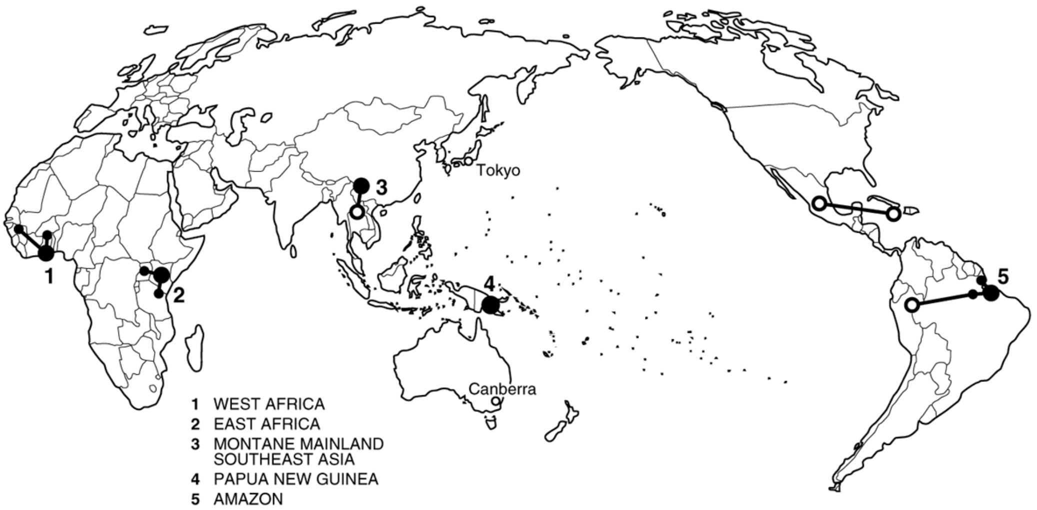
THE UNITED NATIONS UNIVERSITY Project on People, Land Management and Environmental Change (PLEC)

PLEC NEWS AND VIEWS

No. 19 March 2002



The Clusters of PLEC

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PLEC NEWS AND VIEWS

No. 19 MARCH 2002

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

Harold Brookfield

NEW SCIENTIFIC COORDINATOR OF PLEC

Following his nomination at the November meeting in Montreal, attended by most Cluster leaders, and the subsequent strong agreement of other members, **Dr Miguel Pinedo–Vasquez** will become Scientific Coordinator of PLEC, with effect from the business day of the General Meeting in New York in late April 2002. I will continue to do much the same work as now in regard to the present PLEC during the transition period until August–September, but I shall then be Senior Adviser, and no longer coordinator.

One more issue of *PLEC News and Views* will be published from Canberra during 2002. The report on developments will be written by Miguel and myself, not by me alone. The first issue of *PLEC News and Views* appeared in July 1993, and 20 issues will have appeared over a span of nine years. It will continue in some form, but this form is yet to be determined.

CONGRATULATIONS TO LIANG LUOHUI

Prof. Motoyuki Suzuki, Vice-Rector of UNU, has requested that I announce the appointment of Mr. Liang Luohui as an Academic Programme Officer in the UNU Environment and Sustainable Development Programme. Everyone will be glad to see this recognition of Mr Liang's major contribution to PLEC since 1998, and of his considerable abilities. In his new post, Mr. Liang's duties will widen, but he will continue his current role as Managing Coordinator for PLEC.

THREE MAIN EVENTS

Since the publication of *PLEC News and Views* 18 in October 2001, there have been three main events for PLEC:

- the manuscript of *Cultivating Biodiversity* went to ITDG Press in London on 11 December, and is already about to be set up in type. We hope it will appear by July or early August, in time to be launched at the World Summit on Sustainable Development, in Johannesburg, 26 August–4 September, 2002;
- a collection of reports and pieces from Clusters on management regimes and resource access (i.e. on agrodiversity as such) was assembled by Helen Parsons and myself between October and November, and despatched to UNEP (as required in the Project Document) shortly before Christmas. This will be revised from additional and new material in the coming weeks, and prepared for

publication, probably in *PLEC News and Views* style (but without *PLEC News and Views* editing);

- the principal event of the last few months was the symposium in Montreal, first suggested at PLEC's Advisory Group meeting in Rome in November 2000, and quite intensively planned during the period since January 2001. This major event is described below, mainly from extracts taken from the official report prepared by the International Institute for Sustainable Developments.

The International Symposium on Managing Biodiversity in Agricultural Ecosystems, Montreal 8–10 November 2001

The Symposium was organized by the United Nations University (UNU), the Secretariat of the Convention on Biological Diversity (SCBD) and the International Plant Genetic Resources Institute (IPGRI).[1] This three-day Symposium brought together 172 participants from the academic, government, research and nonprofit worlds to share experiences, case studies, initiatives and ideas on the management of biodiversity in agroecosystems.

The Symposium was held just prior to the 7th meeting of the CBD's Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-7), which planned to consider progress made on implementing the programme of work on agricultural biodiversity. Also part of the international background, the International Treaty on Plant Genetic Resources for Food and Agriculture had been adopted at the 6th Extraordinary Session of the Commission on Genetic Resources for Food and Agriculture on 3 November 2001. The International Treaty establishes a Multilateral System for facilitated access to a specified list of plant genetic resources for food and agriculture. Its objectives are the conservation and sustainable use of plant genetic resources for food and agriculture and equitable benefit-sharing for sustainable agriculture and food security. The Conference of Parties (COP) of the CBD established a programme of work on agricultural biological diversity in 1996, and adopted further elaborations in 2000.

The Symposium was organized on a thematic basis covering the topics of: crop and livestock genetic resources; associated biodiversity and agroecosystem services; and landscape, scale and change. The Symposium's objectives were to:

- advance understanding of the complex process and mechanisms for on-farm management of biodiversity and their relation with farmers' livelihoods;
- compare and exchange experiences in encouraging profitable management practices and systems of biodiversity management on-farm;
- identify lessons learned for policy and capacity building;
- contribute to, and promote, the implementation of the CBD Programme of Work on Agricultural Biodiversity.

Professor H. Brookfield and Dr C. Padoch represented PLEC on the programme committee. Mr Liang Luohui was secretary to the committee and in addition had major responsibility for organization of the meeting.

The Vice-Rector of UNU, Prof. M. Suzuki, opened the symposium, and sessions were chaired by Prof. E.A. Gyasi, Prof. H. Brookfield and Mr Liang Luohui. Dr Christine Padoch led the discussion for one session.

[1] In addition to the direct support of UNU/PLEC and IPGRI, the symposium was supported by The International Development Research Centre (IDRC), The FAO-UNEP-UNDP-World Bank sponsored Global IPM Programme (FAO), The Technical Centre for Agricultural and Rural Cooperation (CTA), The German Ministry for Economic Cooperation and Development (BMZ), The Japanese Ministry of Foreign Affairs, The Swiss Agency for Development and Cooperation (SDC), The Directorate General for International Cooperation of The Netherlands (DGIS) and McGill University .

