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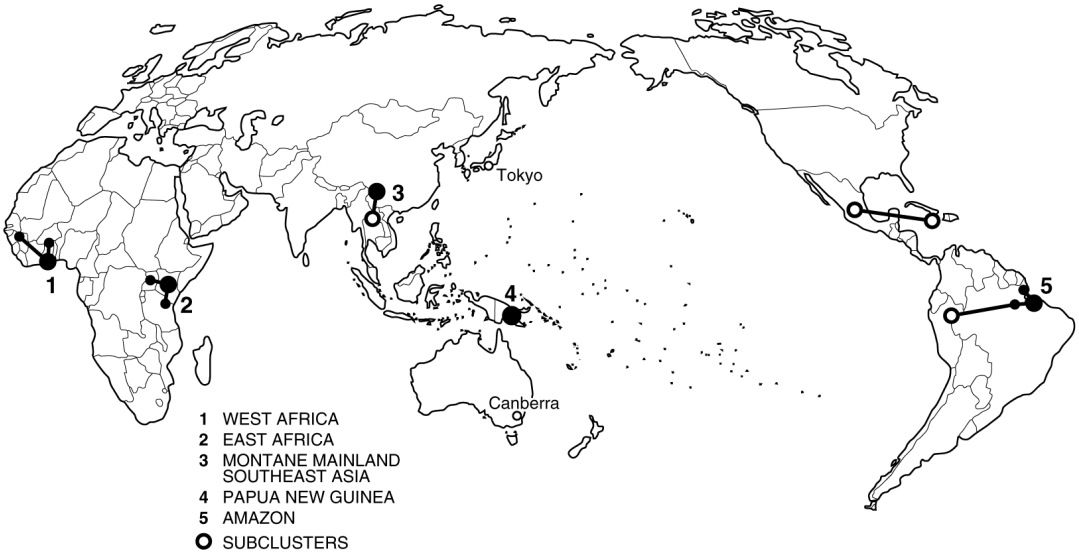

The Clusters of PLEC

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No. 18 OCTOBER 2001

PRINCIPAL SCIENTIFIC COORDINATOR'S REPORT

PAPERS

P L E C N E W S A N D V I E W S

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PRINCIPAL SCIENTIFIC COORDINATOR'S REPORT

A BUSY YEAR FOR PLEC

Harold Brookfield

This is the penultimate issue of *PLEC News and Views* in its present form on current contract expectations. This number includes four papers, three of them requested by the editors, on PLEC's demonstration sites, thus recording some of the very substantial progress that has been made. It also includes a paper by our partners in the Montreal meeting (see below), by the two principals in the IPGRI project on *in situ* conservation of agrobiodiversity.

All of PLEC is now into the final reporting stage. Final reports, in a common format provided in May, are due from all Clusters before the end of February 2002, and will be a major source of information for the final evaluation of the project that will soon follow. Since any future support depends on that evaluation, there can on this occasion be no slippage in the reporting date. These reports will then be collected together, edited and placed in context, for a final book coming out of the present PLEC project, to be edited in Canberra during the six-month winding-up period beginning in March and ending in August. The book will be offered to the United Nations University Press.

This March–August 2002 period is necessary, but has no budget of its own. The UNU/PLEC core budget is only $100,000 in 2002.

By mid-October 2001, some Clusters had already ceased new field work, and were concentrating on data analysis and their reports. The scientific and technical advisory team (STAT), principally Kevin Coffey with advice from Miguel Pinedo-Vasquez, has provided important new guidelines for quantitative analysis of biodiversity and agrodiversity data during the past few months. A final version (including a recently added discussion of principal components analysis) is now available, and has been distributed from Tokyo. It is going into the PLEC book discussed below. More Clusters have now completed database entry of their biodiversity and agrodiversity data, and only two or three groups have still to complete this work.

All Clusters are also focusing on preparation of policy and technical recommendations to their national governments and agencies, and national meetings for this purpose have already been held on 20–22 September in Conakry, Guineé, and on 19 October in Dar es Salaam, Tanzania. Other Clusters will hold their meetings in the period November to January, some of them in association with

other important business (see below). Once the recommendations have been finally completed all Clusters are sending copies to UNU in the original language, as well as in preliminary translation into English where this is necessary. UNU will collate and publish them as a PLEC output during 2002.

The fourth Management Group Meeting

This last project-wide progress meeting of the present GEF-PLEC was the held at Arusha, Tanzania, from 2–6 May. This meeting was mainly concerned with successful winding up of the four-year project, but also included some discussion of future plans. In addition, it was an opportunity for the Tanzanian group, and their collaborating farmers, to show us some of their work in the field. Unfortunately, we were able to see only one of the two sites, at Olgilai-Ng'iresi, but met the Kiserian farmers also at a splendid final dinner and entertainment. The whole meeting was excellently organized by Fidelis Kaihura and his colleagues, and by general agreement was one of the most successful we have held. After the meeting, we all went to the national wildlife reserve at Ngorongoro for two days, at our own expense.

It is worth recording that, in opening the meeting, Dr Mbwana, the Zonal Director of Research and Development for the Northern Zone of Tanzania, under the Ministry of Agriculture and Food Security, highlighted the promising results from on-farm exchange of knowledge between farmers, and greatly appreciated the fast adoption of farmers' knowledge that had been achieved. On behalf of the farmers, as well as his own office, he urged that PLEC work be extended beyond February 2002. Later in the meeting, initial proposals were presented by Cluster leaders present, or on their behalf. Most Clusters wish strongly to continue, but the hopes raised in Arusha for a larger financial support from UNU/PLEC, to cover a bridging period while new funding was being obtained, have been disappointed. It was again stressed that Clusters must take the initiative in seeking their own funding. Some are doing this, but in others detailed discussion is only now taking place. One notable success only can yet be recorded. The PLEC group in Thailand has obtained a large grant from the McKnight Foundation for work mainly on indigenous varieties of rice, in an agrodiversity context.

Sadly, this was also the occasion for most of us to say farewell to Audrey Yuse, who has served the project so well as its financial administrator since the earliest days, and has been a good friend to us all. She finally left Tokyo to emigrate to Canada at the beginning of August, and her place in Tokyo has been taken by Masako Ebisawa. Since this was arranged well in advance, Masako was also able to come to Arusha to meet us all. She has taken up the burden of completing not only the allocation of funds but also of their reporting, which demands a good deal from the Clusters. Audrey Yuse set out some clear guidelines in Arusha.

PLEC IN A WIDER SCENE

The year 2001 has also seen a lot of activity on giving wider publicity to PLEC. Two major initiatives have been planning the Montreal symposium in November, and completion of the PLEC book on *Cultivating Biodiversity*. Each is outlined below.

Symposium on Managing Biodiversity in Agricultural Ecosystems. This is jointly sponsored by UNU/PLEC, IPGRI and the Secretariat of the Convention on Biological Diversity, and will be held in Montreal, Canada, on 8–10 November. Over 70 participants have been invited, including ten from PLEC and several others supported by a grant, to UNU for the symposium, from the Japanese Ministry of Foreign Affairs. The programme committee has included Brookfield and Padoch from PLEC; the Managing Coordinator, Liang, has acted as the secretary, involving a great deal of his time especially in the last three months.

After the meeting, the PLEC members present will spend a day discussing the future of the project's work.

The central theme of the Montreal meeting is the management of biodiversity, especially agricultural biodiversity, by farmers. Invited participants are drawn from all continents. There has been an excellent response, with over 90 abstracts submitted to the programme committee.

The oral programme includes 40 papers, beginning on the first day with papers on managing crop and livestock genetic resources, continuing on the second with managing associated biodiversity and agro-ecosystem services, and concluding on the third day with management at the landscape level, and in face of social and environmental change. PLEC contributions include two on soil diversity on the second day, and five on the third day in the section on managing diversity at the landscape level. Other PLEC members will take chairs, and act as discussants. There will also be a substantial number of poster presentations. The Vice-Rector of UNU, Professor Motoyuki Suzuki, will open the meeting. Proceedings will be published.

The PLEC book on ***Cultivating Biodiversity: the Understanding, Analysis and Use of Agrodiversity***, is to be published by ITDG Publications in London (formerly Intermediate Technology Press). This book is now complete and was despatched to London at the end of October. It has 25 mainly-short chapters, about half of which are reprinted, with from minor to larger changes, from *PLEC News and Views*. The remaining chapters are newly written for the book. It has been edited by Brookfield, Padoch, Parsons and Stocking, with most work done in Canberra by Parsons and Brookfield.

The book is PLEC's statement to a wider readership. It is written entirely by members of the project. It sets out how its members see agrodiversity, how they have analysed it, and how they have worked together with farmers. Twelve case studies from PLEC areas in South America, Africa and Asia, present, by example, what has been achieved. It is being produced under a publishing agreement between UNU and the Press, involving buy-back of a substantial number of copies for distribution to PLEC members and others. For the list of contents see page 40.

OTHER INITIATIVES

There has been a number of PLEC-related initiatives and events. They have included:

- Three members of PLEC, Chen Aiguo, Edwin Gyasi and Harold Brookfield, participated in the production of a set of guidelines on *Managing Agricultural Resources for Biodiversity Conservation*, prepared by the Environment Liaison Centre International for UNEP and the Biodiversity Planning Support Group of the GEF. After a workshop in Nairobi in July, and subsequent final drafting, these guidelines are now complete. Chen and Gyasi prepared case studies, and Brookfield a more general discussion on diversity at landscape level.
- UNESCO sponsored an *International Conference on Biodiversity and Society* in New York on 22–25 May. Christine Padoch was importantly involved in the organization of this meeting, and PLEC case studies from Peru (Pinedo-Vasquez) and China (Guo Huijun) were presented.
- Harold Brookfield's personal book ***Exploring Agrodiversity*** was published by Columbia University Press, New York, in mid-April. UNU bought a number of copies for distribution to PLEC Cluster leaders and others.
- From 11–14 September, Fidelis Kaihura attended a workshop in Lusaka, Zambia, on *Incentives for Sustainable Use and Conservation of Agrobiodiversity* organized by Dr Conny Almekinders of Wageningen. He presented a paper.

- Michael Stocking and Niamh Murnaghan's UNEP-sponsored *Handbook for the Field Assessment of Land Degradation* was published by Earthscan, London, in October. It was launched at the Conference of Parties of the Convention to Combat Desertification in Geneva on 9 October.

FORWARD PLANS

- The submission date for the '**best paper**' prize, open to all PLEC members except the coordinators, has been put back to 31 December 2001. A few papers have been seen on their way to New York, where they should be submitted to Dr Christine Padoch, New York Botanical Garden, Bronx, New York, NY 10458-5126, USA.
- 'Agriculture, Development and Biodiversity' is the title of a **special issue of *The Geographical Journal*** to be published in 2002. Michael Stocking, a member of the Advisory Board to the *GJ* and editor of this special issue, has already invited contributions from PLEC members, to be received by the end of October. Two potential papers have been submitted, but more are urgently needed if PLEC is to take up this opportunity of wide dissemination to geographers, diplomats, teachers and other professionals world-wide.

  Especially sought are papers that:

  - *demonstrate how agricultural practice locally can bring biodiversity benefits;*
  - *show how biodiversity itself is supportive of development and community livelihood objectives;*
  - *illustrate the complex linkages between agriculture, development and biodiversity more broadly.*

  What is wanted are relatively short papers (4000–6000 words is ideal) that discuss the principles and give good examples of their operation in different agro-ecological contexts. Not wanted are detailed data sets and complex tables. The readership will include policy-makers and non-scientific professionals, who will want to understand in direct terms the importance of what we in PLEC are calling 'agrodiversity'.

  So Michael Stocking would welcome a flood of papers and will assist any interested authors in getting their material into an appropriate form acceptable to the *GJ.* The deadline can now be extended to 31 December 2001—but please do not wait for the last minute (m.stocking@uea.ac.uk).
- Under a contract with UNU, Edwin Gyasi is assembling contributions from among his colleagues for a book on *Managing Biodiversity: the Traditional Way in Ghana*, to be received before June 2002. The book will be submitted to the United Nations University Press.

