in this area, including agricultural trials and soil-fertility experiments, market gardening, artisanal activities and conservation of biodiversity and soil.

Our separation into different vehicles did not facilitate more than a verbal exposition of the land-use systems (*tapades*, *champs extérieurs*, *bas-fonds*, livestock use of the lateritic *bowal*), or allow us to see evidence of the great inequality among social classes in access to land. These aspects were well delineated for the Kollangui-Hadia area in the 1996 report. These same aspects will similarly be delineated for the more easterly group of villages, in which main activities are now concentrated, in the formal reports due in December 1999.

A visit to Moussaya, upper Niger

On 9 September, a smaller group (Boiro, Gyasi, Enu-Kwesi, Diallo, Fofana, Brookfield) travelled most of the day in one car to Kouroussa on the upper Niger, where we stayed two nights. On 10 September we visited the Malinké village of Moussaya, where the PLEC-Guinée group set up a second demonstration site some 18 months ago. The selection followed the Tamale workshop in Ghana, where it had been suggested that a Guinée site in a similar climate and vegetation zone to Tamale would provide a valuable comparison.

This was indeed so, not only for reasons of natural comparability, but also because the savanna woodland is managed very differently, and more conservationally, in Guinée as opposed to Ghana. This point was quickly taken up by Diallo and Enu-Kwesi so that the idea was born that the two should study this comparison. Already in October Diallo and Enu-Kwesi have worked together in Ghana.

We found an active demonstration site in existence at Moussaya, with experimental work under way in the fields. There has also been encouragement to cash-producing artisanal activity, and very productive expansion and commercialization of bee-keeping for honey production in the savanna woodland near the large village. Moussaya is in a very poor area. Its people were hunters before they were farmers, and a remarkable traditional greeting contained clear evidence of the past importance of hunting. Moussaya is 600 km from Conakry, and in the year 2000 sub-contract relations will be established with already identified colleagues at the Université de Kankan, the second national university, located only 80–100 km from Moussaya.

General remarks

We were impressed with the very sensitive and innovative manner in which the group has gone about the development of its demonstration sites. As described by Professor Boiro at the meeting in Pita, the method has involved the local people even in the most initial stages, where selection has been based on the presence of existing rich agro-biodiversity, of threats to that diversity, and on the presence of documented information about the sites. Then, after identification of local facilitators, there followed dialogue aimed at determining relevant needs and possibilities. Structured organization of participating farmers has made the promotion of farmer-led conservation and production improvement feasible, with close collaboration between farmers and scientists. The special skill in Guinée has been the insightful selection of opportunities for collaborative work. The scientists have provided expertise and materials, including germplasm. They have not provided any significant cash inputs into the local economy, encouraging self-reliance rather than dependence. One measure of their success was the stated view of Professor Gyasi, based on the presentations by the three Guinée farmers, that the Guinée farmers appear to have grasped the basic PLEC concept better than many of their Ghanaian counterparts. The other measure is the very evident popularity of PLEC in all communities visited.

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MAY 1999 UNU/PLEC-BAG MEETING: SUMMARY AND DATA FORMS

D.J. Zarin, with inputs from Guo Huijun, Lewis Enu-Kwesi and Liang Luohui

The second meeting of PLEC-BAG was held at the University of New Hampshire (UNH) from 20–24 May, 1999, and included BAG Convenor Daniel Zarin, BAG Members Guo Huijun and Lewis Enu-Kwesi, and PLEC Managing Coordinator Liang Luohui. A number of University of New Hampshire participants also attended the meeting. The primary objective was to establish a format for recording the core PLEC plant species diversity data collected by Cluster personnel.

Data entry

We developed a format for data entry within the Microsoft Access database program. Figure 1 (page 9) illustrates the structure of the database, which includes five linked tables for Cluster use. A separate database should be used for each demonstration site. Nomenclature within the database follows Zarin, Guo and Enu-Kwesi (1999, especially Table 1, p.4 where the terms used are defined).

Within each table, record fields preceded by an asterisk (*) link the tables to one another. Within each demonstration site, those data (sample area, plot and species I.D. numbers) must be unique. We have tried to design a format that is both useful and easy to use for Cluster personnel. Given current IPR debates involving biodiversity we stress that some of the data required by the format may not be appropriate for dissemination beyond the Cluster or sub-Cluster/country in which it was collected.

A 'Sample Areas' table records the locations of each sample area within a demonstration site, and assigns each sample area to a land-use stage and field type. A 'Plot Descriptions' table records bio-physical and organizational aspects of each surveyed plot (*sensu* Brookfield, Stocking and Brookfield 1999). A 'Species Data' table records agro-biodiversity data for each surveyed plot. A 'Tree Data' table records diameter and height measurements of trees (we suggest a minimum diameter limit of 5 cm at 1.3 m height) for each surveyed plot. A 'Utility Data' table records categories of use as well as specific uses of plants tallied within each plot. We separated the Utility Data table from the Species Data table to permit easy securing of that data from general use due to real or potential IPR issues.

Data collection forms

Figure 2 (page 10) illustrates a set of example data collection forms which may provide useful models for field use by Cluster personnel. These forms were designed to facilitate easy transfer of field data into the database tables. 'Species Data' and 'Utility Data' forms were combined to facilitate the fieldwork.

We recommend that each Cluster acquire a copy of the Microsoft Access software and additional available training materials in the appropriate language, and that one or more individuals be given clear responsibility for maintaining the database. In the USA, the software generally sells for $300–400 but academic prices are as low as $99. English language training materials are available at http://www.viagrafix.com for US$160 plus shipping. Development of within-Cluster expertise in database applications will both facilitate the agro-biodiversity work and contribute significantly to the capacity-building mission of PLEC.

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BOX 2

ATTRIBUTES REQUIRED OF THE NEW EXPERT
Comments by Prof. E. Laing, University of Ghana

- Enquiring mind, research-minded; with desire to know and understand things in all respects;
- Ability to work in a team, whether as a leader or as an ordinary team member;
- Ability to communicate clearly in the right register for the target audience;
- Strong advocate for the group or community;
- Genuine desire to help; enthusiastic about his role; outgoing;
- Gets jobs done; achieves operacy (de Bodo);
- Shares rewards with the rest of the team or community;
- Serves as an effective link between the group or community and other specialists or experts; a conduit between the technical advisors and the community.

Table: COMPARISON OF THE OLD STYLE EXPERT AND THE NEW STYLE EXPERT

Aspect	**Old style expert**	**New style expert**
Dispensability	Indispensable	Dispensable
Role in team	Dominant; dictates	Contributing member
Sharing	Business terms of charges for service	Willing to share (Luke 12:48)
Emotional attachment link	Separated; objective	Team; community; not an external provider of aid
Health status	Indifferent	Vigorous health with reserve energy
Documentation aspects	Yes, restricted to objective	Yes, to include subjective, management, diplomatic and inter-personal aspects

Figure 1 Database structure

DATABASE NAME: Demonstration Site Name (e.g. Baka)

TABLE 1 Sample Areas

Cluster Name	*Country/ sub-Cluster name*	*Group Name*	*Demo. Site Name*	*Sample Area Location*	**Sample Area Number*	*Land-Use Stage*	*Field Type*	*Date (yymmdd)*	*Researcher(s)*	*Farmer(s)*	*Note(s)*

TABLE 2 Plot Descriptions

**Sample Area Number*	**Plot Number*	*Plot Size (m)*	*Land Tenure*	*Resource Tenure*	*Elevation (m)*	*Steepness (%)*	*Aspect (azimuth)*	*Soil Type (local name)*	*Moisture Status (local name)*	*Date (yymmdd)*	*Researcher(s)*	*Farmer(s)*	*Note(s)*

TABLE 3 Species Data

**Plot Number*	*Local name*	*Scientific name*	**Species I.D. Number*	*Abundance*	*Utility (yes/no)*	*Date (yymmdd)*	*Researcher(s)*	*Farmer(s)*	*Notes*

TABLE 4 Tree Data

**Plot Number*	*Tree Tag Number*	*Local name*	*Scientific name*	**Species I.D. number*	*Diameter (cm at 1.3 m height)*	*Height (m)*	*Researcher(s)*	*Farmer(s)*	*Date (yymmdd)*	*Notes*

TABLE 5 Utility Data

**Plot Number*	*Local Name*	*Scientific Name*	**Species I.D. Number*	*Food*	*Medicine*	*Construction*	*Crafts*	*Commerce*	*Other*	*Notes*

Figure 2 Sample Data Collection Forms

Sample Areas

DATE:	RESEARCHER(S):	FARMER(S):
CLUSTER:	COUNTRY/SUB-CLUSTER:	GROUP:
DEMONSTRATION SITE:	SAMPLE AREA LOCATION:	
SAMPLE AREA NUMBER:	LAND-USE STAGE:	FIELD TYPE:
NOTES DESCRIBING SAMPLE AREA:		

Plot Descriptions

DATE:	RESEARCHER(S):	FARMER(S):
SAMPLE AREA NUMBER		
PLOT NUMBER:	PLOT SIZE:	
LAND TENURE:	RESOURCE TENURE:	
ELEVATION (m):	STEEPNESS (%):	ASPECT (AZIMUTH):
SOIL TYPE (local name):	MOISTURE STATUS (local name):	
NOTES DESCRIBING PLOT:		

Species and Utility Data

DATE:	RESEARCHER(S)	FARMER(S)	PLOT NUMBER:

SPECIES				UTILITY						
Local name	Scientific name	Species I.D. Number	Abundance	Food	Medicine	Construction	Crafts	Commerce	Other	Notes:

Tree Data

DATE:	RESEARCHER(S)	FARMER(S)	PLOT NUMBER:

Tree tag Number	Local name	Scientific name	Species I.D. Number	Diameter (cm)	Height (m)	Notes:

PAPER FROM THE DEMONSTRATION ACTIVITIES ADVISORY TEAM (DAT)

DAT: FACILITATING THE EXCHANGE OF EXPERIENCES ON DEMONSTRATION ACTIVITIES[1]

Miguel Pinedo-Vásquez
Center for Environmental Research and Conservation, CERC
Columbia University

Background

The goal of the Demonstration Activities Advisory Team (DAT) is to provide advice on planning and conducting appropriate demonstration site work. The role of the DAT should not be understood as an attempt to institutionalize a single PLEC model for demonstration activities for or by smallholders. DAT brings experiences gained in some Clusters to help other PLEC Clusters that are behind schedule in carrying out demonstration activities. DAT provides an opportunity to share the practical steps as well as the concepts that we found successful in conducting demonstration activities in our own PLEC Clusters. We hope that our experiences will help members of other Clusters with various aspects of demonstration, including selecting expert farmer-demonstrators and establishing demonstration plots in agricultural, agroforestry and forested areas where production, management and conservation activities are carried out by smallholders.