PLEC papers presented, in order of presentation

Fidelis Kaihura's paper concerned soil management in Tanzania. Agroforestry dominates in the sub-humid uplands, while agro-pastoral farming is the predominant activity in the lowlands. Soil types differ between the sites in a number of ways, including textual composition, organic components and ability to hold nutrients. Differences in soil management at the individual farm level were mostly due to farm size, access to inputs, ability to cope with changes in soil quality, and farmer-accumulated knowledge in soil management.

Sites owned by poor farmers showed more species richness; but species had a lower utility index. Kaihura suggested that this result reflects the need of poorer farmers to achieve additional objectives, such as soil improvement or production of livestock feed. Thus, poor farmers exploit biodiversity as a mechanism for soil fertility improvements while rich farmers obtain diverse uses from the crops grown. He said poor farmers are the custodians of biodiversity. Irrespective of sites, most strategies used are low input and seek to improve the soil, which, in turn, leads to increases in vegetation and enhancement of on-farm biodiversity.

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Michael Stocking focused on soil management by farmers more generally. While noting some environmental degradation problems associated with soil erosion, he also declared that there are 'good news' stories; many small-holder farmers worldwide have been managing their land better to conserve biodiversity, particularly in Asia, Africa and South America. The PLEC project has attempted to capture examples that indicate interactions between rural livelihoods and biodiversity. He said that, as a subset of agrobiodiversity, soil agrobiodiversity is the conceptual framework for a managed agricultural system focused on the interactions of humans and soil, and soil and plants. Soil agrobiodiversity is characterized by its beneficial attributes at three levels: site-based benefits, which include increases in soil resilience; management and organizational benefits, which result in less effort to weed or maintain production; and landscape and social benefits, which include diversification of local economies and rural livelihoods.

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In a keynote paper on management at landscape level, **Miguel Pinedo-Vasquez** discussed valuing and promoting small-holder agricultural practices based on PLEC work in South America, West and East Africa, and Asia. The project focuses on three major issues: the diversity of systems in production landscapes; multiple functions of small-holder production systems; and an expert farmer demonstration approach. With regard to diversity of systems in production landscapes, the example of Peru in Amazonia shows how farmers use their resources to cope with landscape change problems due to catastrophic floods. Regarding multiple functions of small-holder production systems, pilot sites in Brazil, China and Kenya demonstrate farmers' practices in: creating and managing microhabitats for more plant species; using multiple cropping systems to cope with market changes; and developing agroforestry systems to manage disease control. Regarding demonstration of various approaches, it was noted that expert farmers play a significant role in setting up demonstration objectives and developing and modifying demonstration techniques.

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Kanok Rerkasem spoke about farmers' management of fallow succession in Thailand at two mountainous sites. Shifting cultivation followed by fallow succession is the predominant practice among certain ethnic minority groups. The area has been subject to rapid change over the last thirty years with the introduction of highland development as the government has sought to eradicate opium crops and protect forests. Rerkasem showed that if the fallow period is too short, agriculture cannot be sustainable. In response to these pressures, farmers have either turned to intensive cash crops or are using agrobiodiversity management of shorter fallow periods to overcome limitations. In one area, farmers' use of a spiny leguminous weed plant for fallow succession has proved beneficial for building soil. At another site, *Macaranga*, a prolific seed-producing shrub species, is helping to sustain productivity. He concluded that the farmers' innovations offer important information about sustainable land-use practices.

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Guo Huijun discussed agroecosystem change and threats to agrobiodiversity in the tropical mountains of Xishuangbanna region. The case study indicates that agroecosystems in the region are undergoing rapid and profound changes. Some of the changes are having impacts on agrobiodiversity, such as practices of shifting cultivation including replacement with plantations of industrial crops. When the agroecosystem changes, agrobiodiversity is lost. Driving forces for these agroecosystem changes include, in particular, land-use policy changes, economic market change, agricultural technology changes, and creation of biosphere reserves. The presentation outlined some counter-measures to agrobiodiversity loss that local farmers are exploring through new agricultural opportunities associated with diversifying plantations.

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Edwin Gyasi presented a case study on managing diversity in the agricultural landscape in Ghana. The study described traditional systems of managing diversity of the biota in agricultural landscapes with a focus on sites of conservation efforts under the PLEC project. He discussed strengths and weaknesses of traditional systems as well as threats posed to them by other social and economic factors, such as production pressures, introduction of exotic systems, and changes of dietary habits. The PLEC project is designed to build upon the traditional systems to conserve agrobiodiversity and to observe how conservation measures affect agricultural landscapes. Gyasi also highlighted the main policy lessons learned from this case study—the realistic policy option for conserving agrobiodiversity and meeting food production challenges should be based on traditional systems and be made an integral part of the whole land-use system.

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In a final statement, **David Cooper** of the CBD secretariat highlighted some points from the Symposium and suggested next steps. He said the Symposium showed some of the dimensions of diversity, having considered, among others, livestock, livelihood, associated pollinators, pests and diseases, organisms as service providers, the landscape level and the influence that management has on it. He stated that there was no 'single axis' for diversity and that we have only begun to integrate these various dimensions. We have begun to appreciate the effects of change over time and such changes can be managed to benefit human livelihood. Cooper highlighted that the many success stories discussed at the Symposium depended on a rigorous interdisciplinary approach and recognized that we must understand the socio-economic elements in addition to the genetics. He said we need a vigorous commitment to work with farmers and that we have much to learn from the variety of approaches discussed. Challenges for future work include: integrating the different dimensions; seeking to understand the complexity; clarifying potentially conflicting goals; developing indicators; and scaling up the successes.

NATIONAL MEETINGS

National meetings, to present PLEC results and recommendations to decision makers and other stakeholders, have now been held in all countries in which PLEC has operated since 1998. They have varied considerably in nature, some being primarily political and others primarily scientific. In all cases, however, PLEC has been presented to a wider audience, and groundwork for the future has been laid. All recommendations are to be sent to UNU (though by no means all have yet been received) and they will be put together in Tokyo with a general summary that will bring out common points and the more important issues. This will then be published.

THE GENERAL MEETING IN NEW YORK

The fourth general meeting of PLEC will take place at Columbia University, New York, from 23 to 27 April 2002. A first circular was distributed on 8 February, and a second will follow shortly. The meeting will largely take the form of thematic sessions covering PLEC's major promised outputs, in which papers will be presented:

1) biodiversity assessment: methods and database;
2) management diversity and models of biodiversity management;
3) demonstration sites and activities;
4) capacity building and networking;
5) project impacts and recommendations.