Meetings

Several important meetings are being held in the coming months. Reports on these, except for the General Meeting, will appear in the next issue (No. 19) of *PLEC News and Views*, provisionally scheduled for March so as to appear before the General Meeting. Information is presently available as follows.

6th West African regional workshop. This workshop was held on 9–12 October in Accra. It had the purpose of reviewing findings and discussing forward plans.

An **East African regional meeting** on '*Agrodiversity, lessons from PLEC in East Africa and directions for the future*', to be held at Arusha, Tanzania, 26–28 November 2001.

A first **national forum** on *'Agrodiversity and agrobiodiversity of the várzea'*, to be held at Belém on 4–7 December 2001. This has multiple purposes, including presentation of recommendations to policy makers,

demonstrating the PLEC model, and upscaling and integrating new partners into PLEC-Amazonia's network of institutions and experts working on várzea social and natural environments.

The **combined annual meeting of PLEC-China and national workshop** on *'Agrobiodiversity conservation in southwest China'*, on 17–21 January 2002 in Kunming and Baoshan. Technical and policy recommendations at local and national levels will be presented as a part of this meeting, and research findings exchanged with other bodies. The meeting is organized by the Yunnan Environmental Protection Agency and Xishuangbanna Tropical Botanical Garden.

The **fourth General Meeting of PLEC** will be held, tentatively at Columbia University in New York on 8–12 April 2002. This will summarize, present and exchange PLEC results.

It is intended that the two persons who will conduct the final evaluation of PLEC will attend this meeting before separating to visit all PLEC Clusters. The idea is that, beginning in New York and dividing the Cluster visits between them, they will finally come together again at UNEP in Nairobi. Their review, which is for UNEP, is expected to be completed in about one month.

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SAD NEWS

PLEC has suffered a number of losses during the last two or three years, mainly in Africa. They have included PLEC scientists Edward Kaitaba of Tanzania, Edward Nsubuga of Uganda and Charles Anane-Sakyi of Ghana. Now we have another loss of a key person, the site officer at the successful Tumam demonstration site in Papua New Guinea, Chris Tokomeyeh. An obituary appears on this page.

OBITUARY

Yamwah (Chris) Tokomeyeh 1957–2001

Yamwah was the fourth child of Tokomeyeh and Yaikesere of Nghambole Village. He was baptised a Catholic and took the Christian name of Christopher, but was universally known as Chris Tokomeyeh. From the age of 14 Chris left home to pursue his education, at Maprik and then at Port Moresby Technical College where he gained entry to the University of Papua New Guinea. Chris found formal studies difficult and left to become an apprentice electrician, a policeman and a plantation manager. In 1977 he married Yarmoi (Joanna) from Nghambole village. They have six children.

Chris returned home in the 1980s. He used the skills he had gained to good effect, setting up a community business group in the village. In 1997 Chris became the PLEC Project Coordinator at Tumam and Nghambole villages. Chris' skills were ideally suited to PLEC's needs. Under John Sowei's supervision, Chris managed the building of a PLEC field house in the village, carried out data collection and explained PLEC's purposes to his fellow villagers. He died suddenly while on his way home from Canberra where he had spent almost two months, entering data, standardizing spellings and creating a GIS. Despite his years away from home, his knowledge of plants and people proved exceptional and the task could not have been completed without his help. His death leaves me and all his colleagues with a profound personal sadness and the deep sense of loss of a longtime friend.

Bryant Allen

PAPERS

STRENGTHENING THE SCIENTIFIC BASIS OF *IN SITU* CONSERVATION OF AGRICULTURAL BIODIVERSITY ON-FARM: A GLOBAL PROJECT

Toby Hodgkin and Devra Jarvis

International Plant Genetic Resources Institute, Rome, Italy[1]

Summary

In situ conservation on-farm of local varieties supports the continued maintenance by farmers of their traditional crops and varieties. It also supports the conservation of diversity in agro-ecosystems. A major challenge for *in situ* conservation is the development of the knowledge needed to understand where, when and how *in situ* conservation can be effective. IPGRI, together with nine partner countries (Burkina Faso, Ethiopia, Hungary, Mexico, Morocco, Nepal, Peru, Turkey and Vietnam), is undertaking a project to strengthen the scientific basis of *in situ* conservation of agricultural biodiversity. The project is producing significant information on the amounts of genetic diversity maintained by farmers, how the diversity is maintained, who maintains it and the factors that influence its maintenance. Important challenges of the work include defining appropriate relationships between agricultural development, conservation concerns and community interests.

Introduction

In situ conservation on-farm refers to the maintenance of diverse local crop varieties in farmers' fields. It allows the processes of evolution and adaptation to continue in crop plants, ensuring that new genetic material is generated over time. In addition, the use of locally adapted material can support ecosystem health by reducing the need for fertilizer and pesticides. On-farm conservation can also help to improve poor farmers' livelihoods and increase the control and access that farmers and communities have over local crop resources.

Crop genetic resources are passed from generation to generation of farmers and are subject to different natural and human selection pressures. Social, cultural, economic, and environmental factors influence a farmer's decision of whether to select or maintain a particular crop variety at any given time. Farmers, in turn, make decisions in the process of planting, managing, harvesting and processing their crops that affect the genetic diversity of the crop populations: over time farmers modify the genetic structure of a population by selecting for plants with preferred agromorphological characteristics. They influence the survival of certain genotypes by choosing particular farm management practices and by planting their crops in sites with various different micro-environments. Farmers make decisions on the size of the population of each crop variety to plant each year, the percentage of seed or other planting materials to save from their own stock and the percentage to buy or exchange from other sources. Each of these decisions, which can affect the genetic diversity of varieties, is linked to a complex set of social-cultural, economic, and environmental influences on the farmer.

There are growing pressures on farmers who maintain significant amounts of crop

[1] This is an invited paper.

genetic diversity in the form of local varieties. Increased population, poverty, land degradation, environmental change and the introduction of modern crop varieties have contributed to the erosion of genetic resources in crops. For the last few decades, agricultural scientists have responded to the threat of genetic erosion by developing a worldwide network of genebanks for conserving the available useful genetic resources *ex situ*. However, these facilities are unlikely to accommodate the full range of useful diversity in economically useful plant species or to meet all conservation needs. In addition, *ex situ* conservation will not conserve the dynamic processes of crop evolution and farmers' knowledge of crop selection, management and maintenance inherent in the development of local varieties. Nor can they ensure the continued access and the use of these resources by farmers. For all of these reasons, continuing maintenance of local varieties in production systems is needed.

A major challenge for *in situ* conservation on-farm is the development of the knowledge needed to understand where, when and how *in situ* conservation will be effective. The information available to help those wishing to support or make use of on-farm conservation is extremely limited (Brush 1995; Brown 1999). In 1995, in response to this challenge, IPGRI, together with nine partner countries, formulated the project, '**Strengthening the scientific basis of *in situ* conservation of agricultural biodiversity on-farm**'. In this paper we describe the objectives and approach of the project and outline some of the work being undertaken within it. Some issues that relate to the linkage between conservation and development will also be discussed.

A global project

The global project includes nine partner countries—Burkina Faso, Ethiopia, Hungary, Mexico, Morocco, Nepal, Peru, Turkey, and Vietnam—with IPGRI acting as global coordinator. The countries are all within regions of primary diversity for crop genetic resources with world-wide importance. Each has traditional farming communities that maintain crop genetic resources. They all have national programmes organized to conserve crop genetic resources, including *ex situ* conservation facilities, and all have a strong interest in developing the national capacity to support *in situ* conservation. The project serves to strengthen the relationships between formal institutions, farmers and local-level institutions.

The general aims of the project are: (1) developing global and national management frameworks for the implementation of *in situ* conservation on-farm; (2) building national capacity for collecting and analysing information to determine the amount and distribution of genetic diversity in farmers' fields; (3) increasing the understanding of the processes, including human and natural factors, as well as the question of who is maintaining this diversity, and why; and (4) broadening the use of agricultural biodiversity and participation in its conservation by farming communities and other groups.

The overall purpose of the global project is to strengthen the scientific basis, institutional linkages and policies that can support farmers in conservation and use of crop genetic diversity. Three specific objectives are identified:

1. the creation of a framework of knowledge on *in situ* conservation of crop genetic diversity on-farm;
2. the provision of principles, options and approaches that integrate agro-biodiversity in agricultural development;
3. support of national programmes, organizations and farmers to develop *in situ* conservation programmes and policies.

Each country has selected its own set of partner institutions, which always include

Table 1 Countries, sites and crops in the global on-farm conservation project

Country/ Global	Agro-ecology	Crops	Strength and focus
Mexico	tropical lowland shifting cultivation	maize, beans, squash, chili peppers	PPB†, agro-eco surveys, farming systems research
Peru	tropical lowland shifting cultivation	cassava, groundnut, maize, chili peppers	working with indigenous people
Nepal	mountain, mid-hills and lowland irrigated and rainfed	rice, barley, finger millet, taro, sponge gourd, pigeon pea	participatory approaches; GxE interaction*, microsatellites, economic valuation
Vietnam	tropical lowland, medium elevation, irrigated and rainfed	rice, mung bean, taro	agromorphology characterisation and farming systems research
Hungary	temperate	maize, beans	economic valuation, genetic diversity analysis
Burkina Faso	arid and semi-arid	sorghum, cowpea, millet, okra, fra fra potato	GxE interactions* in stress environments and ecosystem perspective
Ethiopia	tropical highland	sorghum	time series on farmers' management of landraces
Morocco	mountain, semi-arid, oasis, irrigated, rainfed	durum wheat, barley, alfalfa, faba bean	institutional development and linking research levels, molecular tools
Turkey	transition zone	durum wheat, chickpea	to be decided

† PPB participatory plant breeders

* GxE genotype by environment interaction

NGOs and community organizations, as well as local research institutes and the appropriate national programme partners. Countries have each selected a set of crops on which work is focused, and areas where the work is concentrated (Table 1). The projects developed by partners reflect their own concerns and needs while also following an agreed work programme which is common to all countries. Funding for different countries is provided from different sources and, while this allows flexibility in a number of key aspects, it can also lead to marked differences in the rate at which activities develop. IPGRI provides global coordination and linkages and supports the work in each country as needed.

Substantial progress has been made since the beginning of the project in understanding the issues involved and the ways in which these need to be addressed. Major objectives, hypotheses and preliminary activities for the project were decided in 1995 during Phase I of the project at the first global partner planning meeting. At the second global partner meeting in 1997, major units of data and methodologies for participatory and empirical data collection were discussed, and six thematic groups were formed to study: (1) social, economic and cultural factors, (2) farmer selection of agromorphological characters, (3) crop population and breeding systems, (4) agroecosystem factors, (5) seed systems, and (6) adding benefits to farmers and other

stakeholders from the use of local crop resources (Jarvis and Hodgkin 1998). In 1999, the partners met again to compare and critique data collected from participating countries, discuss methodologies for data integration within and among thematic areas, synthesize methods used to enhance benefits from local crop diversity to all stakeholders, and discuss progress in increasing access, participation and decision-making for different gender, age and cultural groups.

The third meeting resulted in the publication by Jarvis, Sthapit and Sears (2000). This contains 54 papers from the participating countries and nine synthesis papers covering all thematic areas. It also includes information on linking formal and informal institutions, integrating data, and use of information for social-cultural, and economic, ecological, and genetic benefits of local communities and society at large. A *Training guide for* in situ *conservation on-farm* was later produced to enable partners to provide wider training within their countries and to allow countries outside the original group to have ready access to training material for their own on-farm programmes (Jarvis et al. 2000).

Elements of the approach taken

Implementing the project has involved developing multi-institutional, multi-disciplinary collaboration at international, national and local levels. This included ensuring that trained national personnel were available to carry out the work at central and local levels, and that the teams promoted equity at all project levels, from farmer participation to research to project management and decision making. In addition, as the project is largely community based, much time was devoted to building or creating rapport with the farmers in whose fields much of the work is being undertaken, and whose experience and knowledge provide a central component of the project.