Although the simple definition of DAT as a tool for sharing experiences among Clusters fits within PLEC's main demonstration philosophy, there are important conceptual and practical issues that can limit DAT's mission. As participants of PLEC and witnesses of the process through which PLEC activities are implemented, we all are aware of the difficulties that continue to exist concerning demonstration activities and demonstration sites. Despite the publication of site-specific examples, and documents explaining why demonstration activities are important, and despite the continuing discussion of reasons why PLEC is promoting demonstration activities, some participants still do not fully understand why, as senior scientists, we are asked to conduct demonstration activities.

In the first part of this short article we attempt to answer this question, and another that some participants are still asking, regarding the originality and uniqueness of demonstration activities proposed by PLEC. The simple and direct answers presented in

[1] DAT currently has two members, Dr M. Pinedo-Vásquez and Professor Edwin Gyasi. A third member is to be added in 2000. Pinedo-Vásquez and Gyasi visited Papua New Guinea in August 1999, and reported separately. When Pinedo-Vásquez visited Canberra after leaving Papua New Guinea, he proposed a paper such as this one, to be jointly authored by himself and Gyasi. He has since drafted this paper during a heavy teaching term broken by two visits to Peru. By the time it was complete, most of this issue of *PLEC News and Views* was already formatted, and we wanted the paper immediately. We therefore asked Pinedo-Vásquez to let us have it under his own name, without taking the further period of time that would have been required to achieve a joint text with Gyasi (HB for joint editors).

this article should convince members that, *pace* their in-depth research or science backgrounds, PLEC demonstration activities constitute important and rewarding uses of their expertise.

Suggestions are included in a second section concerning to whom demonstration activities should be directed and how to select the participants. We list a number of reasons why demonstration activities should be directed to all social groups working in rural areas on development and conservation issues, and why among all social groups smallholders are the main targets of demonstration activities.

A separate section includes comments and recommendations on how to work with expert farmers and what role they should play in the whole process. What expert farmers can demonstrate to other farmers and technicians is then discussed.

Are PLEC demonstration activities equivalent to extension and training programs implemented by governmental and non-governmental agencies?

PLEC's demonstration activities and demonstration sites are based on field experience and are not copies of the traditional extension and training models that are implemented by most governmental and non-governmental agencies. By implementing demonstration activities, however, we should be able to provide multiple benefits to rural agencies that are conducting extension and training in the countries where PLEC is operating. PLEC, for instance, can help improve the services that are provided by governmental and non-governmental agencies to rural people, and find alternatives for preserving the agrodiversity and agro-biodiversity that rural societies maintain in their landholdings. In addition, we can help governments to increase the current rates of return from funds invested in rural extension and training programmes.

These and other important contributions can be achieved by developing innovative approaches, which PLEC is offering by promoting demonstration activities that are based on smallholder production and management technologies. Perhaps for the majority of us the PLEC idea of 'farmers demonstrating to farmers, or farmers learning from farmers' is not new, but what may be new is that some PLEC Clusters propose to monitor, record and analyse the processes and events that are part of demonstration activities.

Demonstration activities that are not merely copies of those implemented by agrarian agencies require a considerable level of scientific and technical knowledge. Their design and planning should not be left to field assistants. Certain senior members of Clusters have mentioned that they worry that PLEC requires them to be rural extensionists and not the highly prestigious scientists that they are. In addition, some natural scientists have suggested that since they are not rural sociologists, PLEC should not ask them to engage in demonstration activities. Perhaps understanding that PLEC is **not** merely reproducing old patterns, but is exploring new approaches to rural extension and training, as well as research, can clear up most misunderstandings and change the viewpoints of those of our PLEC colleagues who have been unclear. Such shifts in attitude are necessary if DAT is to perform its mission. Should an attitude of rejecting all exchange of experiences about demonstration activities persist among a few PLEC scientists, we must question why these few dissenters choose to remain within the PLEC family.

The majority of PLEC members clearly understand the differences between the demonstration activities promoted by PLEC, and the traditional training activities conducted by most governmental and non-governmental agencies; but some do not. We believe it is important to reiterate and emphasize the essential differences in the PLEC approach. The aim of PLEC demonstration activities is to facilitate farmer-to-farmer exchange of knowledge about particularly productive and diversity-enhancing technologies. Villagers who participate in demonstration activities are free to try or reject the technologies that are demonstrated by the experts. PLEC demonstration activities are also different from traditional agricultural demonstrations since, through PLEC activities, villagers learn and exchange experiences with the farmer-demonstrators by working together in fields managed by villagers, not by sitting in classrooms or by being told what they are to understand from observing experimental fields.

Toward whom should demonstration activities be targeted?

PLEC has provided the Clusters with several articles on demonstration activities, delineating the appropriate target groups and social groups who should participate (see *PLEC News and Views* Nos. 11, 12 and 13); yet the concept appears to remain unclear to some PLEC members. All PLEC participants have a great deal of field experience. Some of us have our roots in rural societies and agree that there are plenty of production and management systems and techniques that villagers can demonstrate to other people: but who these ‘other people’ should be remains a question for some.

The focus of PLEC on demonstration is based on the principle that farmers are always teaching and learning from other farmers. In addition, in most rural societies there are individuals or families who are more creative in finding solutions to common problems such as low rural incomes, introduction of new varieties, and other problems associated with changes in the social and natural landscape. One of the most important products of such mutual exchange of knowledge in smallholder societies is the agrodiversity and agro-biodiversity that we find in village landholdings.

PLEC recognizes the importance of smallholder technologies and aims to promote them at the local, regional and national level, by directing demonstration activities toward different social groups living in the communities and regions where PLEC Clusters are operating. For instance, in Amazonia and West Africa, smallholders living within our Cluster sites and in neighbouring villages are the main participants in demonstration activities. In addition, researchers and technicians working in NGOs, governmental environmental and development agencies, as well as students from local universities, are also active participants in PLEC demonstration activities.

This year, the Amazonian Clusters with great success brought together farmers from several widely-scattered sites and organized demonstration activities directed to selected farmers from these different regions of Amazonia. In Ghana, the participation of farmers in demonstration activities is increasing and the PLEC team is integrating farmers from communities in neighbouring regions into work in established demonstration sites. Members of the PNG team have identified two main social groups for targeting demonstration activities. The first group is composed of smallholders living in villages within the area of influence of the PLEC team. The second group includes technicians working for governmental and non-governmental institutions, especially those collaborating with development and conservation projects. These and other ongoing experiences can certainly help other Clusters to identify social groups that can be the direct beneficiaries of demonstration activities. Once the target social groups for demonstration activities are identified and agreed upon, it is easier to decide upon the kinds of production, management and conservation experiences and technologies that should be featured in demonstration activities for each group.

Integrating visits and 'working expeditions' as part of demonstration activities, building bridges between expert farmers and villagers and delegating responsibilities among members of the team

Based on past experience, it is evident that demonstration activities should be designed to help farmers to teach farmers. Selected local experts should actually show the results of their production and management techniques. Since farmers (like most of us) tend to believe what they see, we recommend that several visits or 'working expeditions' be made to the fields, fallows, house gardens, orchards and forests owned by the farmer-instructors. 'Working expeditions' have been very successful in Amazonia. They are based on traditional forms of farm work groups (*mutirão* in Brazil; *minga* in Peru). The 'students' learn planting or other management techniques by actually working in the fields of the farmer-instructors. PLEC provides all food and other refreshments and records the process, including the very interesting discussions among the group that invariably take place.

Visits or working expeditions help farmers learn from farmers, and one of the key elements that make demonstration activities attractive to the majority of farmers is that they help expert farmers to be recognized and respected by the other members of the community, particularly by community leaders. A strategy used by Amazonia-PLEC members is to be a bridge between expert farmers and technicians working for a variety of governmental and non-governmental agencies. We have enhanced communication between farmer-experts and scientists and other professionals on a variety of issues. One important contribution has been the passing on of knowledge held by rural folk on the ecology and biology of species and ecosystems, to conservation organizations. This should help increase the chances of success of regional conservation programs. We have found generally that the level of local peoples' acceptance and recognition of farmer-experts has greatly increased since PLEC started promoting these activities.

Although the success of demonstration activities depends mainly on identifying and selecting appropriate expert farmers, and disseminating specific technologies used by them in such a way that makes their impacts easily seen, the composition of the PLEC team and the attitude of each member in relation to farmers is also an important determinant of success. In the majority of PLEC Clusters, most members have experience and have developed strong relationships with farmers. In the few instances where members have not seen the need for at least establishing a working relationship with farmers, such attitudes greatly reduce the chances of demonstration activities having a significant impact.

The integration of expert farmers in PLEC teams and the delegation of particular responsibilities to each member can facilitate the performance of demonstration activities and the establishment of demonstration sites. In Amazonia, for instance, two of our field assistants (who are sons of families living in each site) and the farmer-demonstrators have taken over responsibility for carrying out demonstration activities that are directed to farmers. The demonstrations directed to technicians, scientists and other people working in development and conservation agencies, are under the responsibility of the principal researchers. The expert farmers have obvious skills in explaining and demonstrating production and management techniques that they use, and the two field assistants have demonstrated a capacity for recording what is discussed in each demonstration activity, and monitoring the results at the household and community level.

Although the principal researchers participate in the execution of demonstration activities and the establishment of demonstration sites, their main responsibility is in planning, designing and evaluating demonstration activities. The production of written and graphic material for disseminating the results of the experiences remains the responsibility of the principal researchers. This example from Amazonia can help to build a team where each member knows his or her responsibilities in making demonstration activities a successful experience.

How to select farms and demonstration plots within them

One critical component in planning and conducting demonstration activities is the selection of farms and demonstration plots within them in agricultural and agroforestry areas and in managed forests. Another is the development of participant work on these plots on the farmers' land. The phrase 'demonstration plots' means the areas within designated farms that have been purposively selected together with the farmers.[2]

PLEC has produced written materials about experience in several regions (see *PLEC News and Views* Nos. 12 and 13), and on where and how such farms and plots within them should be designated. To those PLEC participants who are still unclear we point out that we have had great success in setting up demonstration plots on the landholdings of selected expert farm households, after first establishing a relationship of trust with them.