There will also be a press conference, an open coordination meeting, and a business meeting at which the formal handover of the reins of PLEC will take place. Dr Padoch and Professor Stocking will make statements about the prize and the special number of the *Geographical Journal* which latter, because of a very small PLEC response, will now feature PLEC only incidentally.

THE EVALUATION

The meeting will immediately be followed by the final evaluation of the GEF-supported part of the project. Two evaluators have been contracted by UNEP, and they are (1) **Dr Eduardo Fuentes** of Chile, former Principal Technical Adviser for Biodiversity (sustainable uses and conservation) for the GEF Unit at the United Nations Development Programme (UNDP), and (2) **Professor Benjavan Rerkasem** of the Faculty of Agriculture, Chiang Mai University, Thailand. Dr Fuentes will attend the meeting in New York, and then both will go first to UNEP in Nairobi for briefing. Both will visit Tanzania together, then they will separate to visit, between them, all Clusters of GEF-PLEC. Their report is due on 15 June.

AFTERWARDS

During this period, and until late August or early September, the Canberra PLEC office will remain in being, and during that time we will produce text for a final book from Phase 1 PLEC, to be offered to UNU Press. This text will draw on material from the final reports. Some other general PLEC activities will also continue. An important event will be a meeting to be held, probably at the beginning of September, at which whatever succeeds the present PLEC will be finally initiated, in the light of the evaluation.

NEW BOOKS

Helen Parsons

PLEC Project, Australian National University, Canberra

***Dynamics and diversity: soil fertility and farming livelihoods in Africa*. Ian Scoones (ed.) 2001. London: Earthscan**

Sustainable management of soil resources is a priority issue in Africa. Current policies often assume that soils are being degraded on a large scale, and it is farmers' practices that contribute to land degradation and decline in food production. This book presents a series of detailed case studies from Ethiopia, Mali and Zimbabwe which document the ways farmers have dealt with these problems. It explores the complex dynamics of soil fertility change from an interdisciplinary perspective, looking at the diversity and complexity in the way farmers actually manage their soils and the social and environmental processes that impact on farm management. In some cases a positive picture is presented, particularly of farmers' detailed understanding of the land they farm and their capacity to employ different management and livelihood strategies as circumstances vary in space and time.

Most importantly the book examines the application of scientific research to soil fertility management and sustainable agriculture in Africa: it shows the need to develop new technologies and management practices more suited to the diversity of farmers' circumstances. The authors present various technological strategies and outline the impacts of policy on farmer practice. Crisis narratives have sometimes led to interventions that have undermined livelihoods and reduced the potential for good management of soils. In contrast, farmers often know how to maintain soil fertility but their capacity to act or their ability to benefit from interventions depend on range of factors including household size and status, current capital assets, and access to credit, livestock, labour and markets. These factors vary temporally and with the vagaries of climate. Policies aimed at improving soil fertility management and food security must take into consideration the whole livelihood context to be effective.

This is an interesting book that has implications for research and development policy beyond soil fertility and Africa. It brings to the fore the dynamics and diversity of small farmer livelihoods and is relevant to and supportive of PLEC research strategies.

***Handbook for the field assessment of land degradation*. Michael Stocking and Niamh Murnaghan (eds) 2001. London: Earthscan.**

This is a practical handbook based on the farmer's perspective and real farming situations. Funded by UNEP, the book provides guidelines on rapid and non-technical methods for measuring and assessing land degradation in the field. It shows how to calculate indicators such as soil loss, explains the interpretation of results, and in particular how combinations of different indicators can give conclusive evidence of the severity of land degradation. The focus of the book is firmly on understanding the farmer’s interaction with the land, and how environmental protection and food security of rural land users may be assured.

Detailed figures, photographs, worked examples and sample forms are included. These are based on participatory field assessment of land degradation assessment techniques validated by field professionals in Africa, Asia and Latin America. There is an emphasis on Uganda, where a field trial of the methods was conducted, involving members of the PLEC-Uganda sub-Cluster

The book will be an invaluable training manual for field-workers in NGOs and in governmental and educational institutions.

PAPERS BY PROJECT MEMBERS

SCALING UP A PLEC DEMONSTRATION SITE FOR THE NATIONAL PILOT PROGRAMME: A CASE EXAMPLE OF A *HMONG NJUA* VILLAGE IN NORTHERN THAILAND

Charal Thong-Ngam[1], Thamanoon Areetham[1], Prasong Kaewpha[2], Songsak Thepsarn[1], Narit Yimyam[3], Chavalit Korsamphan[3] and Kanok Rerkasem[4]

[1] Highland Agriculture and Social Development Programme
[2] Chiang Mai Hill-tribe Welfare Provincial Office of the Department of Public Welfare, Ministry of Labour and Social Welfare
[3] Highland Development Research and Training Centre, Chiang Mai University
[4] Multiple Cropping Centre, Chiang Mai University

Introduction

In 1993 the United Nations University project on People, Land Management and Environmental Change (PLEC) chose sites in northern Thailand and in Yunnan, Southwest China, to represent the Montane Mainland Southeast Asia (MMSEA) sub-region. This sub-region comprises five countries, Cambodia, Myanmar (Burma), Laos, Thailand, Vietnam (the lower Mekong sub-basin), and the province of Yunnan, Southwest China, on the upper part of the Mekong river (*Lancang Jiang*).

The area in northern Thailand was once remote and inaccessible, and a major supplier of illicit opium. The opium eradication campaign has taken over 30 years to reduce production to an insignificant level. Now the area is connected with large-scale infrastructure and is becoming a new economic development zone in the region (UNDCP 2000; ADB 1994; Talbot 1996). Alternative land use and agricultural practices have been introduced and encouraged with heavy support and subsidies. As a consequence, the traditional systems of shifting cultivation are disappearing (TDRI 1994; Rerkasem and Rerkasem 1994; Rerkasem 1996), and large tracts of uplands have been opened up for permanent cash crops.

PLEC is interested in agrodiversity, the management of this mountainous area by indigenous inhabitants who are of diverse ethnicity. With their traditional practices and rich cultural heritage, the local communities have in the past conserved much of the richness of domesticated and wild biodiversity. With developmental changes, this richness could be lost. But farmers have a capacity to manage and conserve biodiversity in the face of change. Guidelines for assessing agrodiversity in the field by PLEC methods are fully explained elsewhere (Brookfield, Stocking and Brookfield 1999; Brookfield 2001; Stocking and Murnaghan 2001; Zarin, Guo and Enu-Kwesi 1999).

Pah Poo Chom was established as a demonstration site for the PLEC Project in 1999, building on experience with the PLEC approach during previous years. Now the demonstration site is being transferred to the responsible agency as a National Pilot Village for sustainable highland development and conservation. This paper takes *Pah Poo Chom* as a case of scaling up a PLEC demonstration site for wider audiences in the future. It summarizes results of field activity and demonstration for the past 3-4 years. Experiences gained and lessons learned, which provide the basis for scaling up the demonstration site, are discussed.