The global aspect of the project has created opportunities for the partners from different regions of the world to exchange knowledge and experiences gained. These include not only research methodologies but also lessons in linking local and national institutes, public awareness, and information dissemination to policy makers. The international coordination and scientific synthesis by partners across countries has allowed the development and refinement of methodologies that answer questions of conservation and use of agricultural biodiversity (Box 1).

In contrast to research and analysis methodologies that have widespread application, actual interventions to main-stream crop genetic diversity into agricultural development activities are likely to be site specific. The project is creating a portfolio of options, based on many case studies from participating countries, to which other countries may refer for ideas for increasing the benefits to farmers from local crop diversity.

Research in the IPGRI on-farm conservation project is implemented with a participatory approach at all stages of the process. Key informant interviews, focus group discussions, spatial mapping, matrix ranking, and transects, have all provided project data. These include local social-cultural, economic and agroecological conditions, crop and seed management practices, and characteristics and origins of varieties. This information from participants is complemented by household, market and seed system surveys, field trials on-station and on-farm, and genetic diversity measurements in the field and in laboratories.

Understanding the management of diversity on-farm

On-farm conservation of traditional crops will be carried out by farming communities for

Box 1 Cross-cutting discipline and country questions
Social, cultural and economic factors
What social, cultural and economic forces influence variety choice and areas planted? What are the opportunity costs of conserving agrobiodiversity? What are the appropriate social or economic categories for data disaggregation?
Agroecosystem factors
What environmental and biological factors influence farmer variety choice and the areas planted? What does the farmer see as the limiting factors to production of his or her varieties? How does the farmer manage factors that limit production?
Agromorphological characters
What characteristics does a farmer use to distinguish a variety? What characteristics does a farmer select for the next generation? What is the level of consistency between farmer names and genetic distinctions? What traits are preferred and/or not preferred by men and women farmers?
Population structure and breeding systems
What level of genetic diversity is being managed by farmers? What is the divergence between fields and landraces across the landscape ? What is the impact of farmer selection practices on crop diversity; how is this diversity changing over time? Are new combinations of genetic diversity from gene flow between varieties being maintained on-farm?
Seed systems
What is the role of seed exchange and storage systems in the distribution of genetic diversity at household, village, community, and national levels? Where is the seed system vulnerable to environmental, social, cultural or economic change? What is the economic importance of the informal and formal seed system?

farming communities. The primary task for those concerned with conservation and with the maintenance of traditional crop diversity *in situ* is to understand when, where and how this will happen, and by whom the material will be maintained. Thus, it is useful to identify four areas of investigation which lie at the heart of the scientific agenda in the project:

- what is the extent and distribution of the genetic diversity maintained by farmers over space and over time?
- what are the processes used to maintain the genetic diversity on-farm?
- who maintains genetic diversity within farming communities (men, women, young, old, rich, poor, certain ethnic groups)?
- what factors (market, non-market, social, environmental) influence farmer decisions on maintaining traditional varieties?

Obviously, obtaining all the answers to these questions involves a very complex and substantial series of investigations; even this multi-country project can only begin to provide the information needed. Nonetheless, the project is accumulating substantial amounts of data about the different patterns of diversity in the production systems, the ways in which they are maintained and the concerns and interests of the farmers who manage the crops. Space does not allow an extensive review but, in the next sections, we provide a few examples of the information being collected in different countries.

How much diversity is there?

One of the major methodological problems which faces any study of diversity is deciding what type of diversity is going to be measured and analysed. A key element in understanding the amount and distribution of crop genetic diversity managed by farmers is understanding the relationship between what farmers recognize, or name, as a variety and the genetic distinctiveness of this unit. Do farmers use names consistently within an area, or in different areas? Do local varieties have similar amounts of genetic diversity within them? Answering these questions requires genetic, agricultural and socio-economic data. The results obtained will vary from crop to crop, region to region or country to country, depending on crop biology, on production environment and on farmer needs and interests.

Farmers in the Begnas Kaski ecosite in Nepal maintain very large numbers of local varieties. This is especially the case for rice, where some 63 varieties were identified in the baseline survey. By comparison, 21 rice varieties were found at the upland Jumla Talium site and 33 in the lowland Kachorwa Bara site. These varieties are identified by farmers as possessing specific morphological characteristics or being appropriate for specific sites. The genetic variation is being analysed using both agromorphological and molecular approaches. The distribution of these local varieties is very uneven. A few (3–8 depending on ecosite) are grown in relatively large areas by many farmers; but the great majority are grown only by one or two farmers on a single plot. These seem to be particularly vulnerable to loss. Many are retained because they are uniquely suitable for specific environments such as a small area of badly drained land on a particular farm.

Fairly large numbers of rice varieties within a community are also characteristic of Vietnam, and may reflect the biological characteristics of the crop and the way it is managed. In contrast, numbers of named varieties of barley, faba bean and alfalfa maintained by farmers in Morocco are much lower. In some villages of the study area, local barleys are given the same overall name although farmers recognize and clearly distinguish different populations of barley by their agromorphological traits. Thus, the unit of farmer management may not necessarily be the 'name' of the variety. Local varieties are grown by all the farmers in the area and constitute an essential element of the farming system. In the case of alfalfa, the outbreeding and tetraploid nature of the crop is an important factor in determining the number of varieties, and there is very substantial variation within a given population.

How is it maintained?

The maintenance of diversity in local crop varieties (both variation within varieties and the number of varieties maintained) depends on natural selection and on farmer management or human selection. In order to develop a conservation strategy it is important to understand the ways in which these two interact and their relative importance. A variable production environment such as fields with a range of soil types and drainage characteristics will tend to favour the maintenance of within-variety diversity. Farmers may seek variation in some characteristics while trying to eliminate it in others, such as maturity time or flavour.

Seed supply systems and the ways in which farmers select, keep and exchange their seeds seem to be very important to the final observed patterns of diversity (Louette et al. 1997). In Mexico, the project has found that farmers tend to keep their own seeds for very long periods (often over 20 years) and that, when seed exchange does occur, it is more frequent within the community than between different communities. An interesting interaction with type of variety also occurs. It is more common to lose and acquire seed of early maturing varieties than late maturing ones so that diversity patterns

in early maturing materials are greater. More complex patterns of seed distribution and exchange may also occur. In the high altitude site of Talium, Jumla in Nepal one of the two barley varieties grown is maintained within the village while the other is always obtained from another village of higher elevation.

Who maintains it?

Not all the farmers or all the members of a community play the same part in maintaining a diversity of crop varieties. In Burkina Faso there are substantial differences in women's and men's land ownership and use. Men take responsibility for the main, family field, in which all household members work. In addition young unmarried men and women may have their own smaller plots, in which crops are grown for market sale. Women cultivate their own plots after the family fields have been tilled. They may grow okra, peanut, bambara groundnut, sesame and hibiscus. The cash generated by the sale of these crops is used by the women for household needs. Thus, women play the key role in maintaining diversity of a number of the crops grown by the community.

There are also differences in the amount of diversity maintained by different income groups. In the Begnas Kaski ecosite in Nepal, rich and middle income farmers consistently maintain a larger number of varieties than poor farmers. This may be due to possession of larger amounts of land providing both an opportunity and perhaps a need for growing a wider range of material. In all communities studied there seem to be farmers who are particularly interested in maintaining a large number of varieties of many different crops. These farmers often play a key role in resourcing the seed needs of the community and may be important in any long-term conservation strategy. However, the project has tended to emphasize a community approach and to explore the development of diversity maintenance strategies through community institutions and perspectives and has not developed extensive programmes for working with individual farmers.

What factors influence its maintenance?

It is often assumed that local varieties will inevitably be replaced by modern more uniform varieties and that, in the long-term, on-farm conservation of local varieties is not possible. In many of the areas in which the *in situ* project is working, modern varieties are already common and may be in the majority as far as production area is concerned. Yet, a continuing reduction in area and numbers of local varieties has not always occurred. In Vietnam the numbers of rice varieties in individual villages has changed considerably over the last 30 years, going up in some villages and down in the others. On average, no significant changes were found in numbers of rice varieties per village for six villages in three regions.

The factors that influence the maintenance of local varieties seem to be fairly variable. The degree of isolation of a community, the level of poverty and the type of land available are all important factors in determining current patterns of maintenance. Communities with access to good high quality land and to a range of inputs for modern varieties, may still maintain significant numbers of local varieties for specific environments (e.g. waterlogged land), market niches (high value, high flavour products) or social needs (for ceremonies). This seems to be the case in all the countries where the project is working.

Linking diversity to development

Linking research to development is central to the project. A range of activities in the different countries ensures that the project benefits national conservation programmes, partner institutions and, most importantly, the participating farmers.

Benefits for the farmer include:

- improved access of materials to farmers through developing seed networks, diversity fairs and information bases for farmer-use on the characteristics and value of local varieties;
- identifying materials for participatory breeding and selection;
- identifying locally adapted varieties suited to particular marginal agricultural environments;
- market development for the maintenance of on-farm diversity including better processing, marketing and consumer awareness;
- providing information on nutritional qualities of locally adapted varieties that can provide low cost forms of improved nutrition.

Benefits for conservation include:

- identifying farming system practices where the use of local crop diversity improves ecosystem health, reducing the use of pesticides, herbicides and fertilizer with better adapted genetic resources;
- identifying priority regions and best practices for *in situ* conservation;
- identifying farmers and communities to link into national and provincial plant genetic resource management systems;
- identifying limiting factors to the maintenance of crop diversity on-farm.

Benefits for national development strategies include:

- creating methodologies for integrating locally adapted crop varieties and farmer preferences into national and local development and extension projects;
- determining whether new useful genetic materials from gene-flow are being maintained on-farm;
- making recommendations for national economic and agricultural policy.

The project also supports curriculum development in the formal sector (primary, secondary, extension workers, university) on the conservation and use of local crop diversity. It also has a strong public awareness component on the importance of diversity maintenance.

Conclusions

In the five years since work on the project began, there have been substantial achievements both in the individual partner countries and globally. National frameworks, that include government and non-government sectors, have been created and strengthened to implement *in situ* conservation on farm. Government and non-government organizations have started to work together in teams with farmers. In several participating countries, on-farm conservation has become part of the national conservation action plan. The number of women involved in the work has been increased and there is increased gender awareness within the project.

Community participation in on-farm conservation has been enhanced and diversity fairs and community-based registers for monitoring and use of local crop diversity by farmers have been instituted. Plant breeding has become more decentralized and participative, and products of participatory breeding programmes are becoming available. There is also an increased utilization of local varieties by national plant breeding programmes. Awareness of linking conservation to utilization and mainstreaming local agricultural diversity into development activities has increased within the participating countries and the farmers' contribution to *in situ* conservation has become more visible.

The knowledge base needed to support on-farm conservation is steadily being established. Methodologies have been

developed to collect, analyse and use information on the amount and distribution of genetic diversity, the processes involved in its maintenance and the people involved in maintaining it. The *Training guide to* in situ *conservation* will be tested and revised as new information and experiences are collected. It is important that this process continues. There is often a concern that the research component is taking too long and that practical results are not coming quickly enough. This is dangerous because it can lead to inadequate or incomplete research, which is then used to make decisions that later turn out to be mistaken, damaging both conservation objectives and farmers' livelihoods.

At the same time, a number of important lessons have been learned. First, the amount of time needed to create the necessary framework for implementing an *in situ* conservation on-farm initiative should never be underestimated. In some countries, almost two years were needed for the necessary institutional arrangements and rapport to be achieved between formal, informal, and farmer communities before the research stage of the case study could begin. A second important lesson learned was the need to have precise questions to avoid the project partners collecting too much information. Again, time is needed to formulate relevant hypotheses to test that will be useful for the development of conservation and development management plans.