Not to overwhelm the team and the villagers, we recommend that groups select demonstration plots in a maximum of ten farm holdings. In Amazonia, an average of eight demonstration plots were selected in agricultural areas, twelve in agroforestry areas and four in managed forests, within the whole demonstration site region. PLEC participants should remember that what we need is quality and not quantity, and that large numbers of farms and demonstration plots, with many different activities, are very difficult to monitor, and the results almost impossible to document.

How to work in a partnership with expert farmers

The majority of Clusters have already identified and selected several expert farmers and are currently working with them. A few are experiencing difficulties in establishing working relationships with expert farmers. We previously identified as expert farmers those smallholders who are recognized in the villages as the best (often the most innovative) producers or managers of resources (Padoch and Pinedo-Vásquez 1999). Expert farmers are known by other villagers to have the best gardens, to plant a greater diversity of crops and produce the highest yields per crop. In addition, some of the selected expert farmers are the ones who have managed to diversify their agroforestry fields as well as to be engaged in managing forests for multiple use, including the diversification of habitats for wildlife. In Amazonia, expert farmers also include the ones who are the best managers of lakes and streams for the production of fish and shrimp.

Many benefits are gained by establishing a partnership with local experts. In several Clusters, for instance, experts helped to identify the species and varieties of crops and other plants during the biodiversity surveys conducted in the landholdings of selected farmers. We found that the participation of experts in biodiversity surveys greatly facilitated the development of working relationships with landholders, and guaranteed their participation in demonstration activities. We found that some Clusters are missing this opportunity for establishing good relationships while they are conducting biodiversity surveys, because they see farmers as simply informants and not as experts with vast knowledge of their

[2] A distinction is therefore drawn between the purposively-selected demonstration plots referred to in this paper and the much smaller 'sample plots' named by BAG in their paper (p.7). The latter are used for biodiversity inventory purposes.

environment. There is need to abandon these traditional attitudes where they still prevail. Expert farmers are very approachable people.

In demonstration activities, where the main role is played by village experts, PLEC participants need to establish a partnership in which the roles and benefits of the villagers are clearly defined. Based on our experience, experts need to be consulted on when demonstration activities should be conducted, where to designate demonstration plots, how many demonstration activities can be carried out, how many people can visit the expert farmers' landholdings, and other related questions. In some cases experts should be able to tell the team members which families or villages should not participate in the demonstration activities, nor be invited to visit specific demonstration plots.

Incentives should be offered to the village experts as a way of building good relationships. In Amazonia we consulted the expert farmers on the kind of incentives that they wanted. All of them showed great interest in getting seeds, seedlings and other plant materials; in a few cases they requested chickens, ducks, etc. We managed to provide most of the plant materials and domestic animals that were requested and in the majority of cases they in turn distributed the plant materials to their neighbours and relatives. The farmer-demonstrators also suggested what we should provide to make the demonstration activities a success with other villagers. All insisted that the team provide food and drinks for the meetings. The Amazonia team regularly furnishes food, drinks and other materials for people participating in the demonstration activities. In addition we agree to pay each expert $20 per month for their services and for allowing us to designate demonstration plots in their landholdings. Based on the reality of each region where the Clusters are operating, similar strategies in developing partnerships with their selected experts can be tested.

True partnerships between the team and the selected experts will help PLEC members to identify what technologies might be especially appropriate for demonstration and how it should be done. The majority of Clusters have collected very large data sets on production and management practices. The PLEC teams should use this knowledge, and the advice of experts with whom they are already working, to choose the technologies to be demonstrated and the experts who can show the results of using such technologies.

Finally we express our belief that DAT can facilitate the exchange of experiences among Cluster members and increase the chances of making PLEC a successful experience. Perhaps our main concern is that this opportunity be used to enhance the vision we and others have of smallholders throughout the world not as only marginalized poor people but also as holders of great knowledge of their environments, as well as developers of efficient, effective, and ingenious ways of managing the world's biodiversity.

We also believe that if our PLEC colleagues let farmers be our teachers, field experiences can become more interesting and more challenging. Working with farmers both succeeds and is thoroughly enjoyable.

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SOME PLEC DEFINITIONS, WITH CODES FOR DATA-BASE PURPOSES

from the Editors

It has become evident that the definitions set out in *PLEC News and Views* 13, and in this issue, in both cases elaborating but not varying the definitions in the Project Document, need to be brought together. The object is to avoid confusion not only between the inventory work and the collaborative work with farmers within PLEC, but also with other types of research and extension work done by governmental and non-governmental agencies. Suggested codes for database entry are added.

TERMS FOR DEMONSTRATION-SITE WORK AND AGRODIVERSITY ANALYSIS

Demonstration site (D1)

A place or area in which PLEC scientists, farmers and other environmental stakeholders carry out work in a participatory manner to conserve and even enhance agricultural and biological diversity and the bio-physical resources underpinning it. It is an area where the scientists work with farmers in the creation of projects that are the farmers' own, and where, together, the scientists and farmers demonstrate the value of locally-developed techniques and technologies. It belongs to the farmers, in that the work done in a demonstration site is the farmers' own. The role of scientist is to facilitate, measure and evaluate local methods, and help to select the method most likely to be sustained (Abdulai et al., this issue). The demonstration sites are continuous small areas at landscape level, within which inventory of biodiversity and agrodiversity is also carried out (Project Document).

Demonstration sub-site (D2)

One community or group of farms within a larger demonstration site, where such distinct community groups exist (Abdulai et al., this issue).

Selected farm (D3)

Farm within a demonstration site, usually the holding of an 'expert farmer', on which specific monitoring, experimental and demonstration site activities are conducted (Pinedo-Vásquez, this issue).

Demonstration plot (D4)

Specific plot of land, within selected farms, on which monitoring of experimental and demonstration activities is conducted (Pinedo-Vásquez, this issue).

TERMS FOR BIODIVERSITY INVENTORY

Land-use stage (S1)

A general land-use category based on vegetation structure and requiring a plant-species diversity sampling strategy different from that of other such categories (Zarin, Guo and Enu-Kwesi *PN&V* 13).

Field type (S2)

A specific land-use category which corresponds to the finest-scale land-use division made by the farmers and researchers (Zarin, Guo and Enu-Kwesi *PN&V* 13). Field types are assemblages of individual fields, managed sections of fallow or forest, agroforests and orchards, in which a similar characteristic set of useful plants is encountered, and in which resource management methods have strong similarity (Brookfield, Stocking and Brookfield *PN&V* 13).

Sample area (S3)

A contiguous parcel occupied by one field type and selected for data collection (Zarin, Guo and Enu-Kwesi *PN&V* 13).

Sample plot (S4)

The portion of a sample area from which biodiversity data are collected (Zarin, Guo and Enu-Kwesi *PN&V* 13).

Nested plot or sub-plot (S5)

A smaller sample plot located within a larger sample plot (Zarin, Guo and Enu-Kwesi *PN&V* 13).

A DIARY OF MEETINGS ATTENDED BY PLEC MEMBERS, MARCH–NOVEMBER 1999

(A record of all meetings within PLEC, and attended by PLEC members with presentations related to PLEC, is kept by the Managing Coordinator. This is his record. There may have been other meetings attended by PLEC members, not reported to Liang)

1 *Technical workshop* was organized by PLEC-Uganda, Makerere University, Kampala, Uganda, 20 March 1999. Associate Scientific Coordinator attended.

2 *The Annual Meeting of UNU/PLEC Papua New Guinea Cluster* was held at the National Research Institute, Port Moresby, Papua New Guinea, from 25–26 March 1999. Principal Scientific Coordinator attended.

3 *Workshop on five years of PLEC experiences in field methodologies of conserving agriculture and biological diversity in Ghana* was organized by PLEC-Ghana in Kumasi, Ghana, 25–27 March 1999.

4 *International seminar on fallows in tropical Africa*, Dakar, Senegal, 13–16 April 1999. One member of Guinée sub-Cluster presented PLEC work.

5 *IFAD regional workshop* in Bangkok, Thailand, 19–21 April 1999. One member of Thailand sub-Cluster attended.

6 *Field training workshop on methodology* was organized by China Cluster, Yunnan, China, March 27–April 8 1999. Associate Scientific Coordinator chaired.

7 *International seminar on campesino agrodiversity*, Toluca, Mexico, 12–14 May 1999. A PLEC team including Principal Scientific Coordinator attended.

8 *The 3rd Meeting of PLEC Management Group* was held at the Universidad Autónoma del Estado de México, Toluca, Mexico, 15–18 May 1999. At its conclusion the *PLEC Coordination Team* met on 18 May 1999.

9 T*he 4th Meeting of the Joint UNESCO-UNU-TWAS Programme on 'South-South cooperation on environmentally sound socio-economic development in the humid tropics'* 19–24 May 1999, Xalapa, Mexico. A PLEC team represented UNU at the meeting.

10 *The Second Meeting of Biodiversity Advisory Group (BAG)* was held at the University of New Hampshire, USA from 20–24 May, 1999.

11 The *10th International Soil Conservation Organization Conference*, 23–28 May, 1999, West Lafayette, Indiana, USA. Associate Scientific Coordinator and one member of Tanzania sub-Cluster presented PLEC at the Conference.

12 *Papua New Guinea Cluster Planning Meeting* was held on 9 June 1999, at the Australian National University, Canberra. The Principal Scientific Coordinator chaired.

13 *The STAP expert group workshop on land degradation inter-linkages in the GEF*, 14–16 June, Bologna, Italy. The Principal Scientific Coordinator was invited to attend.

14 *International Conference Symposium towards co-operation utilization and coordinated management of international rivers*, June 25–30, 1999, Kunming, China. Managing Coordinator and three Chinese members attended.

15 An *English strengthening training course* was organized by China Cluster with Yunnan Normal University, August 1–September 15 1999, Kunming.

16 *Salzburg seminar special session: sustainability, education and the management of change in the tropics*, August 22–27, 1999, Salzburg, Austria. Chinese member attended.

17 The *6th Meeting of International Geographical Union Commission on Land Degradation and Desertification*, Perth, University of Western Australia, 20–28 September 1999. Associate Scientific Coordinator presented PLEC at the meeting.

18 *The 4th PLEC West Africa Cluster regional workshop* was organized by Guinée sub-Cluster in Pita, Guinée, 6–8 September 1999. Principal Scientific Coordinator attended.