Past development efforts in the demonstration site: the *Hmong Njua* of *Pah Poo Chom* village

During the early 1960s, several *green Hmong* families in the border area moved down to *Pah Poo Chom* in *Nikhom* territory under the government scheme for hill-tribe resettlement. They moved from a higher area (>1200 m) on *Mae Taeng-Chiang Dao* mountain where they had been settled and farming for at least five generations before 1950 (Van Roy 1971). Significant events which have led to dramatic change in the village between 1960 and 2001 are summarized in Box 1.

As part of the government scheme for resettlement, external services and support were given, and further requests made for large-scale development support from international agencies (Oughton and Imong 1970). However, during 1960-69, many settlers fled to join relatives in other areas or resettlement sites, for example Nan and Tak provinces, and *Mae Tho* and *Pakia* villages in Chiang Mai province. This was a difficult period for the villagers since the majority suffered from severe poverty and food shortages. There was a high population of opium addicts and little opportunity for employment. The village site was initially located on a narrow ridge at about 900 m; this was uncomfortable for the *Hmong* who lived previously at a much higher altitude, 1300-1500 m (Walker 1975). According to Cooper (1984) the village after migration was on the brink of collapse due to unfavourable social and economic conditions.

In 1970, a large-scale development project with external support, the Thai-Australia Highland Development Project (TA-HDP) began to assist village development with alternative cash crops replacing illicit opium cultivation. New crops and alternative practices for permanent agriculture were brought in with subsidies and incentives. Farmers eventually stopped growing opium and turned to cash crops. They discovered for themselves that cabbage was the most profitable crop. By the early 1990s production was on a commercial scale with links to external markets. As farmers saw the possibilities, other income opportunities emerged. Examples include various forms of contract farming for high-value vegetables for the food-processing industry and export; and the introduction of lychi tree growing for early harvest with premium prices, 80-120 baht/kg in *Pah Poo Chom* vs. 40-60 baht/kg from other growing areas. Income from lychi is somewhat uncertain due to the alternate fruit-bearing cycle, but the high price gives a strong incentive to growers. Income from cabbage and other vegetables is more reliable, even though the prices fluctuate widely from year-to-year and within the season.

The new crop possibilities also created great tensions within the village. The most powerful families opened up forestland on steep slopes for cultivation, which threatened the natural biodiversity in the forests used by poor families. In principle, villagers had agreed to conserve and allow non-destructive harvesting of minor forest products such as bamboo shoots, wild bananas, wild vegetables and other herbs for food and supplementary income in bad years. In addition there were several cases of land disputes with neighbouring villages. The problem stemmed from the lack of official village demarcation. Villages located in the forest area had yet to obtain legal rights from the Department of Local Administration. The registration of these villages was complicated by their illegal status from the point of view of forestry laws and regulations, and by conflicts in government policies at departmental and ministerial levels.

In 1990, the Thai-Australia Highland Agriculture and Social Development Project (TA-HASD) recognized the problems and from 1990 carried out village land use and watershed management studies to help solve the conflicts. Unfortunately, this external support ceased when the project terminated in 1995. In the following years PLEC built on this experience to empower

BOX 1 The 40-year journey of the *Hmong Njua* in the PLEC demonstration site of *Pah Poo Chom* in *Mae Taeng* district, Chiang Mai province.	
1959	The Royal Thai Government set up *Nikhom* as one of the sites for hill-tribe resettlement under a newly established department of the Ministry of the Interior, the Department of Public Welfare (DPW). A headquarters was built to facilitate the resettlement scheme and aid communities with development. This was thought to be very cost-effective with limited manpower and resources.
1960-69	About 10 households of *Hmong* moved from the borders in Chiang Dao to the *Nikhom* area and settled on the top of the hill in 1960. At that time, the village was poor due to continuous logging and illegal cutting in the forest concession. With the hardships, some households left to join relatives in other *Hmong* settlements. Those who stayed on continued with shifting cultivation. Forests in the village were overused and the area was highly degraded with poor fallow regeneration. Bamboo, the dominant species in secondary forests, was harvested and sold to outsiders to supplement income. The *Hmong* of *Pah Poo Chom* quickly became even poorer with inadequate production of subsistence crops. There was also a high population of opium addicts. Most households engaged in wage labour for the nearby commercial tea plantation, receiving low rates of pay, or even a sack of rice. Collapse of the community was projected if this situation continued (Cooper 1984). In the late 60s, the Tribal Research Centre of the Department of Public Welfare, with external assistance, started a development programme. Alternative cash and subsistence crops such as improved rice and maize were introduced, with livestock to replace opium cultivation. Proposals for further assistance were drafted (Oughton and Imong 1970).
1970-79	In the early 1970s the Thai-Australia Highland Agricultural Project (TAHAP) began to help the village and provided technical assistance for agricultural development in collaboration with the Tribal Research Centre of the Department of Public Welfare. Napier grass (*Pennisetum purpureum*) was introduced as a high-value forage crop for cattle. About 100 *rais* (16 ha) of relatively flat land in the valley was developed for irrigated rice (Oughton and Imong 1970). Unfortunately, the soils could not hold water and the production system failed. Wet rice cultivation was soon abandoned, but the idea of irrigation gave an opportunity to develop intensive cabbage production. The importance of irrigation led the villagers to conserve the headwater area. In 1969 *Mimosa invisa*, a noxious thorny weed, was brought in by Mr. *Paolu Saetao* for fencing his small kitchen garden. The weed spread rapidly throughout the village landscape, but by the early 1980s farmers began to see its value as a soil builder. The use of *Mimosa* as living mulch was later adopted for intensive cropping.
1980-89	During 1980-87, external support from the World Bank was given to village development. Lychi and other fruit trees were introduced in homegardens for local consumption. Then the farmers saw an income opportunity and the tree was planted in major agricultural fields as one of the main cash crops in the village. With government incentive for household registration, villagers decided to move down and settle in the small valley. Cabbage was introduced in 1985 for farmers' trial in small plots. The cabbage technology was obtained from their *Hmong* relatives in *Mae Tho* where intensive vegetable production was successfully developed in the early days of a United Nations Crop Replacement Programme, in 1970 (Geddes 1976). Opium production was virtually stopped in the following season. People grew subsistence crops intensively with more or less permanent farming practices. Ruzi grass (*Brachiaria ruziziensis*) was introduced as vegetative buffer strips for soil and water conservation on some 10 *rai* of sloping land. However, the success of vegetative strips for SWC was very limited. The management of grass strips required too much labour to control, since there was a danger of the grass spreading and becoming a dominant weed.
1989-93	The Thai-Australia Highland Agricultural and Social Development Project (TA-HASD) chose the village as one of the Watershed Demonstration sites to represent *Mae Taman* Development Zone (TA-HASD 1993). A model for sustainable land management and forest protection was suggested. Natural forest conservation and reforestation were planned for the hilltops to protect the ecological function of the headwater area. The idea of Watershed Demonstration has become the foundation of community-based land use planning and other development projects in later years (TG-HDP 1998). With success in cabbage growing and the continuity of external development support, many people returned to the village. The population rose to 217 persons in 32 households in 1993. The village had become a permanent site for the *Hmong* settlers.
1993-96	Middlemen appeared in the village to buy produce, especially cabbage. With connection to the external market, contract farming for vegetable production was introduced and this had intensified into diversified vegetable production for markets in Chiang Mai and Bangkok. Farmers' income increased greatly and *Pah Poo Chom* had become a well-off village with at least 12 pick-up trucks and 15 motorcycles in 40 households (Thepsarn 1998). There was a rapid expansion of lychi grown in association with annual crops and vegetables. Pressure was building to open up land with steep slopes and secondary forests. Internal conflicts on land use, dry season water for irrigation and forest protection then became issues for the village administration. The problems also extended to other nearby villages.
1997-2001	Thailand, labelled a Newly Industrialized Country, was cut off from international development aid. All externally supported projects on highland development ended in 1998. This leaves future support to the Royal Thai Government. A Master plan for Highland Development, Control of Narcotic Crops and Environment Conservation was developed to ensure continuity of support to the highland communities. However, government support was greatly reduced due to the macro-economic collapse in Thailand and the region as a whole. Only a small budget could be allocated to the responsible agency to continue village development. The population of *Pah Poo Chom* had grown to 278 persons in 50 households by 2000, and the majority of people had obtained citizenship.