There are many other projects around the world contributing to the increased understanding of on-farm management of agrobiodiversity. Often the approaches are complementary; different projects focus on different areas of agrobiodiversity conservation. As time goes on it will become increasingly important for the different projects to share their experiences and to complement each other's work. The major challenge will then be to go beyond the relatively small site-specific project and to develop a truly effective national programme. It may be difficult for such a programme to obtain the kind of commitment necessary to transform experimental and investigative projects into a programme at a scale that covers all crops and all production systems for the country. How to do this will remain the next issue on the agenda of on-farm conservation.

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PLEC'S DEMONSTRATION AND TRAINING ACTIVITIES IN A DYNAMIC POLITICAL LANDSCAPE

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Introduction

Recent political shifts in Peru caused the Peru sub-Cluster to adjust its 2001 working plan. When Fujimori and his authoritarian government collapsed, a transitional government was established, which then proceeded to call for a national presidential election.

The issues of sustainable development and biodiversity conservation are part of the political agenda for all politicians. The current electoral environment opened an opportunity for the sub-Cluster to advertize the results and experiences gained from work conducted in Muyuy. PLEC Peru decided to conduct more demonstration and training activities than originally planned. Since December 2000, the PLEC team has organized several workshops, training courses and demonstration activities to show how smallholders are managing and conserving biodiversity in their landholdings. The technical information gathered can be utilized by local politicians in the planning of sustainable development and conservation programmes.

Although the team thereby increased its workload, PLEC Peru continued analysing the information stored in the Cluster's database. Data analysis has provided valuable results to present at demonstration and training activities. Information on resource use patterns and local technologies are organized in tables and charts, some of which are shown below. Also included are comments on the receptiveness of local politicians, researchers and technicians to new and challenging ideas.

Demonstration activities

Demonstration activities benefitted from the support of researchers and technicians from the Instituto de Investigaciones de la Amazonia Peruana – IIAP (The Research Institute for the Peruvian Amazonia) and members of two NGOs. Expert farmers were the main instructors and key players in the planning and implementation of demonstration activities for the local farmers. Several rural agents, teachers and students also participated.

PLEC-Peru conducted a total of six demonstration sessions and working-visits to demonstration sites in January and February 2001. An average of 45 farmers participated in each demonstration activity (Table 1), much the same number as last year. An average of 10 rural agents from government and non-government agencies took part in each session. Most of them had family ties to local farmers. This year rural teachers also participated. They are gradually including locally developed production and management technologies in their courses. An average of 8 teachers and 23 students from rural or agrarian high schools have attended demonstration sessions and work-visits during January and February (Table 1).

Expert farmers demonstrated an array of locally developed cropping, storage and processing techniques. They explained strategies and methods employed for protecting germplasm during flood periods. They also helped to produce posters and other illustrative materials for demonstration

Table 1 Demonstration sessions and work-visits to demonstration sites conducted in January and February 2001

Date	Village	Techniques demonstrated	Number of			
			farmers	rural agents	rural teachers	students
5 Jan	Santana	Storing and preserving seeds of annual crops (corn, beans, etc.) using tobacco, chili paper, catahua, etc.	56	16	7	28
8 Jan	Yarina	Building rise platforms and treatment of soils and organic matter to protect ornamental, medicinal and vegetable species from floods	28	11	9	14
18 Jan	Cañaveral	Land preparation for cropping in silt and sand bars	42	5	3	25
14 Feb	Mazana	Harvesting palm fruits without cutting down the palm	53	8	11	18
18 Feb	San Lorenzo	The *vuelito* agroforestry system to plant forest species that produce fruits and other valuable products	48	12	14	32
24 Feb	Mazanillo	Processing of guava, ubos and other fruits that are planted and managed	45	10	5	24

sessions. Each technique was depicted with pictures, diagrams and/or tables showing the results from data collection. PLEC-Peru is making pamphlets and other written materials displaying the techniques demonstrated. The team will provide these documents to schools and rural agencies to promote locally developed technologies among farmers within and outside PLEC's sites in Muyuy.

Training activities

PLEC-Peru conducted a total of five training activities during January and February. Three were workshops and two were courses on specific production techniques (Table 2).

Workshops

Workshops were organized to inform politicians, business people, government representatives, and leaders of indigenous and farmers' groups on how the residents of Muyuy are producing, managing and conserving diversity. People from the business community and government institutions were the largest group of participants in the workshop conducted in January 10–11. Perhaps the most important result from this workshop was the discovery that the majority of business people and technocrats believed biodiversity could be sold only as part of eco-tourism.

PLEC-Peru presented some examples to illustrate how Muyuy's residents use biodiversity to overcome changes in the market, in state policies, high floods and other natural and social variables. The workshop showed how biodiversity constitutes the most important source of income for smallholders. Data presented on the market value of biodiversity, as well as the income that it generates, helped the participants to understand the many uses for

Table 2 Workshops and training courses conducted in January and February 2001

Date	Place	Subjects	Number of participants
10–11 Jan	Santana	Training course on agroforestry systems for varzea	18
16–17 Jan	Iquitos	Workshop on markets and biodiversity	58
5–8 Feb	Iquitos	Workshop on biodiversity and society	83
15–16 Feb	Mazana	Training course on storing seeds of annual crops	24
22–24 Feb	Iquitos	Workshop on agrodiversity	66

biodiversity in sustainable development planning.

Technologies used by small farmers to produce and manage biodiversity were described in a discussion on the role of society in the formation and transformation of biodiversity. This was the central topic of the four-day workshop conducted at the beginning of February 2001. Discussions were enriched with examples of smallholders' conservation practices documented by PLEC-Peru in the Muyuy site. The majority of participants were politicians and their advisers; several candidates for the upcoming regional election were present. Demonstration sites established in Muyuy, as well as lake reserves, were visited as part of the workshop.

The third workshop focused on agriculture and agroforestry practices and the resultant agrobiodiversity. This three-day workshop at the end of February was organized for researchers and people working in governmental and non-governmental agencies from development and conservation projects in the Iquitos region. Participants discussed agriculture and agroforestry systems which were presented by members of PLEC-Peru and expert farmers. Results from all three workshops were used for developing a Muyuy case study presented at the UNESCO-Columbia University Conference on Biodiversity and Society in May.

Training courses

While workshops were conducted in Iquitos, training courses were conducted in villages. The first course of 2001 was on agroforestry systems in flooded areas and included technicians working in development and conservation projects. Techniques for selecting the best phenotypes of flood-resistant species were explained by expert farmers during training sessions and visits to demonstration sites. Planting, protecting and managing agroforestry crops under the *vuelito* system were explained by the farmer-instructors.

PLEC-Peru also gave a training course on locally developed techniques for storing and preserving seeds of annual crops. This course was conducted at the request of government rural agencies. The expert farmers described and explained how seeds can be protected from insect damage using their own storage and preservation techniques.

Perhaps the most important result of these training courses will be the expansion of techniques learned to other regions. PLEC-Peru is evaluating its training courses to identify the factors that enhance or inhibit the success of training courses.

Data analysis used in the demonstration, training and extension activities

Some of the most relevant results of data analysis had to do with measuring

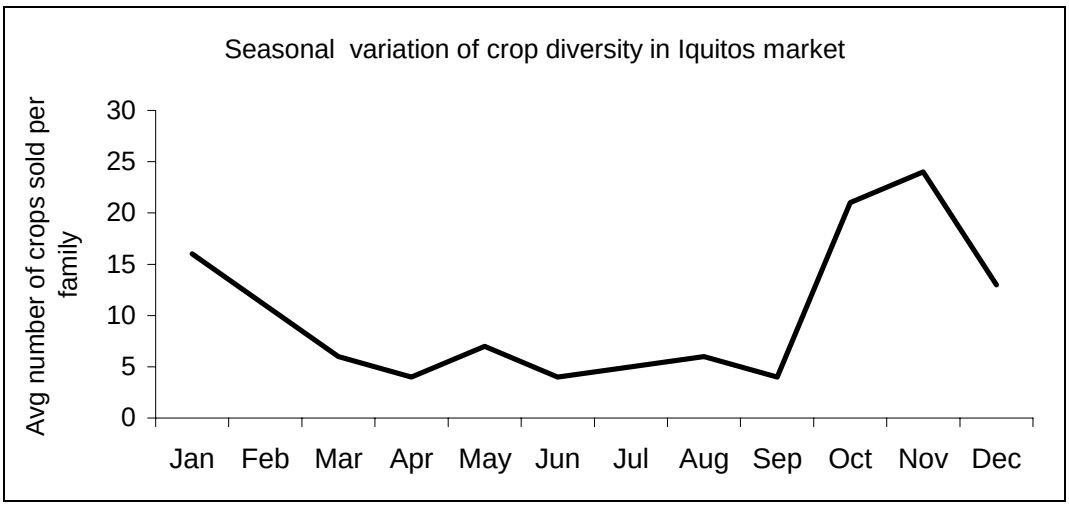

Figure 1 Diversity of agriculture, agroforestry and forest species sold by eight households during the year in the markets of Iquitos

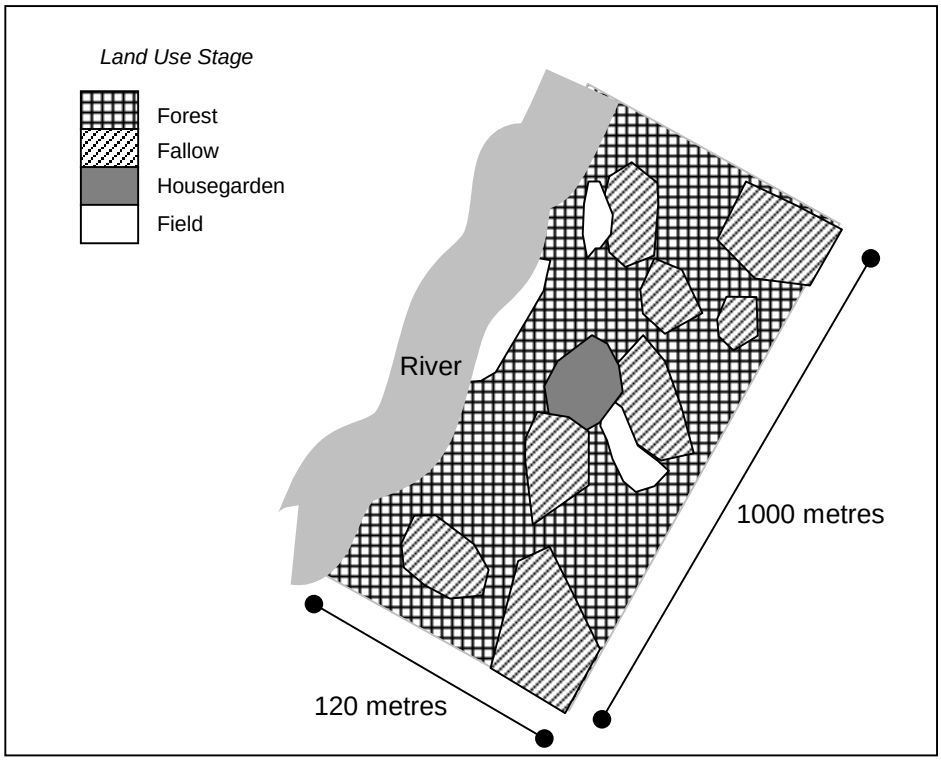

Figure 2 Distribution of land-units forming the patchy landholdings of a Muyuy resident

biodiversity in the marketplace. Based on market data, Iquitos is an urban centre that can absorb a great diversity of products. The data show that residents of Muyuy bring a tremendous diversity of agricultural, agroforestry and forest products to the market throughout the year (Figure 1). The market demand for diversity, rather than volume, is one of the reasons why farmers in Muyuy maintain patches of forests, fields, fallows and house gardens within their landholdings (Figure 2). The data also show that much of the biodiversity produced by small farmers is consumed by poor people living in shanty towns around Iquitos.