19 *UNU and IWRA workshop on transboundary waters: the Salween River basin*, Chiang Mai, Thailand, from 13–16 September 1999. Managing Coordinator and one Chinese member attended.

19 The *2nd Asia-Pacific Conference on sustainable agriculture*, Phitsanulok, Thailand, 18–20 October, 1999, organized by the American Association for the Advancement of Science. One member of China Cluster presented PLEC at the conference.

20 *Tanzania workshop* has been organized by Tanzania sub-Cluster, Arusha, Tanzania, 1–2 November, 1999.

21 The *third session of the Conference of Parties to the United Nations convention to combat desertification*, Recife, Brazil, 15–26 November 1999. One member of Amazonia Cluster will present PLEC at the GEF workshop during the conference.

PAPERS BY PROJECT MEMBERS

MAPPING OF SETTLEMENTS IN AN EVOLVING PLEC DEMONSTRATION SITE IN NORTHERN GHANA: AN EXAMPLE IN COLLABORATIVE AND PARTICIPATORY WORK

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with assistance of
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[9] A local farmer and a PLEC local facilitator

Background and objective

Settlements are localities where people live. They constitute the principal focal points of human activities. As such, settlements are a first point of call in virtually all field-oriented studies of human activities. By the pressure exerted through their spacing, morphology, population size and cultural or socio-economic activities, settlements, to a very significant extent, determine bio-physical status and the character of farming and other forms of land use. Also, precisely mapped, settlements are an important basis for development of geographical information system, which is very important for storing, retrieving and analysing spatial data.

Thus, knowledge of the spatial patterning of settlements is a necessary first step towards study, understanding and improved management of land and related environmental resources.

Against this background, we sought to map settlements and certain associated geographical features to advance the basic PLEC goal of conserving agricultural and biological diversity, in an evolving PLEC demonstration site centred on Dugu-Song in the 'guinea-savanna zone' in northern Ghana (Figure 1).

The approach was participatory and collaborative. It involved participation of local rural people, and collaboration between scientists and students of the southern and northern Ghana PLEC teams based, respectively, at the University of Ghana, Legon, and the University for Development Studies, Tamale.

The object of this paper is to share the experience gained from the participatory and collaborative endeavour at Dugu-Song.

Demonstration site

Broadly speaking, a demonstration site may be said to be a place where PLEC scientists, farmers and other environmental stakeholders carry out work in a participatory manner to conserve and even enhance agricultural and biological diversity and the

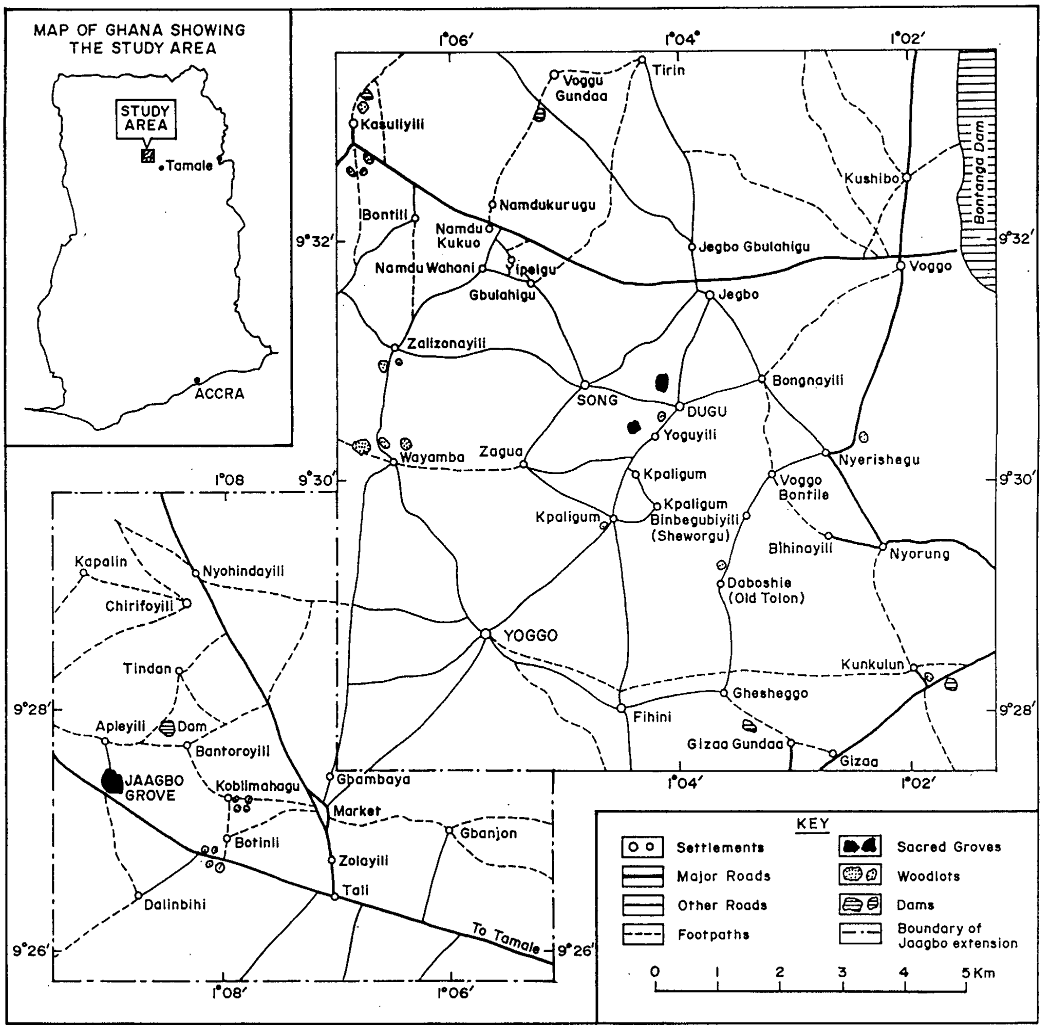

Figure 1 Map showing the Dugu-Song demonstration site

Note: Since the writing of this paper the demonstration site has been renamed Bongnayili-Dugu-Song

bio-physical resources underpinning it. It is an area where the scientists 'work with farmers in the creation of projects that are their [the farmers'] own, and [where, together, the scientists and farmers] demonstrate the value of locally-developed techniques and technologies' (Scientific Coordinator 1997:4). It belongs to the farmers, in that the work done in a demonstration site is the farmers' own. The role of scientist is only to facilitate, measure and evaluate local methods, and help to select the method most likely to be sustained.

The sites may vary in size, and a site will contain sub-sites, selected farms and patches. However, sites must be at the local or perceptible landscape level (United Nations University Programme 1998).

In Ghana, the PLEC operational definition of a primary demonstration site area is a small-farmer area measuring approximately 10x10 km = 100 sq km. Such an area is 'small enough to facilitate in-depth field work, but large enough to show significant internal agroecological variations, and to permit study by aerial photographs and satellite imagery' (Gyasi 1996:3; WAPLEC 1995). The final sites lie within this area. Increasingly, the primary sites, like those developed in southern and central Ghana, contain sub-sites.

Historical and socio-economic profile of Dugu-Song, the evolving demonstration site

Dugu and Song are twin villages located approximately 1.5 km apart (Figure 1), about 8 km west of Tamale (capital of Northern Region), in Tolon/Kumbungu, a district in western Dagomba which is inhabited predominantly by the Dagbon people.

The 100 sq km area centred on Dugu-Song was identified as a potential PLEC demonstration site, firstly on the basis of its agroecology, which is typical of that of the northern savanna ecosystem, a focus of PLEC work. Secondly, the location is close enough to Tamale to facilitate frequent visits by the Tamale-based northern Ghana PLEC team. Thirdly, nearby is the biologically rich Jaagbo sacred grove, a focal point for ecosystem conservation under CIPSEG (Co-operative Integrated Project on Savanna Ecosystems in Ghana), a promising aborted project which PLEC hopes to revive (UNESCO 1996; Agyepong et al. 1999). Moreover Dugu and Song are important seats of Chiefs and centres of traditional culture and, therefore, function as central places.

On the basis of oral history, field observations and available literature, the traditional small-farmer essentially subsistence agrarian economy focused on yams and guinea corn (sorghum), is in transition towards a commercial one increasingly focused on maize, groundnuts (peanuts), rice and cassava, but still integrating livestock, especially cattle, sheep, goats and fowls, on a significant scale. Other crops which, like the rest, are grown once within the year in accord with the uni-modal rainfall, include cowpea, soyabean, sweet potato, tomato, okra and a variety of other vegetables. A significant agricultural feature is compound farming, whereby areas immediately around compound houses are intensively cropped.

Agricultural modernization is in response to growing population pressures and market demands. It is reflected by: dams and irrigation; more exotic crops; mechanization; use of chemical fertilizer; and associations of male and female farmers that maintain bank accounts.

There is considerable division of labour along gender lines. Men do more fieldwork but the responsibility of carrying farm produce and of harvesting sheanuts and processing them into butter, lies mainly with the females. These and other manifestations of agrodiversity including those noted above, are a major target of PLEC work (Oppong 1973; Staniland 1975; UNESCO 1996; Agyepong et al. 1999)

Global positioning system (GPS) of determining spatial location

Location of the settlements was determined by the global positioning system (GPS).

The GPS system is designed specifically for geographic mapping, and for geographic information system (GIS) applications, or for the creation of geographic databases. It involves the use of a handheld receiving device that determines location by relating to a constellation of artificial satellites orbiting the earth. A GPS receiver computes distance from a satellite on the basis of travel time of a signal transmitted from the satellite. Using such measures of distance from at least three satellites in a two-dimensional mode (2D), and four satellites in a three-dimensional mode (3D), a receiver calculates its position by a coordinate system of latitude and longitude, or by

Universal Transverse Mercator (UTM). The receiver is also capable of calculating its altitude and velocity or time.

The magic of the GPS is its ability to almost instantaneously determine location within a small margin of error ranging from 30 metres to less than a metre (Ardo and Pilesjo 1992; Hoffman-Wellenhof, Lichteneger and Collins 1993).

The mapping

In accordance with local custom, the mapping was preceded by a meeting at Dugu with the Chief and a group of his people. There were over a hundred of them, all males, made up of about 40 percent adults and 60 percent children. Generally, at such meetings the females do not feel comfortable with the presence of the males (Plate 1).