the community for forest and biodiversity conservation. As a result of government decisions on decentralization, highland villagers will need the capacity to draw development support and services from the grass-root organization, the *Tambon* Administrative Organization (TAO).

Developing the PLEC demonstration site

PLEC has worked in *Pah Poo Chom* since 1993. An interdisciplinary approach was adopted with the active participation of responsible implementing agencies from both government and non-government organizations. Before 1993, we had conducted field research to assess village agroecosystems in relation to change and sustainability (Rerkasem and Rerkasem 1994; TDRI 1994). As the area had been targeted for opium replacement and highland development policy, it attracted many scholars and researchers for field studies after 1969 (Oughton and Imong 1970; Van Roy 1971; Keen 1972; Walker 1975; Cooper 1984). These writers have provided valuable data on changes that have taken place in the past 30-40 years.

In 1999, *Pah Poo Chom* was selected as a PLEC demonstration site. A survey of agrobiodiversity management was conducted across diverse village land-use and field types to identify areas and farmers for demonstration purposes. The participatory PLEC agrodiversity approach (Brookfield, Stocking and Brookfield 1999) was used. While the dominant land use is for commercial crop production, the *Hmong* farmers recognize three broad land-use categories. These are: the hilltops, with forested and protected headwater areas, and community (utility) forests for local use; the upper slopes with rain-fed and partially irrigated land; and the lower slopes for intensive gravity-fed irrigated agriculture. The pattern of present village land use is shown in Figure 1. Various field types and a diversity of management occur across this landscape. The results of field assessment are summarized in Box 2.

Since the year 2000, the team has worked with local expert farmers to promote use, management and conservation of domesticated and wild plant species to ensure sustainable rural livelihoods. This has included demonstration of:

- management of edges between fields for conservation of traditional crops, vegetables, fruits as well as tree species in the form of mixed annual and perennial to agroforest/forest types;
- communal organization and management of land and forests for conservation and sustainable uses; and
- management of intensive cropping on slopes.

The detail of these demonstrations will be presented elsewhere.

Some 10 expert farmers have joined PLEC to demonstrate best practices. Prior to this, PLEC researchers conducted intensive field assessment to identify best practices for management and conservation of biodiversity. The expert farmers then used their plots for demonstration and training, both for farmers in their own village and from other villages in northern Thailand, as well as for local development workers. A series of village forums were organized to encourage discussion and information exchange.

In 2001, two sessions of farmer-to-farmer dialogue were arranged in *Pah Poo Chom* for a total of 22 *Hmong* farmer leaders from Nan and Phrae provinces. PLEC local experts and community leaders received visitors on their demonstration plots. Techniques demonstrated (Box 2) were related to upland farming: management of *Mimosa*, methods of fertilization and irrigation, fruit tree treatments, and management of edges. Community based planning for sustainable land use, forest protection and biodiversity conservation were discussed. PLEC also works with

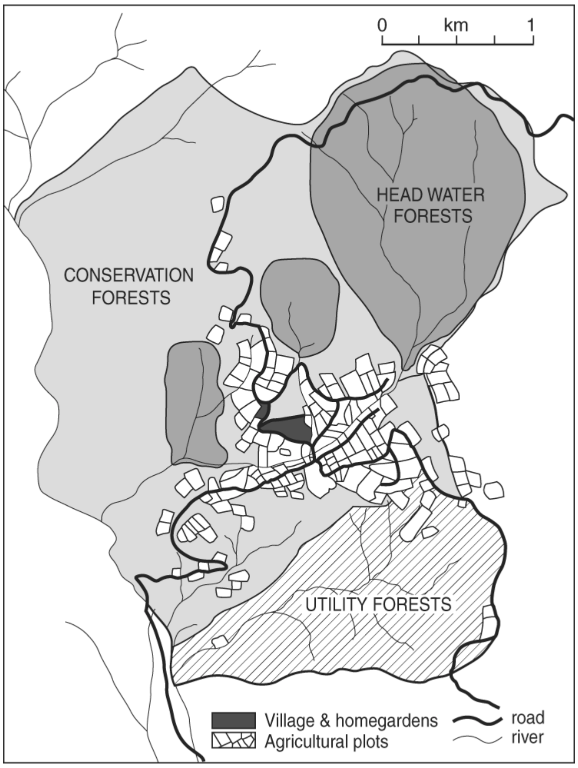

Figure 1 Map of existing land use in *Pah Poo Chom* demonstration village in 1999