Although the social value of biodiversity is appreciated by most people in Amazonia, most development projects in rural areas are still promoting single crops or single products. PLEC-Peru discovered that it was difficult for governmental and non-governmental agencies to obtain agrobiodiversity resources for rural development projects. Data collected by PLEC-Peru can alleviate conflicts between the groups that promote development in rural areas and the farmers who are producing and maintaining biodiversity.

While the capacity of the Iquitos market to consume biodiversity is an advantage for the Muyuy residents, the unstable market prices hinder profits from biodiversity. PLEC-Peru has collected data on the price of several agricultural, agroforestry and forest products. Preliminary results show that very few products produced by farmers have stable prices throughout the day/year. Agricultural products have the most unstable prices in Iquitos markets. The varying prices of one of the most important agricultural products, cassava, are tracked on an hourly basis in Figure 3.

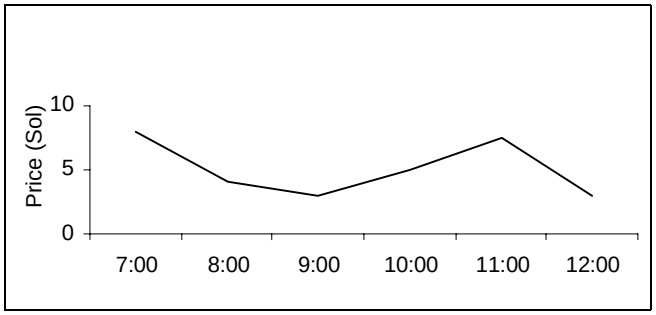

Figure 3 Variation in price per hour of a sack of cassava in February 2001 in the Iquitos markets

Conclusion

The biodiversity found in the landholdings of Muyuy residents is the product of complex production and management technologies. These have been developed, in part, to reduce the risk associated with rapidly fluctuating markets. PLEC-Peru will later present some results on the types, number and intensity of uses of production and management systems employed by the Muyuy residents.

DEVELOPMENT OF DEMONSTRATION SITES IN GHANA

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The demonstration sites

In Ghana various demonstration sites are in development in the major agro-ecological zones. Five have reached an advanced stage. They are:

- Gyamfiase-Adenya, Sekesua-Osonson and Amanase-Whanabenya in the forest-savanna mosaic zone in southern Ghana;
- Jachie in the humid forest zone in central Ghana; and
- Bongnayili-Dugu-Song, which, together with Bawku-Manga, a subsidiary site, is located in the interior savanna zone (Figure 1).

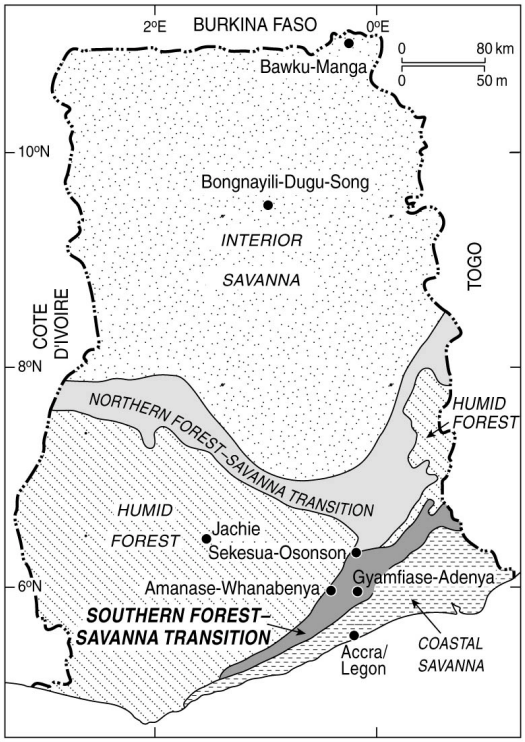

Figure 1 Major agro-ecological zones and PLEC demonstration sites in Ghana

General characteristics

Considerable pressure is exerted on biophysical resources by the high density of the dominantly agricultural population. In the southern Ghana sites, the range is from an estimated 105 to over 180 per km^2, compared to a national average of 70. Numbers of people per household average about nine, while the numbers of children below 18 years average four. This indicates a high dependency ratio, particularly when the aged and infirm are taken into account. In northern Ghana, pressure is exacerbated by large numbers of cattle, goats and other grazing livestock.

In all sites, a major source of demand for resources is from nearby urban centres (notably Tamale and Bawku in northern Ghana, Kumasi in the central sector, and Accra and other coastal towns in the south) for foodstuffs, fuel wood and other primary commodities. In the past, much of the production pressure placed on the southern and central sectors originated from outside Ghana. The demand then was for mineral resources and primary agricultural and forest products, notably palm oil, cocoa and timber.

Effects of increased pressure on biophysical resources have included:

- deforestation;
- change in floral composition from forest tree species to grass and herbaceous species;

- break up of forest canopy and decrease in levels of humidity, which are detrimental to certain crops, notably cocoa, yams and cocoyam (taro);
- deterioration of soil quality;
- declining yields;
- increased monoculture (Gyasi et al. 1995; Gyasi and Uitto 1997).

Yet amidst all these adverse changes, there survive traditional management regimes or practices that conserve biodiversity and secure food. To these are added new agrodiversity practices devised by farmers using their own ingenuity in response to deteriorating production conditions (Gyasi forthcoming). Agrodiversity and food security have also been enhanced by practices introduced through migrations or cross-border movements, including some of an international character.

Activities

Examples of favourable, essentially traditional, management practices, or local adaptations of outside introductions, are listed in Table 1. Among them is traditional agroforestry, which involves cropping among trees left *in situ* on farms. This has the advantages of:

- conserving trees while producing a diversity of food and other crops; and
- regenerating soil fertility through nitrogen fixed by some of the plants and by the substantial biomass they generate.

Table 1 Management practices/regimes, essentially traditional, in PLEC demonstration sites in Ghana

Practices/regimes	Major advantages
1. Minimal tillage and controlled use of fire for vegetation clearance	Minimal disturbance of soil and biota
2. Mixed cropping, crop rotations and mixed farming	Maximize soil nutrient usage; maintain crop biodiversity; spread risk of complete crop loss; enhance a diversity of food types and nutrition; favour soil regeneration
3. Traditional agroforestry; cultivating crops among trees left *in situ*	Conserves trees; regenerates soil fertility through biomass litter. Some trees add to productive capacity of soil by nitrogen fixation
4. *Oprowka*, a no-burn farming practice that involves mulching by leaving slashed vegetation to decompose *in situ*	Maintains soil fertility by conserving and stimulating microbes, and by humus addition of decomposing vegetation; conserves plant propagates including those in the soil
5. Bush fallow/land rotation	A means of regenerating soil fertility and conserving plants in the wild
6. Usage of household refuse and manure in home gardens and compound farms	Sustains soil productivity
7. Use of *nyabatso, Newbouldia laevis* as live-stake for yams	The basically vertical rooting system of *nyabatso* favours expansion of yam tubers, while the canopy provides shade and the leaf litter mulch and humus. It is thought that *nyabatso* fixes nitrogen
8. Staggered harvesting of crops	Ensures food availability over the long haul
9. Storage of crops, notably yams, *in situ* in the soil for future harvesting	Enhances food security and secures seed stock
10. Conservation of forest in the backyard	Conserves forest species; source of medicinal plants at short notice; favours apiculture, snail farming and shade loving crops such as yams

Source: PLEC fieldwork since 1994

Other examples are the no-burn farming that avoids use of fire for clearing vegetation, and which involves mulching by leaving slashed vegetation *in situ* to decompose, in the practice called *oprowka* or *proka* by Akan speaking people. It maintains soil fertility by conserving and stimulating microbial activity and by humus addition from decomposing vegetation. Plant propagation, including from seeds in the soil, is conserved by this method.

Through associations of PLEC farmers, these and other management practices form the basis of PLEC experiments and demonstrations in biodiversity conservation, (Table 2). Foremost among the experiments is one designed to determine the scientific basis of the popular claim by farmers that certain trees combine effectively with food crops, while others do not (Owusu-Bennoah and Enu-Kwesi 2000). Another is the demonstration of how income may be generated from, or value added to, conserved resources through the use of forest maintained in the backyard; plus the use of a biodiverse agroforestry home garden for keeping bees for honey and wax. A further example of a value added activity is the processing of cassava for flour and pastries by PLEC female farmers.

Table 2 Demonstration activities in Ghana

Activity	Outcome	Location
1. Experiment to determine trees that combine or do not combine well with food crops; and to determine optimal tree-food crop spacing	Still under assessment, but initial findings appear to be generally consistent with claims by farmers	Duasin and other locations in Gyamfiase-Adenya
2. Use of selected farms as agroforestry models	• Increased popularity of traditional agroforestry • Apparent improvement in soil fertility and crop yield • Increased fuel wood	All sites in southern and central Ghana
3. Use of home gardens as germplasm bank and source of food; medicinal and other useful plants	• Spread of home gardening • Reported income increase • Growing modelling of school gardens on home garden principles	All sites in southern Ghana
4. Yam management; techniques of planting, staking, harvesting; storing *in situ* in the soil unharvested small yams for use as seeds	• Spread of yam farming involving a diversity of varieties	Initiated in Gyamfiase-Adenya, but spread to other sites in southern Ghana
5. Conservation of over 20 varieties of yam in a demonstration plot at Dugu	• Conservation of a diversity of yams including some already disappearing • Propagation of rare yams among farmers	Bongnayili-Dugu-Song northern Ghana
7. Conservation of sacred forest groves through PLEC farmer associations	• Conserved assorted trees and diversity of other plants • Popular awareness of prospects of conserving biodiversity through conserved forest	All sites in Ghana
8. Medicinal plant conservation through arboreta	• Conserved assorted medicinal plants, which are starting to yield a modest income • Popular awareness of methods and prospects conserving medicinal plants through arboreta	Amanase-Whanabenya and Sekesua-Osonson, southern Ghana
9. Systematic biodiverse farming	• Inspired integration of trees into farming around the Adenya to Gyamfiase road along which the farm is located	Gyamfiase-Adenya, southern Ghana
10. Demonstration of plant propagation by grafting/ budding and split-corm techniques	• Over 100 farmers have learnt the techniques from a PLEC-sponsored training programme at University of Ghana Agricultural Research Station (ARS) or subsequently, through farmer-to-farmer demonstration. An estimated 40 of them are now practising	All sites in southern Ghana

Table 2 continued

Activity	Outcome	Location
11. Pilot plant nurseries through PLEC farmer associations	• Establishment of similar group-owned nurseries in all sites, with seedlings output sold to sustain work of the farmer associations • Inspired privately owned nurseries operated on commercial basis • Propagation of rare exotic and endemic plant species	Initially limited to southern Ghana, but now spread to all sites in the country
12. Biodiversity conservation through a multi-purpose floral and faunal nursery	• Female farmers trained in aspects of biodiversity management, notably snail farming, bee-keeping and plant nurseries, for income	Jachie, central Ghana
13. Experiment in semi-intensive commercial breeding of the giant African snail, making use of the canopy of a huge tree in a conserved forest patch at Obom	• Growing snail population • Demonstration of commercial value awaiting significant increase in snail population	Gyamfiase-Adenya, southern Ghana
14. Semi-intensive commercial raising of rare local breeds of domestic fowl	• Rapid multiplication of fowl • Popular awareness that certain breeds are getting rare, hence a need for their conservation • Growing awareness of the semi-intensive method as opposed to the common free-range method • Commercial value yet to be systematically assessed	Jachie, central Ghana
15. Biodiverse crop-farming using traditional and modern principles	• Increase in farmer income from the diversity of crops raised • Principles integrated into farming by others including school children managing school gardens	Gyamfiase-Adenya, southern Ghana
16. Conservation of rare indigenous varieties of rice by female expert farmers; for domestic consumption and commercial purposes	• Conservation and propagation of disappearing varieties of crop • Improved farmer income from sales	Bawku-Manga, northern Ghana
17. Forest conserved in the backyard for bee-keeping (for honey and wax) as a means of generating income	• Remarkable spread of bee-keeping involving over 30 farmers. This development has attracted substantial financial support from a Ghanaian affiliate of an American NGO	Initially at Sekesua-Osonson, but has now spread to other sites in southern and northern Ghana
18. Development of teak woodlot on a commercial basis	• Popular awareness of prospects of income from woodlots • PLEC female farmers of Sekesua-Osonson plan similar trial • Actual commercial viability yet to be assessed	Jachie, central Ghana
19. Integration of high yielding citrus into traditional farming	• Initial group-owned citrus have started flowering and bearing fruits	All sites in southern Ghana
20. Spinning and weaving of cotton by elderly PLEC females for benefit of younger women	• Acquisition of spinning and weaving skills by young females and potential reduction of unemployment, poverty and out-migration	Bongnayili-Dugu-Song, northern Ghana
21. Processing of cassava into flour for bread and pastries by PLEC female farmers	• Improved rural incomes	Jachie, central Ghana
22. Piggery and sheep raising to be integrated into the conservation process on a commercial basis	• Activity still in formative stage	Amanase-Whanabenya and Gyamfiase-Adenya, southern Ghana