After the Chief had granted approval, the mapping started at Dugu. It proceeded according to two sectors on the basis of two sub-teams, each led by a local person. One team proceeded entirely by foot, whilst the other proceeded by both foot and motor vehicle.

Using Garmin 12XL receivers, location of settlements and other relevant features was identified as GPS 'fix'. This was assisted by local residents, who also provided or confirmed names of the settlements, and furnished information on such pertinent features as sacred groves, community woodlots and grazing fields, dams and other watering points, KVIP (Kumasi Ventilated Improved Pit) toilets and schools.

At Song, the team paused for a courtesy call on the Chief and five of his elders. This provided an opportunity to further explain PLEC.

Although Jaagbo sacred grove falls outside the emergent demonstration site, the mapping was extended to cover it because of the plan to integrate it into Dugu-Song work (Figure 1).

Plate 1 Meeting of PLEC researchers and the Chief and people of Dugu

Table 1 Format used for recording GPS and related information in the field

Locality	Long.	Lat.	remarks/notes
Dugu	01°03'54.4"	09°31'03.8"	Sacred grove; community grazing ground
Song	01°04'50.0"	09°30'58.5"	
Daboshie	01°03'59.3"	09°29'31.3"	Primary school
Namdu Kurugu	01°05'53.8"	09°32'32.9"	Community water resource (dam)
Namdu (Wahani)	01°05'72.0"	09°31'86.8"	Sacred grove
Voggo	01°05'63.0"	09°28'79.6"	Home of Jaagbo fetish priestess; serious gully erosion; high density of wells
Yogoyili	01°04'16.9"	09°30'43.8"	Bihimagu grove located west of community
Jaagbo sacred grove	01°09'10.7"	09°27'61.3"	Abandoned CIPSEG biodiversity conservation reserve
Chirifoyili	01°08'12.2"	09°29'08.6"	Residence of Wayamba Chief
Wayamba	01°06'45.7"	09°30'23.0"	Community woodlot

Information generated was recorded according to a format on a field sheet as illustrated by Table 1. A total of 45 GPS 'fixes', including 38 settlements, was recorded over the two-day survey period.

Subsequently, the locations determined by the GPS were plotted on map extracts from Ghana Survey Department topographical sheets to derive Figure 1. In some cases, positions determined by GPS did not coincide with their corresponding positions defined by geodetic coordinates on the topographical maps. This was because of the greater margin of error associated with the use of a single receiver, instead of three or more operating in the differential mode. In situations of this kind, we followed convention by using the geodetic co-ordinates on the topographical maps.

Output

An important output of the mapping exercise was identification of settlements not located on the official topographical maps, and correction of the position of those wrongly located, *e.g.* Binbegubiyili (Sherworgu). A second is insights into changes in the spatial structure of settlements, through confirmation of the continued existence or otherwise of settlements, *e.g.* Namdu Kukuo, Yipelgu, Kpaligum and Gbulahigu. Others include the location of other geographical features having significance for planned PLEC work, and the social awareness of PLEC engendered by the exercise.

Conclusion

The Dugu-Song mapping demonstrates that the system of GPS could, cost-effectively, be employed to further PLEC work, particularly if the accuracy of the mode of application system is improved. This could be achieved through the differential mode of operation, which involves the determination of position with reference to a 'base station' of the kind operated at Legon by the Remote Sensing Applications Unit (RSAU) of the University of Ghana, and at Kumasi by the Institute of Renewable Natural Resources (IRNR) of the University of Science and Technology.

But, above all, the Dugu-Song joint exercise demonstrates the feasibility of carrying out PLEC work through collaboration among various groups of PLEC scientists with participation of farmers and other local people.

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AGRODIVERSITY HIGHLIGHTS IN EAST AFRICA

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East Africa is renowned for its high natural biodiversity. From the forested mountains of Western Uganda with remnant populations of gorillas, to the lush highlands of Central Kenya with intensive agricultural systems and the remarkable endemism of Tanzania's equatorial mountain chain, the whole region has a wealth of flora and fauna as well as a rich natural bio-physical diversity. Sharp contrasts over short distances in altitude, climate, vegetation, soils and hydrology contribute to this diversity. Rainfall variability and soil fertility change markedly between villages, as shown in Embu in semi-arid Kenya (Tengberg et al. 1998), which has important implications for the practices that local people follow, such as terracing or trash-lines.

Diversity is also depicted in society and demography, with widely different ethnic groups such as the Masai, Kikuyu, Arameru and Mwizi people. The role of cultural diversity interacting with biological diversity, encouraging active and inventive indigenous agricultural problem solving has been well-documented (Sumberg and Okali 1997; Prain, Fujisaka and Warren 1999). It helps to explain why, even with rapid population growth and densities varying from over 2000 per km^2 to less than 20 in drier parts, there are many examples of innovative agricultural practice throughout the region.

Consequently, East Africa is a natural candidate for the study of how local agricultural and land-use systems interact with this natural biodiversity and how, in turn, the biodiversity contributes to local livelihoods. The sustainability of rural livelihoods, especially in dryland areas of East Africa, is critically dependent on livelihood diversification supported by a variety of natural capital assets in soils, plants, ecologies and other resources (Ellis 1998)

This mutual support between land use and livelihoods on one side and biological diversity on the other is a particular feature of East Africa. In the face of considerable external pressures, such as declining areas of land per person and rapidly changing market economies, land users are coping by exploiting biodiversity while at the same time demonstrating their protection of it if the circumstances are right. This article highlights some of the findings from the pilot phase and first year of GEF-funding for PLEC in East Africa. It is highly selective and gives only a partial picture of the many interesting results being derived.

EAPLEC's original objective during PLEC's pilot phase was to examine the interaction between increasing population pressures, the intensified use of land, and associated effects such as migrations and rapid urbanization, and the various aspects of agrodiversity. East Africa is famous for the Machakos (Kenya) study entitled *More people, less erosion* (Tiffen, Mortimore and Gichuki 1994) where it was argued that intensification leads to more sustainable land use practices and improved livelihoods.

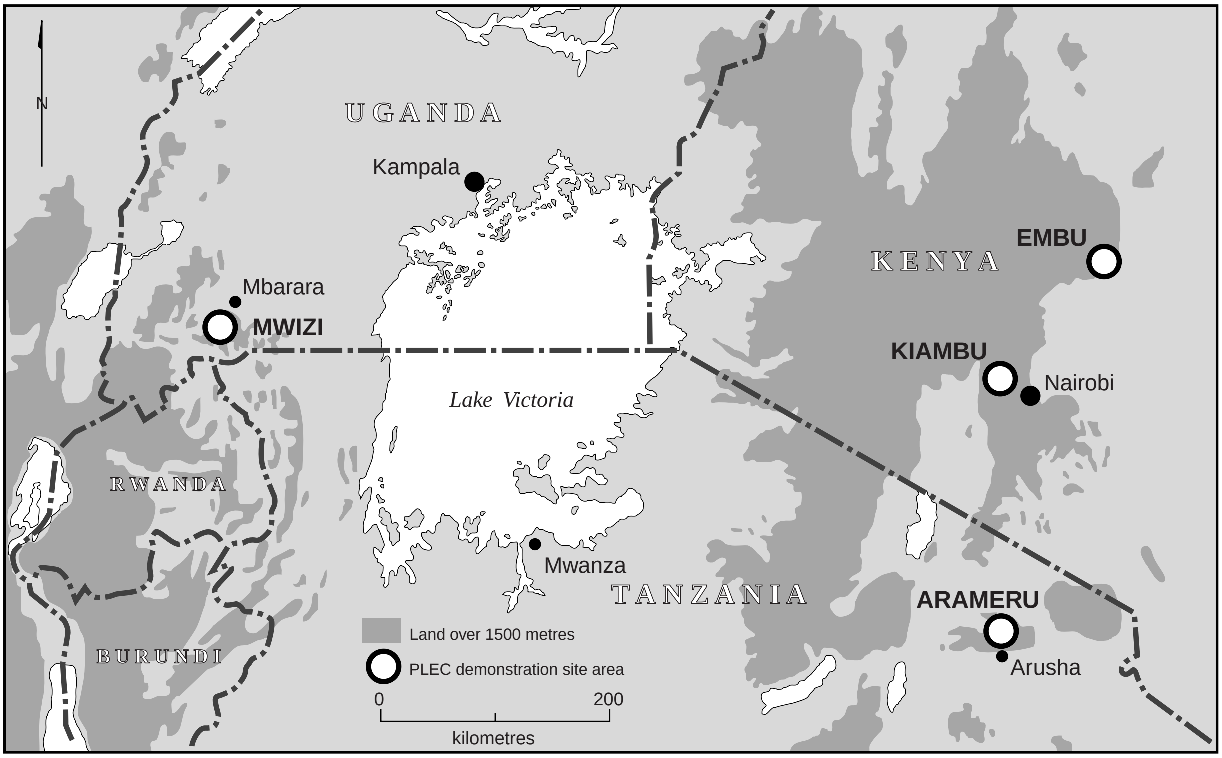

Figure 1 Location map of PLEC demonstration sites in East Africa

EAPLEC is now working on demonstration sites (see Figure 1), using the GEF-funded PLEC framework (Padoch and Pinedo-Vásquez 1999), from which it will be possible to gain detailed insights into farmers' strategies of managing biodiversity. The PLEC goal is to help farmers develop and conserve productive, sustainable and biodiverse land management systems. In East Africa, these systems consist of a wide range of managed land uses from forests to agroforestry, dryland cropping to intensive vegetable production, stall-fed livestock to rangeland.

Uganda and species richness in the landscape

Local processes of agrarian change often employ the biodiversity potential of different parts of the landscape (e.g. Mali: Simpson 1999) and the assimilation of introduced species (e.g. Nigeria: Phillips-Howard 1999). EAPLEC-Uganda has, therefore, undertaken a detailed recording of biodiversity across toposequences in the landscape, and a preliminary survey of farmers' practices in on-farm domestication (and thereby conservation) of wild species with medicinal properties.

Biodiversity was captured using a belt transect method to assess the species composition of each major land-use type representing the farming systems of Mwizi sub-county of Mbarara District. A Global Positioning System device located the transects, and approximately 2 km per day was covered. The results (Figure 2) indicate a steady increase in species richness downslope, where lower slopes have approximately twice the species of upper landscape units. The valley bottoms (not shown in the figure) are generally planted to pure stands of bananas with a thick managed surface mulch of organic residues. Mulching demonstrates an indigenous practice that is both valuable to livelihoods and conservative of agrodiversity, and which is special to this land-use type.