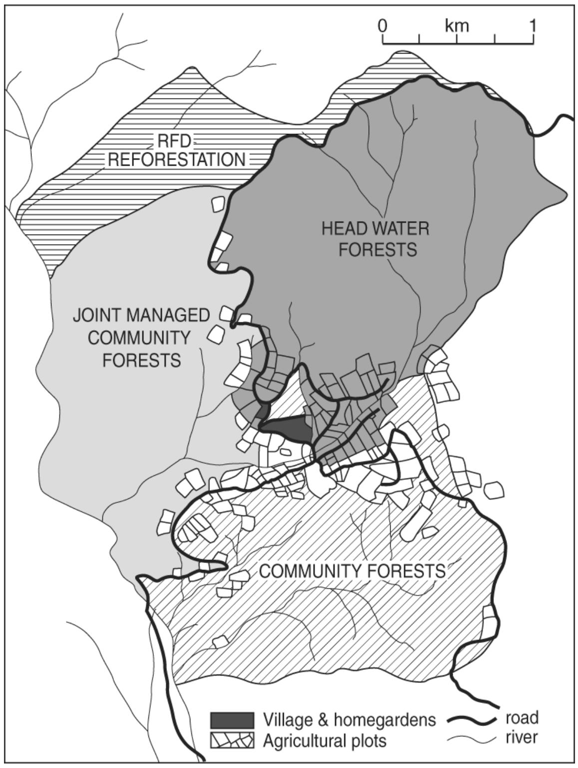

Figure 2 Map of revised land use based on community agreement of *Pah Poo Chom* village in 2002

community organizations, both formal and informal groups, to improve data collection for monitoring village land use and forest management.

Significant outcomes

By the year 2000, the population of the village had grown to 278. An informal group of village leaders, both men and women, was formed as the Village Group for Forest Protection and Biodiversity Conservation. The group has evolved and become a sub-committee of the Village Administration Committee with a formal structure attached to the *Tambon* (sub-district) Administration Organization (TAO), the formal grass-root organization established in a legal framework as part of the government decentralization process. The Village Forest Protection and Biodiversity Conservation Committee (VFP&BC) comprises four male village leaders and seven PLEC local experts (four men and three women) and the Village Headman who chairs the committee.

With technical information and support from PLEC scientists, the VFP&BC Committee has been able to make agreements with nearby villagers about demarcating village boundaries. This has enabled the Committee to draft village land use planning, to encourage biodiversity conservation, and resolve land disputes within and between the villages. Village land use is currently under revision to prevent further expansion of intensive cropping into natural forests and headwater areas (Figure 2). Landowners with plots within the protected areas are being encouraged to limit further expansion and to allow the land to return to natural forest where appropriate. There is a proposal to extend the protected headwaters area to include some of the

Box 2 Some significant management diversity in relation to land and biodiversity conservation in the *Pah Poo Chom* demonstration site, 1999-2000

1. **Use of natural vegetation as ground cover**. Mixtures of annual, perennial grasses and some introduced legume species, e.g. *Ageratum conyzoides, Brachiaria ramosa, Chromolaena odorata, Chrysopogon aciculatus, Eupatorium adenophorum, Mimosa invisa, Pennisetum purpureum, Pennisetum pedicellatum, Panicum repens* and *Paspalum spp.,* are being used as ground cover and green manure during fallow periods in the wet season.
2. **Management of weeds for soil improvement**. This is now common practice in *Pah Poo Chom*. Since the introduction of Spiny Mimosa (*Mimosa invisa*), this weed has become the major green manure crop for intensive cabbage production. The amount of nitrogen fixation in *Mimosa invisa* as live mulch or green manure in the maize crop was estimated at about 47 kg N/ha, giving the total amount of nitrogen with trashed corn of 67 kg N/ha (Rerkasem, Yoneyama and Rerkasem 1992).
3. **Management of 'edges' for soil, water and biodiversity conservation**. This includes strips of vetiver or *Leucaena leucocephala/Cajanus cajan,* and trashlines of crop residues and weeds for soil and water conservation. Swidden crop species, wild fruits, other perennials and forest trees, are conserved at field edges, along with narrow strips of wild banana or bamboo for field edge marking.
4. **Use of physical barriers such as dead logs, tree stumps and big rocks, to prevent soil erosion on sloping fields**. Farmers often leave these materials in the fields across the slope. With intensive cultivation, tree stumps will rot and possibly be removed or burned. Coppicing is uncommon, and big trees are seldom left in agricultural fields unless for spiritual or personal reasons.
5. **Row planting across the slope is adopted in the dry season for crop irrigation by mobile (movable) sprinklers**. This helps prevent soil erosion due to excessive water. Row planting along the slope was said to prevent landslip in the wet season.. The amount of erosion will depend on the percentage of ground cover. Severe erosion may be expected under poor ground cover.
6. **Use of minimum tillage**. The method is traditional to the *Hmong;* when planting opium they used hand tools for land preparation. A few farmers use tractors to plough low-lying fields where slopes are fairy gentle, usually between 10-15%. No farmers use tractors on steep slopes.
7. **Non-clean weeding**. Another traditional practice with annual crops and vegetables. Farmers do not weed out useful species that emerge naturally in the fields; they use them for household consumption. The method helps increase the percentage of ground cover between the rows of crops.
8. **Fallow management in the wet season**. Fallowing is an uncommon practice for the *Hmong*. Farmers in *Pah Poo Chom* use natural regeneration for fallow in the wet season, before the first season cabbage crop between the middle of October-and early November. With intensive cropping practices, the landholders allow adequate time for *Mimosa* growth in the fields to obtain significant biomass before slashing. Soil erosion in this system is fairly low, varying from 1.05 to 4.93 t/ha/year.
9. **Incorporation of crop and weed residues**. A common practice with hill farmers. In the case of fruit trees, cut branches after pruning are left underneath the trees, including the leaves. Weeds are slashed down to open up the tree canopy and the trashed material is left as a ground cover.
10. **Using shade-resistant bush species like coffee to improve and sustain bench terraces**. This is the farmers' innovation after the introduction of bench terraces by a development project. A lychi grower in the village practised this system of interplanting by growing coffee under the mature lychi along the edge of the terrace. This would help support the bench terrace on a long-term basis.
11. **Sustainable harvest of minor forest products**. The collection of bamboo shoots in utility forests in the village has been agreed. In the past, the bamboo forests almost collapsed due to uncontrolled harvesting. There are now rules and regulations to promote a sustainable harvest.
12. **Intercropping and strip planting of swidden crops and local (*Hmong*) vegetables**. This occurs in cabbage fields to meet household needs and to some extent conserve genetic resources of local varieties. This may be seen as another type of an 'edge', but the practice is much simpler than that found in separate patches of swidden crops.
13. **Staggered planting and rotation of crops between different fields with a combination of traditional and local crop species**. These cropping strategies reduce pest and disease problems and pick up fertilizer residue from the previous crops. Cabbage is never planted twice consecutively in the same plot. This is another measure to reduce pest and disease problems between crops. Fertilizer residue from the first season cabbage crop may be carried over to the following glutinous corn crop in the next season on the same piece of land. Farmers do not apply any fertilizer to glutinous corn.
14. **Spot application of chemical fertilizers to individual mounds of cabbage and other cash crops**, e.g. Chinese cabbage, potato, carrots, vegetable soybean. This saves large amounts of fertilizer input, and increases efficiency of fertilizer use.
15. **Branch pruning and girdling to induce flowering and fruit set in commercial fruit trees** are local innovations among lychi growers and were introduced for farmers' experimentation.
16. **Growing a living fence in homegardens**. A method adopted to protect animals and to prevent soil erosion. The practice is, however, limited to a few farmers in *Pah Poo Chom* who take good care of their homegardens.

agricultural fields in the upper part of the village. The intention is to conserve natural biodiversity in the agroforestry and forest edges, where wild banana and other wild species can be of local use.