Conclusion

The PLEC goal of seeking best ways of conservation, especially of biodiversity within agriculture, through a participatory approach that draws on local, traditional or indigenous knowledge, is being achieved in Ghana. Commitment of school children is a measure of the growing success and of the promise of sustainability of the PLEC initiative. It is echoed by the following poem titled *The Trees Prayer*, by a young pupil at Tinkong, a village near the Gyamfiase-Adenya site:

> Every year many trees are cut all over the country for timber, firewood, charcoal, farming activities and more. Have you ever stopped to think about the importance of trees to man?
>
> Just look around you. You will find several uses of trees (wood). Think about many things in your schools, offices, homes, churches, mosque and what have you, which are made from wood.
>
> But the trees have many more uses than you can think of. They help us in rainfall, fertilize the soil, check erosion, are used for medical purposes, and give us oxygen to breathe and more.
>
> Trees are so important that we must take very good care of them. We must only cut them when it is very necessary to do so. As far as possible we must plant new trees in place of those we cut and at places where there are none.
>
> Have in mind that when the last tree dies the last man will also die.

(Composed by Vida Kumi, a pupil of the Local Authority Junior Secondary school, Tinkong).

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PLEC EXPERT FARMERS IN GHANA

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Introduction

PLEC (United Nations University Project on People, Land Management and Environmental Change) uses knowledge of smallholder expert farmers as a basis for demonstrating effective ways of conserving agrodiversity.

In Ghana, excluding their family members, PLEC farmers are estimated to number more

than 600 in the five leading demonstration sites (Gyamfiase-Adenya, Sekesua-Osonson and Amanase-Whanabenya in southern Ghana; Jachie in the central sector; and Bongnayili-Dugu-Song with one subsidiary site (Bawku-Manga) in northern Ghana; and an emergent site (Tano-Odumasi, central Ghana).

Among the farmers are many experts in agrodiversity management, who lead demonstrations at the sites. They include those profiled below. The profiling is in recognition of the salutary role of smallholder farmers in conserving biodiversity as part and parcel of agricultural practice.

Expert farmers in Amanase-Whanabenya

Salathiel Yemotey Freeman

Age (years): 69

Marital status: Married with eleven children

Educational background: Fire Service Technical College, Great Britain

Occupation: Farmer; retired Fire Service Officer

Farming/agrodiversity expertise: Biodiverse crop farming

Position in the PLEC Farmers' Association: Chairman, Amanase-Whanabenya PLEC Farmers' Association

Unique contribution to PLEC: A pioneer PLEC farmer, who has chaired Amanase-Whanabenya PLEC Farmers' Association since its inception. Regenerated on his land a deforested patch into a biodiverse forest that serves as a model in forest regeneration and conservation under the popular name, 'PLEC forest'. Leased portions of his land for a major plant nursery and a commercial biodiverse crop farm owned and operated by the PLEC Farmers' Association.

Rosamond Appiah

Age (years): 59

Marital status: Single with four children

Educational background: Teachers Training College

Occupation: Teacher who combines trading and farming as subsidiary occupations

Farming/agrodiversity expertise: Home gardening

Position in the PLEC Farmers' Association: Member, Amanase-Whanabenya PLEC Farmers' Association

Unique contribution to PLEC: The model home gardener in Amanase-Whanabenya demonstration site.

Expert farmers in Gyamfiase-Adenya

Victoria Odum Asiedua

Age (years): 55

Marital status: Married with nine children

Educational background: Middle School Leaving Certificate

Occupation: Farmer and trader

Farming/agrodiversity expertise: Mixed cropping with a special emphasis on onions and yams

Position in the PLEC Farmers' Association: Women's organizer, Gyamfiase-Adenya PLEC Farmers' Association

Unique contribution to PLEC: Instrumental in organizing women for the cause of PLEC in Gyamfiase-Adenya demonstration site.

George Amponsah Kissiedu

Age (years): 53

Marital status: Married with six children

Educational background: General Certificate of Education (GCE) 'O' level

Occupation: Farmer and former Field Assistant in the Cocoa Services Division of the Ghana Cocoa Board

Farming/agrodiversity expertise: Oprowka, a mulching and no-burn farming system; biodiverse crop farming; plant nursery

Position in the PLEC Farmers' Association: Secretary to the PLEC Farmers' Association, Gyamfiase-Adenya demonstration site. The very first PLEC farmer when PLEC work started in 1993 in Ghana

Unique contribution to PLEC: Highly knowledgeable in: medicinal plants; local names of trees, other plants and their utility; and traditional farming including cropping alongside trees left *in situ*; developed increasingly popular biodiverse crop farming based on traditional and modern principles; instrumental in integrating school children into PLEC work. A driving force in development of Gyamfiase-Adenya as a demonstration site.

Expert farmers in Sekesua-Osonson

Felicia Naatey

Age (years): 50

Marital status: Widowed with seven children

Educational background: Secondary form 2

Occupation: Farmer and trader

Farming/agrodiversity expertise: Mixed cropping with emphasis on tomatoes

Position in the PLEC Farmers' Association: Leader of the women's group, PLEC Farmers' Association, Sekesua-Osonson

Unique contribution to PLEC: Inspires mobilization of women for the cause of PLEC.

Expert farmers in Sekesua-Osonson (continued)

Emmanuel Kwadjo Nartey

Age (years): 46

Marital status: Married with four children

Educational background: Middle School Leaving Certificate

Occupation: Farmer; former employee of Akosombo Textiles Company Limited

Farming/agrodiversity expertise: Bee keeping; home gardening (agroforestry)

Position in the PLEC Farmers' Association: Financial controller of the Association of PLEC Farmers, Sekesua-Osonson demonstration site

Unique contribution to PLEC: An outstanding exponent of the PLEC purpose. His home garden of the agroforestry type serves as a model in sustainable biodiverse farming. Spearheads demonstration of how value may be added to and income generated from conservation through bee-keeping in conserved forests. A key factor in the attraction of substantial support by an NGO for development of apiculture through the Association of PLEC Farmers in Sekesua-Osonson demonstration site.

Expert farmers in Jachie and Tano-Odumase

Cecilia Osei

Age (years): 52

Marital status: Widowed with four children

Educational background: Middle School Leaving Certificate

Occupation: Farmer

Farming/agrodiversity expertise: Commercial food production; expert in maize, cassava and yam production, and in bee, mushroom, poultry and snail farming

Position in the PLEC Farmers' Association: President of PLEC Women Farmers Association, Jachie demonstration site

Unique contribution to PLEC: An expert farmer, and instrumental in the formation, establishment and daily management of the PLEC Women Farmers Association of Jachie. A key player in disseminating PLEC. Promoted biodiversity conservation and community/school woodlots by attracting support of government departments and religious organizations.

Expert farmers in Jachie and Tano-Odumase (continued)

J. C. Oppong

Age (years): 51

Marital status: Married with seven children

Educational background: Middle School Leaving Certificate

Occupation: Farmer

Farming/agrodiversity expertise: Proka/oprowka mulching and no burn farming system; a specialist in oil palm, citrus and cocoa farming, rabbitry and local poultry production. Also an expert in traditional medicinal plant collection and utilization

Position in the PLEC Farmers' Association: President, Tano-Odumase PLEC Farmers Association

Unique contribution to PLEC: As an expert farmer, he has demonstrated to other farmers in and around Tano-Odumase agro-technologies gained through PLEC. Responsible for organizing PLEC members in nursery establishment, bee-keeping, mushroom production, and snail and rabbit farming.

Expert farmers in Bongnayili-Dugu-Song and Bawku-Manga

Abdulai Sumani

Age (years): 52

Marital status: Married with three children

Educational background : No formal education

Occupation: Farmer/Pastor of Assembly of God church

Farming/agrodiversity expertise: Grafting of fruit crops; nursery techniques/ transplanting; dry season cultivation of vegetables on residual moisture; and composting

Position in the PLEC Farmers' Association: Chairman, Dugu PLEC Farmers Association

Unique contribution to PLEC: Main organizer of PLEC field activities at Bongnayili-Dugu-Song main demonstration site. He is in charge of animation and contact with all the 18 communities with whom northern Ghana PLEC group works.

Gifty Akparibo

Age (years): 35

Marital status: Married with children

Educational background : Basic (primary) level

Occupation: Farmer

Farming/agrodiversity expertise: Farming of indigenous varieties of rice, dry season vegetable farming

Position in the PLEC Farmers' Association: Secretary of Kusanaba Agoare PLEC women group at Bawku-Manga subsidiary demonstration site, northern Ghana

Unique contribution to PLEC: Instrumental in organizing cultivation of local rice varieties in Kusanaba, in the subsidiary site. Actively involved in the production of vegetables as source of additional income in the lean, 'hungry' dry season. Promotes other PLEC activities.

USING FARMER-LED EXHIBITIONS OF AGROBIODIVERSITY TO REACH POLICY MAKERS AND OTHER FARMERS: EXPERIENCES OF PLEC–UGANDA

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Editors' Note

Last year the PLEC team in Uganda undertook to gauge how widely the PLEC philosophy had become known in one of its demonstration areas. A major concern was how to reach more policy makers and stakeholders at local, regional and national levels. The method chosen for this public relations exercise is described below.

Introduction

Bushwere is one of the five parishes of Mwizi sub-county in Rwampara County in the Mbarara district of southwestern Uganda. Bushwere has a population of about 5000 people comprising approximately 500 households. PLEC is collaborating with nearly one-fifth of these households through one or more of the following ways:

- biodiversity/agrodiversity monitoring of plots (96 fields of 80 households);
- demonstration activities (there are nine 'expert farmers'/innovative demonstrators);
- farmer experimentation with promising technologies for biodiversity conservation and use (14 households);
- working with community or farmer groups.

Demonstrations started with four expert farmers in 1999, increased to six in 2000 and to nine by January 2001. As new ideas were incorporated, demonstration farmers trained others on their farms and formed common interest groups. The Bushwere zero-grazing crop integration association (BUZECIA) formed around one expert farmer following his three demonstration sessions. Ten farmers are now experimenting with different systems of intercropping fodder species with banana cultivation. Eight take monitoring measurements with the help of PLEC scientists. The group has made an outreach visit to three other similar farmers in neighbouring communities.

Another four farmers are investigating post-harvest handling and storage of crops. One demonstrates uses of different banana plant parts, while another demonstrates agronomic control of weeds and weevils in valley plantations. Bushwere, like the rest of Mwizi sub-county and other high potential highland areas of Uganda, has a banana and annual crops based farming system.

How the farmer-led exhibition idea evolved

The PLEC approach of working initially with only a few farmers often aroused curiosity, and in some cases jealousy, among neighbouring farmers and villages. Some approached PLEC seeking to be included. Collaborating farmers have expressed concern that local leaders in Bushwere did not actively participate in technical issues of development as much as they did in political and social or infrastructural matters. Yet those local leaders were expected to mobilize their communities for development activities in the area.