Differences in soil fertility and erosion status help to explain much of the pattern in Figure 2. Bananas, for example, are also planted on lower slopes where topsoil is not less than 24 cm thick. These plantations are well known for their variety of types of banana, as well as underplanting and edge-planting with other species. Deposition of soil from upslope is common in a banana stand. Conversely, the dominant annual cropping on the upper slopes has much lower biodiversity, higher rates of erosion and deficient soils. These steep upper slopes do, however, have significant wild species biodiversity amongst the grassland, shrubs and trees. It is here, where farming practices have lowest managed diversity, that there is the greatest threat. Not only are these generally the sites of settlements and trading centres, the cultivated land loses sediment and organic matter to the lower slopes. Nevertheless, even here, home gardens including bananas show that biological diversity can be managed and be productive on the poorer land.

In their demonstration sites in Mwizi, the Ugandan team will pay particular attention to the interaction between these landscape units and study how farmers manage this diversity.

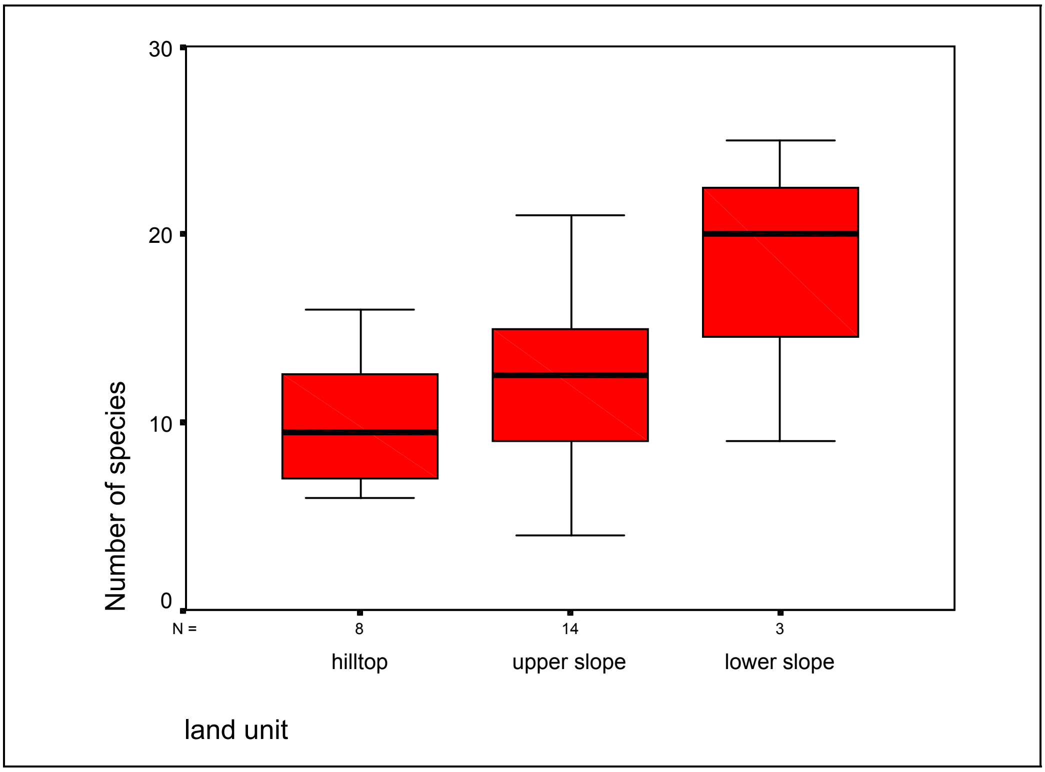

Figure 2 Species richness in different landscape units, Mwizi, Uganda

Farmers in Mwizi also have considerable interest in conserving medicinal herbs. Most such herbs occur in areas classified as 'bush' and least where annual crops are grown. Survey results showed that 57% of the Mwizi community ranked herbal medicines as their number one source of health care, and 80% indicated they obtained medicines from herbalists. 59% used herbs on their own land. However, as land pressure increases more herbs are transferred to managed plots and home gardens. In a community workshop, farmers reported that the expansion of agricultural land has deprived them of natural sources of wild plants for fuelwood and medicines. They are therefore increasing their efforts locally to conserve species and undertaking replanting on their own lands. These changes will be monitored on the demonstration sites, but already it can be deduced that farmers' management of some land use types is strongly supportive of maintaining biodiversity and enriching the general agrodiversity of the whole landscape.

Tanzania and its natural bio-physical and organizational diversity

The development of indigenous knowledge is itself complex and diverse (Sillitoe 1998). The PLEC demonstration sites in Arameru District in northern Tanzania well exemplify how this complexity translates to different ways of managing diversity. Two contrasting transects on the eastern and western sides of the slopes of Mount Meru by peoples who are ethnically distinct show important differences in how local farmers exploit the natural bio-physical diversity.

A preliminary analysis of organizational diversity using PRAs and consultations with key informants indicates a wide range of resource endowments. There are significant differences between different farmer categories in both total farm size and number of owned dairy cows. The poorest farmers have smaller plots and fewer cows than richer farmers. The majority of farmers (47%) belong to the average wealth category as determined by farm size, number of cows, type of house, farm implements used, number of women and level of education. Average farm size is about four hectares where the majority of poor farmers have less than half a hectare per household, while the majority of rich farmers have over one hectare per household. Similarly the average number of dairy cows per household is 2.2 with poor farmers having less than one cow and rich having about 3.3 cows. Both dairy cows and farm size are good wealth indicators. Farm size is largest in the agro-pastoral semi-arid landscape and smallest in high altitude, high rainfall landscape.

Organizational diversity is underpinned by a considerable natural diversity in soils. Fertility in topsoil as expressed by base saturation averages 70%, being lowest at high altitude with high rainfall, and highest in the low rainfall semi-arid landscape unit. Nutrient leaching due to high rainfall reduces soil nutrients at high altitude. Despite high rainfall, however, nitrogen is adequate (0.52%) for the high rainfall zone and deficient (0.06%) in the semi-arid landscape. Phosphorus is, on the other hand, extremely limiting at high altitude. The availability of nutrients N and P is strongly influenced by high levels of organic matter and by application of P in the high and middle altitude landscape units respectively. On the western side of Mount Meru, high sodium levels caused by past erosion and exposure of subsoils, as well as excessive alkalinity, are problematic. In contrast, the high altitude, high rainfall eastern side has deep, productive soils.

These differences in natural bio-physical diversity have a considerable influence on land use. The high altitude landscape is dominated by an agroforestry-based system with farmyard manure and crop residue inputs being widely applied. The coffee-banana agroforestry system on the eastern side maintains a deep fertile profile. This management has sustained livelihoods in the area for many years. The middle altitude, peri-urban agricultural zone concentrates on production of vegetables which need high levels of N and P, either naturally or artificially-applied. The majority of farmers apply farmyard manure (63%), and a few combine it with nitrogen fertilizer (11%). 9% use no inputs.

Thus, there exists a wide variety of cropping systems and land management practices. The middle altitude landscape unit has the greatest number (8) of cropping systems, influenced as it is by the market demand from nearby Arusha town. The low altitude, low rainfall landscape has the lowest diversity in cropping systems (5), because of reduced opportunities with moisture stress. The predominance of local cattle here that graze freely also prevents the development of more diverse cropping practices.

These differential resource endowments have enabled us to distinguish between farmer wealth categories, and to relate these to specific conservation practices (Figure 3).

Greater proportions of poorer farmers in our sample practise no conservation, whereas farmers in the medium wealth category regularly practise contour bunds, often strengthened by grass and trees. These distinctions will be further evaluated in our demonstration sites over the coming year.

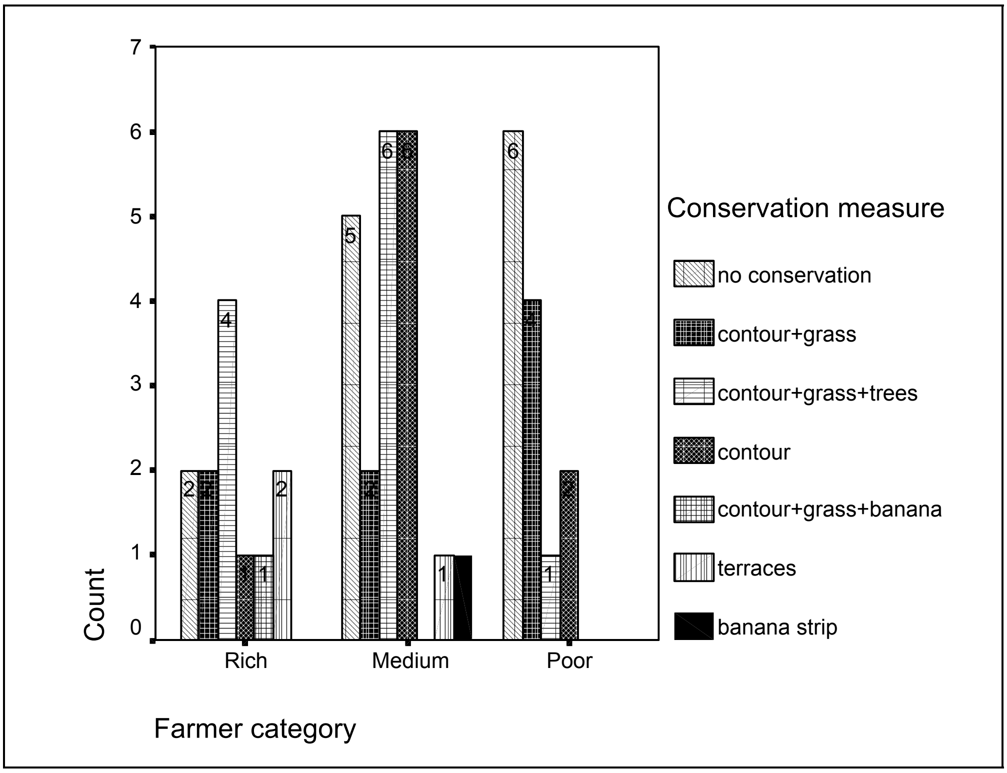

Figure 3 Land management by farmer category in Arumeru District, Tanzania.