With village agreement, the revised land use and forest management plans are in the process of submission to TAO for further development action. The proposal of *Pah Poo Chom* as a new administrative village is now underway. The TAO has taken further steps with formal demarcation of the village boundary, conducting surveys and processing official documents for submission to higher authorities. *Pah Poo Chom* is expected to become the new administrative village within the next few months. This should improve the village's administrative status, and the community should gain direct access to government support and services under the on-going process of decentralization.

Lessons learned from the demonstration site

A number of lessons have been learned from the application of the PLEC approach and demonstration activities:

- ***employment of the holistic approach***

  Agrobiodiversity management should be assessed in the totality of village land use. It is best identified, from individual field types to the whole village landscape and local watershed, based on farmers' definitions. In contrast to the conventional practice of biodiversity conservation in protected areas, farmers view the whole of the village landscape and fragmentation as the area for biodiversity conservation;

- ***use of farmers' conservation approaches***

  Much diversity of traditional crops, local vegetables and other useful species is being conserved in different ways, in this case by the management of 'edges'. Edges are the farmers' way of conserving biodiversity in a dominantly agricultural landscape. Unlike agricultural fields, edges of this type are often omitted in discussion with farmers. The pattern of organization and function of the edges vary greatly, according to the preference of the grower. The edges are a personal matter, and many growers are reluctant to talk about them. They could easily escape notice by the field observer.

  The *Hmong* have been known to cultivate a diversity of traditional crops and local vegetables in opium fields, upland plots and homegardens (Anderson 1993; Sutthi 1989, 1996). The use of edges is linked to livelihood security. Women are the principal cultivators, but the indigenous systems are under threat. There is an increasing demand for land and household labour for cash crop production. The value of edges is less important for men who sometimes see them as a negative, as harbouring insect pests and diseases;

- ***recognition of the dynamics and trade-off between conservation and production***

  Conservation systems change from year to year and place to place. They depend on household decisions on the type of field and intensity of major crop production, such as upland rice *vs.* cabbage production, and the shift from annual crops and vegetables to lychi and commercial fruit trees. However, the whole community shares and exchanges products and germplasm;

- ***respect for local values, customary rules and practices***

  Pioneer swiddeners are often condemned for forest destruction but they have their own systems of protection and conservation of biodiversity. Evidence from the demonstration site shows that the *Hmong* community has control of this resource, i.e. agroforest and forest edges, protected areas and utility forests. Arrangements are made by collective decisions with local rules and regulations;

- ***support for capacity building and empowerment of the community for biodiversity conservation***

  Along with the pressures on land, hill-tribe communities in northern Thailand are facing a change to formal leadership and administration. Without capacity building and empowerment, the community organization is weakening with inability to resolve conflicts within community and between neighbouring communities.

Human resources and networks

Village leaders (formal and informal) and local experts are a human resource for management of land, water and natural resources, and for ensuring sustainable livelihoods and biodiversity conservation. This has recently become critical for the highland villages as problems of land disputes, which stem from national policy on forest protection and biodiversity conservation, are increasing within and between villages. In working with the *Pah Poo Chom* community, the Village Forest Protection and Biodiversity Conservation Committee has helped them build up a local community network through the TAO structure. Local participation in the PLEC project is also moving towards community empowerment. The villagers are now legally able to plan village land use, forest protection and biodiversity conservation.

The experience gained from the PLEC project in *Pah Poo Chom* can be shared with other communities on a larger scale. The opportunity for scaling up the demonstration site occurred in 2001 when the Department of Public Welfare started to implement the government programme on Farmers' School for Sustainable Highland Development and Environmental Conservation (SHDEC). Against the above background, *Pah Poo Chom* is seen as appropriate to serve as a National Pilot Village for the government programme.

Scaling up the PLEC demonstration site: the transition period

The transfer of the *Pah Poo Chom* demonstration site to a National Pilot Village is planned to take place towards the end of the PLEC project Phase 1 in 2002.

The general objectives of the Farmers' School project follow government policy and direction towards:

- better livelihoods;
- community strengthening in support of the decentralization process;
- better management of environmental conditions;
- sustainable utilization of natural resources;
- capacity building;
- maintenance of the cultural diversity of ethnic minorities.

The strong support and long term commitment of the government is shown by the additional budget allocation to the Department of Public Welfare of at least 0.5 million baht for this farmer-to-farmer interaction, starting from 2002. On a longer term basis, the target population of the Farmers' School programme includes ethnic minorities from 72 villages in northern Thailand and a few villages from Kanchana Buri province. Staff members from 14 centres of the Hill-tribe Welfare office are expected to learn from the project so that the idea can be propagated on a larger scale.

Additional support from international NGOs is also available on a shorter-term basis. At present the Heinrich Boll Foundation, a German NGO Foundation for Thailand and Regional Southeast Asia has provided an addition of 340,000 baht to support the Farmers' School project. This would cover about 450 hill-tribe farmers for 29 sessions from five provinces in the upper part of northern Thailand. Other sources of funding support are being sought for the Project for the future.

For institutional building, the strategies for the Farmers' School project are to build on inter-government agencies at the local level where PLEC has already initiated interaction. Establishment of team efforts for responsible government and non-government agencies is being proposed for project implementation, where there is a good understanding of the PLEC approach. An introduction to this approach will be conducted in early 2002 for key members of the 14 Provincial Hill-tribe Welfare Centres in northern Thailand. PLEC team members from Chiang Mai University will continue to provide training and technical consultation to the Farmers' School Project.

Conclusions

Scaling up of a PLEC demonstration site to national level requires a minimum set of conditions. These include:

1) commitment of key persons from responsible implementing agencies and active participation of local experts;
2) positive commitment of field extension or development workers and the local community for building on existing partnerships in sustainable development and on-farm biodiversity conservation;
3) provision of field training in agrodiversity survey and field assessment well before the transfer of the PLEC demonstration site for scaling up. Training must include analytical skills for agrodiversity assessment, and evaluation of local experts' plots and their farming techniques;
4) institutional and policy support;
5) niches for scaling up PLEC demonstration sites at local administration, departmental, ministerial and national policy levels;
6) communication and promotion of PLEC ideas and approaches from field level to government policy makers; and
7) funding support and commitment.