In order to attract the local leaders and to ensure sustainability of PLEC activities in Bushwere, PLEC scientists discussed with the PLEC farmers ways to reach out to the rest of the community. This resulted in the decision to hold a farmer-led exhibition of agrobiodiversity potential in the demonstration site.

The PLEC farmers enthusiastically formed a local organizing committee comprising eight men and six women. They nominated the Agricultural Extension worker who is also a field assistant to the PLEC Project, as their adviser, and held four meetings to plan activities. PLEC scientists were invited to the fifth, and helped the farmers organize their exhibits into 15 categories. The farmers provided local names for each species and variety while the PLEC team provided the respective English and/or scientific names. They also facilitated the selection of a few thematically relevant skits, songs and dances out of the many that were prepared by interested groups.

The PLEC–Uganda Project Management team agreed to facilitate publicity by radio announcements, to provide materials for posters, and transport of exhibits and invited participants. The farmers would cook and serve lunch. Leading members of the local councils and schools, the parish chief, District Officers, the Dean of Agriculture, Makerere University and the Resident District Commissioner (Mbarara) were then invited.

The exhibition

The exhibition was conducted in six sessions. All proceedings were held in the local language.

Session I

Highlights of PLEC methodology and findings on agrodiversity and biodiversity conservation in Bushwere were introduced.

Session II: *Stall exhibitions of agrobiodiversity*

- 25 different crops, showing different varieties (both indigenous and introduced);
- wild edible plants e.g. *Ekituruguma* used to make traditional dishes and drinks which the youth no longer use regularly;
- over 50 species of medicinal plants for human medicines and livestock drugs;
- 15 fodder species;
- soil and water conservation species, e.g. *Setaria* grass, elephant grass;
- apicultural plants; for nectar and pollen collection; and for making beehives;
- apiculture products; honey for home use and sale, wax for sale (for making candles);
- different woody species (trees and shrubs) for construction and building;
- products of local biodiversity: handicrafts, wood carvings and basins, stools, wooden parts of saws, calabashes, clay pots;
- the biggest banana bunch in Bushwere weighing 80 kg and how it was produced.

This session was fascinating for the non-PLEC participants. The large number of crop varieties and other biodiversity potentials displayed encouraged both policy makers and farmers that there was still hope of conserving genetic resources; and that these, if managed properly, could boost production and improve rural livelihoods. There was a general confession of ignorance of the existence of such a great potential of food and cash resources, and even more so of the local people's ability to demonstrate this to policy makers.

Session III: On-farm exhibitions

Two on-farm exhibitions were given by PLEC farmers. For logistical reasons the audience had to be limited to invited guests and policy makers.

- The first farmer showed how to increase biodiversity conservation and improve household welfare by integrating stall-feeding (zero-grazing) cattle with banana production. He emphasized the purposeful growing and spatial arrangements of different fodder species, soil and water conservation grasses and banana varieties, and the complementarity of plant diversity and zero-grazing cattle in increasing income.

- The second farmer showed the use of biodiversity for post-harvest handling of farm produce. In the past he used to lose a large part of his produce to pests. Yet he had woodlots, shrubs and banana leaves which he could have used to construct a modern store for drying and conserving the produce. He thanked the PLEC Project for showing him how to build a rat-proof modern crib.

Session IV: Local music, dance and drama

Highlights of the impact of PLEC in Bushwere were presented in songs, dances and drama. These did not only simplify the message of biodiversity conservation. They also increased participation of different community and household members from several ethnic groups. One caution here is that more groups and individuals wanted to participate than could be selected, causing disappointment.

Session V: Policy makers increasing biodiversity

Policy makers helped increase useful biodiversity in Bushwere, by planting economically and environmentally beneficial trees (both indigenous and exotic species) on the windward side of the hosting primary school. Species included *Grevillea, Casuarina, Neem* and *Combretum.* Two methods of drip irrigation were shown, using perforated re-cycled materials—a calabash, and disposable empty mineral water bottles. This was an new exciting activity for the spectators. Most of the policy makers pledged to incorporate PLEC concepts in their official work and farming.

Session VI: 'PLEC in Action' Posters

Posters and photographs depicted the following:

- transect work during preliminary surveys—mostly showing the biodiversity potential of Bushwere;
- demonstration activities, PLEC farmers training other farmers in good practices of conserving biodiversity;
- farmer field visits and sharing of experiences.

Evaluating the farmer-led exhibition approach

Table 1 is based on the registration lists. 548 adults attended the exhibition, of which 52% were women. In addition over 200 children were present. The 29 policy makers included six administrators, 15 political leaders and eight technocrats. They represented all three administrative levels (parish, sub-county and district headquarters) of Mbarara district. About 16 had attended previous sensitization and feedback workshops, and seven were new participants. PLEC farmers composed only 8% of the participants.

Table 1 Distribution of Bushwere farmer-led exhibition participants by category and administration levels

Category	Number of participants per administration level			
	Bushwere	Sub-county H/Q and other parts of Mwizi	District (H/Q)	Total
Policy makers	14	6	9	29
Non-PLEC farmers	443	11	-	454
PLEC farmers	44	2	-	46
Children	?	?	?	200
News reporters	1	-	4	4
School teachers	6	1	-	7
Extension workers	2	1	1	4
Religious leaders	3	1	-	4

The good turn up of people from a wide area and the fact that participation was enthusiastic till the end of the day showed that the function successfully increased PLEC's impact on the community.

Analysis of responses to evaluation questions showed that the majority (78%) of the participants learned of the exhibition by radio announcements and 11% by word of mouth from PLEC farmers. All participants admitted new knowledge of PLEC and the potential and usefulness of agrobiodiversity and its conservation in Bushwere. They said they understood that PLEC works with farmers as partners, but they expected this combined effort to look for solutions to production constraints.

There was some very positive feedback from different groups.

Feedback from policy makers

The immediate reaction from the sub-county chief was to invite the PLEC team and the Bushwere PLEC farmers and drama groups to put on a similar exhibition at 'Rwampara day', a county wide celebration. Generally, there was greatly increased realization among policy makers of how much local people knew and needed to know about agrobiodiversity, and an appreciation of the PLEC household approach which enabled husbands and wives to work together.

Some policy makers, particularly the technocrats, requested copies of PLEC's findings, so that they could use them in policy formulation and development plans. They suggested that such exhibitions should be staged for wider audiences, including NGOs, political leaders and national level stakeholders like NEMA, Ministry of Agriculture.

Continuity of PLEC work after donor funding ceases was raised as a concern. It was hoped that the Ugandan government and donors would strengthen support for PLEC and enable it to spread and continue for another ten years.

Feedback from non-PLEC farmers

Many non-PLEC farmers were keen to collaborate with PLEC, having gained a much better idea of their own agricultural potential and of the importance of properly managing resources (especially the soil, crops and trees). They recognized the importance of biodiversity to peoples' livelihood and the benefits of cultural diversity and traditions in land management. They hoped their rural livelihood would be sustainable through generations.

There was general appreciation of the Exhibition, 'even though some people missed lunch'; and an appeal for PLEC to stay at least five more years in Bushwere.

Other feedback

The school teachers pledged to incorporate PLEC concepts in their teaching of agriculture and environmental issues, through demonstrations, school clubs and competitions. They also pledged to plant more trees as appropriate for better school compound management.

Ingredients of success

The basic ingredients for success of the farmer-led exhibition approach in Uganda were:

- encouragement by PLEC of collaborating farmers (both individually and in groups) to take the lead. During fieldwork on the PLEC project, farmers had learned anew that they were the custodians of their land resources and agrobiodiversity, and that it was their responsibility to disseminate information about the importance of conserving these resources;
- delegation of responsibility to the local organizing committee enabled them to exploit their potential and gain in self-confidence. This significantly reduced

the cost of PLEC staff inputs. It was also more impressive to the local people and to the policy makers;

- regular networking and coordination with relevant stakeholders, especially policy makers, sustained their interest in PLEC work resulting in a good response to invitations;
- the use of modern technology. Slides and overhead projectors plus use of photographs of local people involved in PLEC work attracted the full attention of all participants. It boosted the local community's prestige, and trust in PLEC. Seeing the photographs on posters reassured farmers that PLEC was for them, dispelling misconceptions that photos taken of them were sold to foreigners;
- using the local language for presentations and discussions enhanced participation and saved time;
- purposeful use of music, dance and drama.

The specific objective of the PLEC team of sensitizing a wider community to PLEC concepts, goals and activities was successfully achieved. A big audience was reached in a very short time and with minimal resources. The PLEC message was able to impact several different levels of stakeholders (farmers, village leaders, sub-county and district level leaders) at the same time.

What did not work so well and lessons learned

1. While the on-farm demonstrations were a success in respect to policy makers and local leaders, they represented only a small part of the large audience, due to time and transport constraints.
2. Most of the stall exhibitions were displayed indoors (in classrooms), for fear of interruption by rain. This caused crowding during viewing, and blocking of windows, which interfered with photographing and video recording. Spacious outdoor stalls with rainproof facilities are recommended for such exhibitions.

Conclusion

The farmer-led exhibition approach has much to commend it as a means of disseminating good practice in PLEC demonstration sites. It holds major advantages in:

- being community-led and hence more impressive to local people than externally imposed activities;
- being full of activity and interest involving real farmers and demonstrations;
- not requiring major subsidy from outside, yet attracting a lot of local interest;
- giving PLEC farmers a much higher profile and direct access to policy makers.

Of course, the approach does have a few dangers. Some people feel excluded. Drama and exhibitions may not meet people's preconceived ideas as to what they need (e.g. modern irrigation equipment). So to explain what PLEC is doing and what it is not is difficult. The main challenge is to adequately sensitize and encourage the collaborating farmers to realize their central role as custodians of resources and owners of good practice, and their capability to disseminate this knowledge. On balance the approach is well worthwhile as a low-cost means of spreading demonstration site experience to a much larger stakeholder base.

PROMOTING SUSTAINABLE AGRICULTURE: THE CASE OF BAIHUALING, YUNNAN, CHINA

Dao Zhiling[1], Du Xiao Hong[2], Guo Huijun[3], Liang Luohui[4] and Li Yingguang[5]

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PLEC-China was one of the early Clusters working with farmers on demonstration activities before GEF funding in 1998. Activities started in Baihualing village, one of four research sites in Yunnan, China. With GEF funding, the village later became a demonstration site. This paper will describe agrodiversity in Baihualing and review the experiences and lessons learned during the eight years working on demonstration activities in the village, during which there have been important changes in our methods. At the beginning we sought to meet farmers' needs by something akin to an extension approach. But this neglected farmers' own roles in developing sustainable agroforestry systems. Some locally developed agroforestry is biodiversity rich, and productive. In 1999 we moved to a farmer-led approach, emphasizing the role of innovative farmers in diffusion and improvement of technologies.

Baihualing and its agrodiversity

Baihualing Administrative village is located on the eastern slope of the south part of the Gaoligongshan Mountains, western Yunnan, China. The slope is on one side of the valley of the Nu Jiang River—the upper stream of the Salween. The village lies between 850 and 2000 metres above sea level, and the upper part borders the State Nature Reserve of the Gaoligongshan Mountains.

The Reserve is well known for the richness and uniqueness of its flora and fauna (Li Heng, Guo Huijun and Dao Zhiling 2000). An ancient path—known as the 'Southern Silk Road'—goes through the village from China to Burma and India. Due to its special location in a biodiversity-rich environment and long history of cultivation, Baihualing is a good example of high agrodiversity.

The land area of Baihualing village is 1810 hectares or 27,150 mu (Table 1). Population numbers 2180 persons, including the Han, Bai, Lishi, Yi, Hui, Zhuang, and Dai ethnic groups (Table 2).