Increasing biodiversity with intensification in Kenya

EAPLEC-Kenya has completed characterization of agrodiversity in transects in its two demonstration site areas of Kiambu and Embu districts. Results from Kiambu especially show interesting interactions between intensification, land tenure, production pressures and species diversity. Intensification is one interesting adaptation to external pressures, which combines greater production, the concentration of land-use activities on smaller, more fertile areas, and a greater use of agro-biodiversity (see case studies in Hinchcliffe et al. 1999). Additionally, adjacent more fragile areas (often forests in the Kiambu case) benefit in reduced exploitation.

The Kiambu site, situated 20 km west of Nairobi, is populated by industrious and enterprising Kikuyu who have migrated from other parts of the district. The influence of the urban market of Nairobi, with its 3 million people, is substantial. Settlement in Kiambu has continued progressively since the early part of the century by allocation of forest plots, with some new allocated settlement occurring even now in 1999. The study transect, at altitudes between 2200 to 1400 metres, has sampled agro-ecological zones ranging from humid montane forest to semi-arid highland.

Preliminary analysis of these surveys has revealed an unexpected relationship between major land-use types and biodiversity. Table 1 highlights some of the significant differences.

Table 1 Agrodiversity in major land-use types in Kiambu, Kenya

Land-use type	Main features	Average number crops and trees per plot	Total number of SWC practices	Number of domesticated animals
1. Natural forest	Protected, conserved natural forest mainly on hills	15	1	3
2. Planted forest	Government-owned tree plantations; mainly pine and cedar	9	2	3
3. *Shamba* system	Rotations of trees and food crops; a modified *taungya* system, where farmers are allocated forest land provided they look after planted trees	17	5	4
4. Smallholder tenured farms	Intensive smallholder farming of maize, vegetables, livestock	77	14	11
5. *Nyayo* tea zone	A buffer tea zone around government plantations of trees	1	1	3

Land-use system No. 4 has the largest average number of species of crops and trees per farm unit. This is attributable to the intensive management and the need for farmers to diversify their production opportunities for the market, as well as meet their different needs for food and cash. It results in a considerable variation of cropping types and planting patterns from farm to farm, which further increases agrodiversity at a landscape level. The planted forest has the lowest species diversity, and surveys have indicated that it has considerable land degradation due to erosion and runoff under the forest canopy. The *shamba* system also has a relatively low species diversity, exacerbated by the temporary tenure of the land by farmers and the regular removal of trees and undergrowth. In addition, during the cropping period, the *shamba* system is subject to degradation, as the farmers tend to 'mine' the stock of nutrients over which they only have temporary control, rather than manage the land. The *Nyayo* tea is a crop managed by the government and kept free of weeds and other plant species, and is also subject to land degradation.

Conclusion

EAPLEC is showing that, in this region of considerable demographic pressure and significant influence of the market, agrodiversity is flourishing. Farmers are coping in several of our land units both with these external pressures and with a large variability in climate and quality of land resources. They are doing this through diversifying their land-use types and farming systems, and by employing their differential resource endowments. Land uses involving trees are not necessarily conducive either to biodiversity or support to livelihoods, as witness the plantations and *shamba* systems in Kenya. Species diversity, however, is not the only (or even the most important) aspect of agrodiversity, as witness the Ugandan banana plantations with their surface mulch of organic residues, utilization of indigenous knowledge, and good environmental protection.

Diversity is being revealed at different spatial scales, using a variety of investigative techniques (Table 2). We have established much of the basic information at landscape level, especially on soils. Inventories of species, particularly of interesting herbal and medicinal plants, have been undertaken. This reveals substantial diversity in:

- species, introduced and indigenous, managed for a variety of uses;
- management techniques, especially in soil fertility maintenance techniques and types of soil and water conservation;
- utilization of the various attributes of the landscape in order to trade-off risks in marginal bio-physical conditions.

During the remaining period of PLEC, our focus will be on demonstration sites and understanding the rationale of land users in protecting their agrodiverse systems. We intend to engage closely with farmers to help them conserve their rich heritage of plants and techniques, while at the same time impressing national policy-makers of the benefits of promoting agrodiversity.

Table 2 Agrodiversity variables for EAPLEC at different scales.

Scale	**Material/Data**	**Method**	**Output**
Regional	All available data	Data base development	Regional comparisons of: • The effect of demographic and macro-economic factors on land management • The effect of different agro-ecologies on agrodiversity
Landscape	Aerial photographs Topographical maps Soil samples Climatic data Demographic data	Multitemporal analysis Transect walks Soil survey Botanical survey Rainfall and temperature Collection of secondary data	Land-use and land-cover changes Main landscape units, land uses, crops, livestock and land management Diversity of soils Biodiversity Trends, cycles and events Population pressure, migration, age-sex structure
Demonstration site		PRAs Socio-economic survey In-depth interviews with elders and women Market surveys	Wealth ranking Natural resources management, population Nutrient flows Oral environmental histories, gender differentiation Market prices of crops, fertilizers, other chemicals
Household	Demo site trials/ treatments	On-farm monitoring of: Yields, labour, inputs and implements Soil and crop status Soil biota, nutrient flows, agro-biodiversity	Gross margins Identification of bio-physical sustainability indicators

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AN ENLARGEMENT OF PLEC WORK IN MEXICO

(Edited from a proposal to PLEC by Carlos Arriaga-Jordán, Centro de Investigación en Ciencias Agropecuarias, Universidad Autónoma del Estado de México, Toluca, Mexico)

Centro de Investigación en Ciencias Agropecuarias—CICA (Research Centre in Agricultural Science) of the *Universidad Autónoma del Estado de México—UAEM* (Autonomous University of the State of Mexico) has been conducting participatory research on smallholder peasant (*campesino*) agrodiversity within UNU/PLEC since 1996, basing its work in two indigenous Mazahua *campesino* communities (*San Pablo Tlalchichilpa* and *Mayorazgo*) of the municipality of San Felipe del Progreso in the highlands of the State of Mexico.

Initial pilot work was centred on the management of indigenous *criollo* maize land races, and the management of the maize cropping system as the axis of rural livelihoods in the area (Chávez-Mejía and Arriaga-Jordán 1999; Nava-Bernal, Chávez-Mejía, and Arriaga-Jordán 1999). Current work has been extended to study the management of agrodiversity in its broader context taking into consideration the four components of agrodiversity (Brookfield, Stocking and Brookfield 1999). The research team at CICA has been expanded with the collaboration of an expert in soils and students from the Faculty of Geography of UAEM.

A new proposal [now funded by UNU/PLEC] includes two additional organizations. One of these is the *Asociación Mexicana para la Transformación Rural y Urbana, A.C. (AMEXTRA)* (Mexican Association for Rural and Urban Transformation). This is an NGO, established in 1984, whose goal is to achieve the integral transformation and development of rural and urban communities to overcome poverty. In the State of Mexico, AMEXTRA has also been working with Mazahua *campesino* communities in the municipality of Villa Victoria, in the western part of the state; bordering the municipality of San Felipe del Progreso to the south. The other is the *Grupo Interdisciplinario de Tecnología Rural Apropiada, A.C. (GIRA)* (Interdisciplinary Group for Appropriate Rural Technology), also an NGO, which has as a main objective the provision of technical and methodological proposals to improve the livelihoods and the environment in rural areas of Mexico and Latin America. Currently, work is mainly based in the highlands of the indigenous Purhépecha region of the state of Michoacán in western Mexico.

Activities have been developed towards the evaluation of the re-introduction of the diversity of traditional indigenous crops that have been lost. These include *Amaranthus hipocondriacus, Quenopodium spp.*, species of the squash family (*Cucurbita pepa* and *C. ficifolia*), as well as common (*Phaseolus vulgaris*) and runner (*P. coccineus*) beans. Some forage species are included given the importance of the animal component in the livelihoods of *campesinos* in the highlands of central Mexico (Pérez Agis 1999).

The enlarged project

The enlarged project will take place in two regions, one in the western part of the State of Mexico, home to the Mazahua indigenous people (the second largest indigenous group in the state). The second region is in the highlands of the Pátzcuaro area in the State of Michoacán (380 km NW of Toluca), home to the Purhépecha people of western Mexico, one of the most important indigenous groups in pre-Columbian and current Mexican history.

Demonstration activities will be varied. The starting point of work, as has been the case for all three participating groups, is the existing knowledge and technologies from the wealth of the Mazahua and the Purhépecha culture. Diverse on-farm experiments, monitoring, and developments will be undertaken jointly with farmers to analyse, measure and compare resource management methods and also technologies to improve the existing systems incorporating soil, water and plant conservation. This will include the re-introduction of the traditional agro-biodiverse Mesoamerican cropping patterns (the *milpa* system) (Altieri 1990; Gliessman 1990; Woodgate 1994) which have been largely lost to maize monoculture. Where appropriate, new crops or technologies will be introduced to improve food security and income sources, and the conservation of plant and soil resources. Demonstration activities will be based on the collaboration and active participation of 'expert farmers' (Padoch and Pinedo-Vásquez 1999).

Restoration of *milpa* diversity

The central part of the proposed work will concern the restoration of traditional *milpa* and associated cropping systems. The Mesoamerican *milpa* system, in which several landraces of maize are associated with a variety of bean and squash types and species, was the basis for the development of pre-Hispanic cultures. It has continued to be a most important agricultural system for *campesinos* in Mexico and Central America into modern times (Gliessman 1990; Ortega-Paczka 1999).

Besides indigenous species, local *campesinos* in the highlands of Mexico readily introduced in their cropping patterns species from temperate climates which enabled them to overcome some of the limitations of farming at high altitudes and low temperatures as described above. Among these are the crop species brought by the Spaniards during the colonial period, including the cereals wheat (*Triticum aestivum*), barley (*Hordeum vulgare*) and oats (*Avena sativa*), food legumes like the faba beans (*Vicia faba*), lentils (*Lens esculentum*), and peas (*Pisum sativa*), and forage legumes such as spring vetch (*Vicia sativa*) and alfalfa (*Medicago sativa*). Besides the European crops introduced by the Spaniards, species from other lands were also adopted by *campesinos* in the volcanic range. Potatoes (*Solanum tuberosum*) were introduced from the South American Andes during the 17th century, and became the staple crop for communities located above 2,800–3,000m, beyond which maize does not grow.