Table 1 Land types and area of Baihualing village

Land Type		Area (ha)
Community forest		1,020
Farm land	Wet-Rice	141
	Upland	80
Upland newly opened in community forest		269
Fallow		210
Settlement		54
Road		15
Water		21
Total		**1,810**

Table 2 Ethnic groups of Baihualing and Hanlong

Ethnic groups	Population	
	Baihualing	*Hanlong*
Han	1,165	132
Bai	394	26
Lishi	367	22
Yi	161	15
Hui	81	0
Zhuang	9	0
Dai	3	1
Total	**2180**	**200**

PLEC fieldwork takes place mainly in Hanlong, which is one of ten natural villages in Baihualing Administrative Village. There are 48 households with a population of around 200. The Hanlong community is located in the highest part of the Baihualing village, and has a large area of forest and upland fields (Table 3). Its wet-rice fields are located three to five km away from the village proper, in the far valley of the Zhaotang stream. It takes a lot of labour to manage these fields.

Table 3 Land types and area (mu 1/15 ha) of Hanlong community

Land-use stage	Area (ha)	Area (mu)
Wet rice	15.0	225.0
Upland	12.0	180.0
Forest	100.0	1500.0
House gardens	1.7	25.5
Total	**128.7**	**1930.5**

Most upland fields are distributed around the village proper while the community forests are distributed above the village and bordering the Nature Reserve. There are seven major land-use stages and 22 field types in Hanlong. A general description of these is provided in Table 4.

Demonstration activities

Economic development remains the foremost objective of the Baihualing people because they are poor. However, the boundary of the State Nature Reserve of the Gaoligongshan limits extensive development of agriculture, the village's main livelihood. This leaves only an option of agricultural intensification, as the village is remote from any cities. For many years, sugarcane has been an important cash crop in the village and, with the support of a nearby sugar factory, has been expanded into uplands which were formerly rich in biodiversity. The expansion was detrimental to both biodiversity and soil fertility. Some sampling plots in natural forests examined for the biodiversity inventory have since been completely cleared and changed into sugar or coffee plantations.

Alternative cash crops and good practices needed urgently to be promoted in order to counteract expansion of sugarcane monoculture, and to diversify cash cropping for sustainable development (Guo Huijun, Li Heng and Dao Zhiling 2000). There is a long tradition of agroforestry practices in this area. It was rational for PLEC to promote profitable agroforestry through relevant demonstration activities.

Approaches to demonstration

The approaches to demonstration in Baihualing have evolved since 1995, when demonstration started with support from a MacArthur Foundation project. The initial approaches included both demonstration farmers and something rather like the standard extension programme that emphasized the role of technicians in teaching about new crops and management techniques. The combined approach met well the needs of many farmers who were eager to learn about new cash crops and their management. The technicians also gave special instruction on intercropping of cash trees with annual crops.

Table 4 Land use stages and field types of Hanlong village

Land use stage	Field types	Management
1. Natural forest	FT1 Timber forest	Upper part of community forests close to Nature Reserve, usually for timber
	FT2 Fuelwood forest	Middle part of community forests for fuelwood
	FT3 Scenery forest	Close to village site and near by the road or path
2. Cultivated forest	FT1 Chinese fir forest	Introduced timber trees, usually planted on steep sloping upland fields or around upland fields, young trees inter-cropped with corn before shade formed
	FT2 *Phoebe puwenensis* forest	Native timber species, naturally growing in the Gaoligongshan Mountain around 1800 m above sea level, domesticated by local farmers more than thirty years, seedlings prepared by farmers and planted on slightly steep fields
	FT3 *Toona ciliata* forest	A native tree, seedlings obtained from old tree sprouts, cultivated on sloping farmland or in home gardens
3. Agroforests	FT1 Chestnut	Usually intercropped with maize, beans, planted on upland fields
	FT2 Persimmon	As above
	FT3 Walnut	As above
	FT4 Coffee	As above
	FT5 Tea	Monocropping or as above
4. House gardens	FT	Trees planted on the edge, herbs and vegetables in the garden
5. Fallow	FT	Used for pastures, very small area
6. Annual cropping on upland field	FT1 Maize intercropped with other annual crops	In summer
	FT2 Pea monocrop	In winter
	FT3 Sugarcane monocrop	Change to plant maize after three years
7. Annual cropping in wet-rice field	FT1 Wet rice monocrop	In summer
	FT2 Sugarcane monocrop	Change to plant wet rice or other annual crops after three or four years
	FT3 Potato monocrop	In winter
	FT4 Wheat monocrop	In winter
	FT5 Maize intercrop	Both in summer and winter
	FT6 Tobacco monocrop	In winter

Extension activities

Several training courses on techniques of planting fruits such as grafting, pruning, prevention and cure of plant diseases were organized to help farmers expand areas of coffee, orange, chestnut and persimmon as alternatives to sugarcane. The expansion and diversification has increased farmers' income and reduced risks arising from market fluctuation. Table 5 summarizes the results achieved.

Table 5 Area and production of main cash tree crops in 1997 and 2000 in Baihualing village

Crop	Area (mu)		Yield (kg)	
	1997	*2000*	*1997*	*2000*
Walnut	35	150	500	3,200
Chestnut	50	130	600	4400
Coffee	82	1,272	1,200	18,500
Longan	10	480	1	120
Persimmon	4	4	80	93
Orange	43	42	172	970

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

Table 6 Comparison of productivity between agroforestry and monocropping in Hanlong village

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

Note: 15 chestnut trees/mu, 5 years age ; local market price.

Coffee has become an important new cash crop in Baihualing due to its relatively high profitability. On average, the income from coffee is 1100 yuan (about 8.3 yuan equal to 1 US dollar) per mu, while it is only 800 yuan per mu for rice. With PLEC support, Mr. Sai Huwa experiments with intercropping coffee with vegetables and fodder crops, in contrast to the monoculture of coffee by other farmers. He has put 30 mu of his contracted and rented fields together for a coffee plantation and has made good money. As coffee is a new crop, most farmers need some time as well as external advice to manage it well.

Also under PLEC support and technical guidance, Mr. Yang Zhixue has developed an intercropping system of chestnuts, peach, maize, and peas on steep uplands. The productivity of the agroforestry systems is much higher than the former cropping patterns (Table 6).

Expert farmer-led demonstration

The approach described above neglected the farmers' own role in developing sustainable agroforestry systems. Since 1999, PLEC household-based assessment has identified several innovative farmers and their practices in Hanlong and other communities in Baihualing. These farmers are very experienced in management of cash crops, and some of them have developed sustainable agroforestry systems, which they are encouraged by PLEC to demonstrate. In contrast to the extension approach, the modified approach emphasizes the role of innovative farmers in diffusion and improvement of technologies.

Household survey and agrobiodiversity assessment showed that farmers differ in the management of biodiversity for their livelihood. Nine expert farmers were selected in 1999 and one was added in 2000 on the basis of their farming skills. Expert farmers are further divided into generalist farmers and specialist farmers. The former have multiple skills in management of soil and diverse cash crops. The latter have one or two special skills in management of soil or cash crops. Details about the ten farmers are provided in Table 7.

Table 7 Expert farmers and their skills

Household (farmer)	Demonstration type	Natural village	Main skills
Wu Chaoming	Generalist	Hanlong	Walnut, chestnut, *amomum*, coffee, honeysuckle plantation, home garden, grafting
Yang Zhixue	Specialist	Hanlong	Walnut and chestnut based agroforestry systems management
Gao Denglin	Specialist	Da Yutang	Grafting
Yang Xiubo	Generalist	Da Yutang	Upland management and timber tree plantation
Chen Shihou	Specialist	Mang Gang	Nursery and seedlings
Mi Yunheng	Specialist	Mang Gang	Chinese fir plantation
Yang Chengwu	Specialist	Gu Xinzhai	Home garden
Zheng Jiafan	Specialist	Baihualing	Dry fruit tree plantation
Li Jiahu	Specialist	Mang Gang	Fruit tree plantation
Li Dayi	Specialist	Tao Yuan	Native timber tree plantation

Mr. Wu Chaoming is one of the best expert farmers, managing his farmlands diversely and well. He was also one of earliest farmers to turn his annual cropping upland into a perennial biodiversity-rich system since the individual allocation of former community land under the Household Production Contract System in l982. One of the plots his household received in 1982 is about 7.5 mu, which used to be for annual crops such as maize and beans. Because this plot of land is too rocky and steep to continue farming annual crops, he has planted different trees, such as walnut, chestnut, Chinese fir, *Zanthoxylum*, flowering quince, and bamboo. Some wild species regenerate naturally, such as *Phoebe puwenensis*, *Pinus armandi* and *Lindera communis*. There are now more than 100 species in his agroforestry plot.

Mr. Wu also does a lot of experimentation in his small but diverse home garden. There are 73 species in his garden, 71% are useful species. He has grafted many pear, persimmon, and new apple varieties on to local variety trees; and has prepared grafted seedlings of walnut and chestnut and cardamom (medicinal use) seedlings. Mr. Wu tells young farmers that when you cultivate a tree crop, planting counts for only 30% of the effort, while management absorbs 70%. He often discusses grafting techniques with older farmers and teaches the younger generation both in his house and in his fields. Mr Wu, who has a large family, is now one of the most prosperous farmers in Hanlong.

Mr. Li Dayi is an expert in tree plantation. *Phoebe puwenensis* is a preferred native timber in Baihualing. His household received two hectares of upland from the cooperative for maize in 1982. Since 1983 Mr. Li has prepared seedlings and transplanted them and other timber trees in his uplands. In 1995, he rented about two hectares of land from other villagers for expansion of his native tree business. He also started to provide seedlings of *Phoebe puwenensis* to other farmers, and to train them in plantation techniques, with support from both PLEC and the MacArthur Foundation (Guo Huijun et al. 2000). At present, all of his uplands are covered by timber trees and other cash crops (*Amomum villosum* etc.). He also prepares seedlings of coffee and timber trees.

Usually, farmers exchange their ideas informally. It is difficult to organize a large meeting of farmers. It is more convenient for farmers to meet in the fields accidentally and exchange their ideas. Expert farmers demonstrate their skills in the fields, not in the house and are happy to share their knowledge with other farmers. For example, Mr. Yang Zhixue helps four farmers with land around his chestnut agroforestry plot teaching them management techniques. Another example is Mr. Chen Shihou. He began cultivating a traditional rice variety of high quality instead of hybrid rice two years ago. Now, more and more farmers are following his example and cultivating this variety because of its high quality and high market value.

Gaoligongshan Farmers' Association for Biodiversity Conservation

Gaoligongshan Farmers' Association for Biodiversity Conservation was established in Baihualing in 1995 to coordinate biodiversity conservation and rural sustainable development. It also provides a bridge between government departments (State Nature Reserve) and communities, and between projects and farmers. The Association began in Hanlong, but has now expanded to include members in other natural villages. Membership now numbers 108, ten of them women. Several training courses in practical agricultural techniques and biodiversity conservation have been organized. One of the new roles of the Association has been to identify expert farmers in agrobiodiversity management, and to take an important part in the organization of PLEC demonstration activities.

Effects of PLEC demonstration on intensification

In summary, sugarcane has been the dominant cash crop in Baihualing village. A large part of upland fields on the slope below the Nature Reserve used to be devoted to sugarcane and maize in rotation. However, this pattern is changing. The sugar price is unstable, and the factory is demanding a high quality of sugarcane that should be grown below 1300 metres. The sugarcane plantation is very destructive of soil quality as well as biodiversity. As a result, some risk-taking farmers and expert farmers have successfully developed profitable agroforestry systems of fruits, timber and coffee as an alternative to sugarcane. They replace sugarcane on the uplands above 1300 metres.

PLEC demonstration activities, including extension of new crops and techniques, and farmer-to-farmer exchanges, have facilitated gradual diffusion of environmentally friendly and profitable systems in Baihualing village. The leadership of Baihualing village has remarked that that the PLEC project, especially the farmer-training courses, have promoted development of cash tree plantations, which have increased farmers' income and the conservation of flora and fauna in and around the Nature Reserve.

In spite of these positive changes, monocropping of newly introduced cash crops (especially coffee) is expanding. This could become another dominant way of production, displacing biodiversity-rich systems and associated native crops, if their environmental and social benefits are not appreciated and supported.

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Edited by Harold Brookfield, Christine Padoch, Helen Parsons and Michael Stocking

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