These temperate species were adopted and included in a variety of forms within the local cropping systems; and *campesinos* developed local landraces of these crops. The shorter cycle frost-resistant cereals like wheat (to complement or substitute for maize) or oats (used mainly for forage) were adopted by the Mazahua *campesinos*. They grow wheat in years when rains are late and therefore the risks of early frosts damaging a late sown maize crop are very high; as in 1998 when the El Niño weather pattern disrupted rains in Mexico. Oats are sown by *campesinos* to supply forage for the draught animals and other livestock of *campesino* households.

Faba beans substituted the common bean (*Phaseolus vulgaris*) in the *milpa* system in the highlands of the State of Mexico long ago, so that elderly people recognize faba beans as a traditional component of their *milpas*.

A kind of highly pigmented 'purple' barley (*Hordeum vulgare*) became a traditional food complement to the maize crop (barley used to be mixed with maize in making the dough for *tortillas*) in the Mazahua and other regions of the State of Mexico. It had the advantage of a very short growing cycle and is very frost resistant, so that it was commonly associated with the maize crop or sown immediately if maize was damaged by early frost (September) to ensure some grain harvest towards food security. *Campesinos* at San Pablo Tlalchichilpa, who have lost their seed stocks of 'purple' barley, told the CICA team in 1998 that they were interested in sowing it again since it used to ensure some harvest in difficult agricultural years. Seed stock of 'purple' barley has been located through contacts with other Mazahua communities in the neighbouring municipality of El Oro.

Also, these temperate species enabled *campesinos* to obtain multiple crops in areas of high soil moisture, as in the Purhépecha region in Michoacan and the Valley of Toluca in the State of Mexico, or on irrigated land in some valleys in the Mazahua region. Farmers grow maize during the spring/summer cycle, and temperate cereals or legumes in the winter.

These complex multiple cropping systems, that provided food and forage for the farming households, have been largely lost due to the drive to modernize agriculture. Over the last five decades, maize monoculture has been promoted in the highlands of Central Mexico to such a degree that traditional associated and multiple cropping systems are being eroded or completely lost (Pérez-Agis 1999).

This drive towards maize monoculture has worsened the inherent low fertility (in nitrogen and phosphorus), characteristic of the volcanic soils in Central Mexico. It has represented an excessive demand on soil nutrients, requiring the increased use of synthetic fertilizers. This practice has in many cases aggravated the situation by increasing the natural acidity of the soils, requiring even higher applications of fertilizer, and creating a vicious circle which, coupled with the high cost of these external inputs, means poor returns from the crop.

Historical as well as scientific evidence has shown the advantages of intercropping maize with leguminous crops such as common bean (*Phaseolus vulgaris*), runner (*Ph. coccineous*) or faba bean (*Vicia faba*), as well as with other legumes, within the cropping systems in the highlands of Central Mexico (Pérez-Agis 1999; Reyes-Reyes, González-Díaz and Nava-Bernal 1999). Market oriented maize monoculture in the highlands is practised in *campesino* farms of small size near its ecological ceiling at high cost. Given the current economic scenarios brought about mostly by the North America Free Trade Agreement (NAFTA), it produces less income. Monoculture has proven more vulnerable than systems based on maize intercropped with beans, or these plus *Amaranthus hipocondriacus,* another native plant that has recently gained renewed popularity given the high nutritional value of its grain (Pérez-Agis 1999).

Under the increasingly difficult economic scenarios they confront, *campesinos* have expressed a great interest in farming systems which enable them to assure their food needs, reduce costs and cash expenditures (cash is usually a most limiting factor in *campesino* agriculture), and may provide supplementary sources of income.

Encouraging results from *campesinos* who have conserved their *milpas* or who have tried traditional associated crops (maize-beans/amaranthus) in the Mazahua (Reyes-Reyes, González-Díaz and Nava-Bernal 1999) and the Purhépecha regions (Pérez-Agis 1999), indicate that traditional associated and multiple cropping systems, which include local indigenous or adopted species, have the ability to improve production to meet food needs for the family. They also provide forage resources for the animal component of the systems. This plays a very important role in the *campesino* livelihoods in central Mexico, both by the savings and income generated from keeping animals (draught animals, cattle, sheep and poultry), and from the manure which is highly valued by *campesinos* as an organic input for their soils (González, Arriaga-Jordán and Sánchez 1996; Arriaga-Jordán et al. 1999).

Restoring the inclusion of legumes in the cropping systems has also the benefit of conserving and improving the nitrogen content of soils. This is an aspect of which *campesinos* are well aware, since they all recognize the better crops and yields are obtained if sown after a legume crop such as faba beans (Reyes-Reyes, personal communication).

Due to economic pressures in the Purhépecha region, there is an interest from *campesinos* to increase production from their limited land resources, by intensifying the yearly fallow which is typical in this area. Local winter crops of the Purhépecha region including legumes like faba beans, lentils or peas, may be an option to increase the productivity of their resources, while improving the nitrogen fertility of their soils (Pérez-Agis 1999).

Therefore the objectives of on-farm experiments and demonstration activities on intercropping will be:

- To evaluate on economic, social and environmental terms traditional *milpa* and other inter- and multiple cropping patterns based on:

  Cereals: Maize (*Zea mays*) as the main crop, but also considering wheat (*Triticum aestivum*), oats (*Avena sativa*) and exploring the potential of the traditional (but now basically lost) Mazahua 'purple' barley (*Hordeum vulgare*);

  Food legumes: Common beans (*Phaseolus vulgaris*), runner beans (*Ph. coccineous*) faba beans (*Vicia faba*), lentils (*Lens esculentum*) and peas (*Pisum sativa*);

  Vegetable and other crops: squash (*Cucurbita pepo, Cucurbita vicifoilia)*, amaranthus (*Amaranthus spp., Chenopodium spp.);* and

  Forage legumes: Spring vetch (*Vicia sativa*).

- To evaluate and demonstrate the use and potential of traditional multiple cropping systems in increasing the productivity of yearly fallow land in the Purhépecha region.

Secondary topics, developed in full in the proposal, are (1) enrichment of *campesino* homegardens (*solares familiares*), and (2) work on soil conservation practices.

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A DIRECTORY OF PLEC DEMONSTRATION SITES, WITH DATE OF FIRM ESTABLISHMENT, NAMES OF CLUSTER LEADERS AND E-MAIL AND FAX ADDRESSES FOR FURTHER INFORMATION

WEST AFRICA, GHANA

Prof. E.A. Gyasi
Plec@ug.edu.gh
+233 21 500 382

Southern Ghana (Legon-based):

1. Gyamfiase-Adenya (1996)
2. Amanase-Whanabenya (1998)
3. Sekesua-Osonson (1998)

Central Ghana (Kumasi-based):

4. Jachie (1997)
5. Tano-Odumasi (1998)
8. Bofie (subsidiary site, in development 1999)

Northern Ghana (Tamale-based):

6. Bongnayili-Dugu-Song (1999)
7. Bawku-Manga (subsidiary site, 1997)

WEST AFRICA, GUINÉE

Prof. I. Boiro
waplecg@leland-gn.org
+224 46 5637

Fouta Djallon

1. A group of villages in Bantignel Sub-Prefecture (1997–8) (Missidè Héïré, Dianguel, Tioukoungol, Lari, Dar ès Salam, Goloya)

Upper Niger

2. Moussaya, Sanguiana Sub-Prefecture, Kouroussa Prefecture (1998)

EAST AFRICA, KENYA

Dr R.M. Kiome
kiome@arcc.or.ke
+254-2 583 344

Kiambu District

1. Lari Division (in development 1999)

Embu District

2. Nduri village (in development 1999)

EAST AFRICA, TANZANIA

Mr F. Kaihura
kaihura@mwanza.com
+255 6 841 726

Arameru District

1. Olgilai/Ngiresi (1998)
2. Kiserian (1998)

EAST AFRICA, UGANDA

Mrs J. Tumuhairwe
plectumu@imul.com
+256 41 543 382

Mbarara District

1. Bushwere parish, Mwizi sub-county (in development 1999)
2. Kamuri parish, Kabingo sub-county (subsidiary site, in development 1999)

CHINA, YUNNAN PROVINCE

Prof. Guo Huijun
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cred@public.km.yn.cn
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Baoshan Prefecture

1. Hanlong/Baihualing, Baoshan County (1995)
2. Shabadi, Tengchong County (1998)

Xishuangbanna Prefecture

3. Daka, Mengla County (1997)
4. Baka, Jinghong County (subsidiary site, 1997)

PAPUA NEW GUINEA

Mr J. Sowei
jwsowei@datec.com.pg
+675 326 0213

East Sepik Province

1. Tumam-Nghambole, Dreikikir district (1999)
2. Miko, Wosera District (1999)

Southern Highlands Province

3. Kikita, Heli, Wenani, Tari district, initiated 1998, work halted in 1999 for security reasons)

Central Province

4. Furimuti-Ogotana (being initiated 1999)

BRAZIL

Profa. Dra Tereza Ximenes-Ponte
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dmcgrath@amazon.com.br
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Santarém area

1. Aracampina Island reforestation site (Renascer) (1996); agrodiversity (1999)
2. Ituqui Island: Santíssimo reforestation site (1998); range management treatments (1999); Ilha de São Miguel: lake management (1996); sub-sites for agrodiversity in São José and São Benedito (1999)

Macapá area

3. Mazagão-Ajudante-Carvao (1996)
4. Ipixuna-Lontra Pedreira (1996)

Marajó island

5. Retiro Grande and Jabuti (subsidiary site in development, 1999)

SITES IN THE NON-GEF CLUSTERS

MEXICO

Dr C. Arriaga-Jordán
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Estado de México

1. San Pablo Tlalchichilpa, San Felipe del Progreso municipality (1998)
2. Mayorazgo, San Felipe del Progreso municipality (1998)
3. San Marcos de la Loma, Villa Victoria municipality (in development, 1999)

Estado de Michoacán

4. Casas Blancas, Salvador Escalante municipality (in development, 1999)

PERU

Dr M. Pinedo-Vásquez
Map57@columbia.edu
+ 1-212 854 8188

1. Hamlets in the Zona de Muyuy, Peruvian Amazonia (1998)

JAMAICA

Prof. E. Thomas-Hope
ethope@uwimona.edu.jm
+1 876 977 6029

1. Fellowship/Moore Town, Rio Grande valley, Portland parish (in development 1999)

THAILAND

Dr K. Rerkasem
kanok@cmu.chiangmai.ac.th
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1. Paa Poo Chom (Hmong, Chiang Mai Province) (1998)
2. Tee Cha (Karen, Mae Hong Son Province) (in development, 1999)

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