In *Pah Poo Chom*, as compared to other areas, a great deal of research experience has been built up over the past 30 years. The PLEC agrodiversity approach is a field-based method, and allows researchers to examine in detail farmers' management of diverse agricultural systems for sustainable land use and biodiversity conservation. Best practices are identified along with expert farmers, and the ideas from this approach can readily be utilized for larger-scale application.

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PROMOTING AGROBIODIVERSITY UNDER DIFFICULTIES: THE JAMAICA-PLEC EXPERIENCE

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The PLEC demonstration site

Demonstration activities of Jamaica-PLEC are located in the lower Rio Grande watershed in the Parish of Portland. The Rio Grande valley covers an area of approximately 286,000 hectares, or about one-third of the parish of Portland. The watershed is characterized by high elevations, steep slopes and is the wettest area in Jamaica. Over 75 per cent of the valley lies above 1500 metres and more than 50 per cent of the area has slopes exceeding 20 degrees. Although highly seasonal, rainfall in the watershed averages 2250 mm annually. The combination of high rainfall, humidity and temperatures results in a diversity of flora, which is unmatched elsewhere in Jamaica.

The geology of the Rio Grande watershed consists primarily of friable cretaceous and sedimentary rocks. The dominant formation is the Richmond formation, which is comprised of highly weathered grey to yellow sandstones, siltstones and mudstones. The Rio Grande, which drains the area, is bordered for 50 per cent of its length by alluvial deposits consisting of carbonaceous and silica-rich sands. Steep cultivated slopes, with minimal conservation strategies and high intensity rainfall, contribute to high levels of vulnerability to landslide and flood hazards, as well as soil loss and land degradation.

Although this is an area of high agrobiodiversity, increasing emphasis on specialized crops such as banana (*Musa sapientum*) and the tendency towards reduced interplanting are major contributors to biodiversity loss in the area. It was important therefore, that these developmental issues, as also the particular social dynamic of the communities, be firmly integrated with any efforts made towards biological conservation.

Social dynamics of the communities

The demonstration site contained five main communities, comprising some 1000 farm households and a total population of approximately 5000 people. Among rural communities in Jamaica, including those of the demonstration site, there exist strong networks based on family and kinship groups. Church affiliation is also the basis of networks of friends and supporters in times of difficulty. Associations, such as the Burial Scheme Society and other informal 'fraternities' and 'partner' groupings, provide various levels of assistance especially in times of grief or other personal distress. However, social capital, taken as the set of resources inherent in patterned or structured social relations within the context of farm management and practice, was surprisingly low. The reasons need examination.

Relationships with external agencies

The Jamaica Agricultural Society is an association of farmers that meets to discuss common problems in relation to agriculture. The topics of discussion are usually those relating to problems faced by the government and government agencies, factors that are controlled externally such as the price of seeds and agrochemicals, the problems of the fluctuating market for major crops, and poor road access. On internal matters, such as those relating to farm management and crop selection, there seemed to be no communication between farmers.

The Banana Export Company (BECO), which is the sole channel for exporting bananas, presses farmers to produce the crop as a monoculture, with farms clean weeded, and intensive use of agrochemicals for both pest control and fertilizers. The company itself sells and distributes the agrochemicals. The farmers complained that the price of agrochemicals was high and that despite their best efforts, the level of rejection of their bananas grown for the export market left them perpetually impoverished. Nevertheless, many farmers felt that they had no option but to keep producing for BECO since other market opportunities were virtually nil. Those farmers who have rejected the traditional system of diversified farm plots and complied with the requirements of BECO are held up by the extension officers of the Rural Agricultural Development Agency as models of good practice.

There had been no support or acknowledgement of agrobiodiversity as a model of good practice, until the arrival of the PLEC team. Yet some farmers had persisted in intercropping bananas with a wide variety of other plants, ranging from timber and fruit trees to a ground cover of condiments and medicinal plants. The rationale was explained to other farmers at a demonstration site field day held on one farm; it was based on the economic advantages of having alternative cash crops to supplement variable income from bananas, as well as increasing the range of crops available for household consumption. Farmers who did this were also aware of the ecological benefits of mixed cropping in providing shade, ground cover and some measure of pest control.

Conflict within the community

The issues that were a source of conflict in the communities were important in guiding our selection of the expert farmers. Political differences provided one important area of disharmony and suspicion between groups. A majority in each local community supported one or other of the two major political parties. Though hostility was not expressed most of the time, negative feelings were sufficiently strong that farmers from certain communities would not go to some other communities for meetings. We therefore decided that the venue of the initial community meetings should be in different locations. It was essential that expert farmers be selected from communities on both sides of this political divide, even if this meant some compromise in terms of the range in diversity of farm systems that would be represented.

Acceptance of leadership

Additional tensions concerned the acceptability of some persons to teach or otherwise disseminate information. For example, one outstanding farmer was a returned migrant from the UK, having lived there for more than thirty years. A highly progressive farmer, he demonstrated potential leadership qualities and seemed willing to share his skills and ideas with other farmers. He engaged in organic farming and introduced a number of non-traditional plants and livestock that had greatly increased the agricultural diversity on his land. He specialized in growing exotic fruit for the hotel industry, and sought out marketing outlets and organized the process himself. In addition he kept geese, produced honey and was a member of the national bee-keepers association.

Despite all this, and the fact that he had been born and grew up in the area, and had retained his family connections there, he was widely resented. His wife was a foreigner and well-educated, and the farmer had become more sophisticated in his approach to farming, his social and business contacts and livelihood generally. These factors had combined to create a significant barrier to his acceptance in the community. It soon became evident that he would not be able to effectively demonstrate anything to other farmers. Although he has remained loosely connected with PLEC activities and was invariably the one who loaned his drinks cooler and went into town to purchase the food required for the meetings, it became clear that he could not be included as an expert farmer.

There was a general suspicion of leaders who emerged within the community. People were ready to accept leadership from outside the community—and the further away, the better. Those from outside were assumed to be genuinely more knowledgeable, and were seen to provide a means of generating social capital that could have other benefits. Networks established with persons 'outside' were therefore valued, those established 'inside' were seen of little use except for social support.

Plate 1 PLEC work experience day on Henry Smith's farm.

Henry Smith (expert farmer, left) in discussion with Balfour Spence (PLEC scientist, centre). Neville Campbell (expert farmer), Elizabeth Thomas-Hope (PLEC scientist), Veda Atkinson (new expert farmer), Althea Atkinson and other farmers listen.

The propensity for seeking 'assistance' from outside explains why the PLEC team was accepted, even though we did not give the kind of assistance that farmers had come to expect from outside networks. Nevertheless, they still accepted the team and over time became more confident about their own agriculturally diverse practices in both management and crop selection. As a result, the farmers became increasingly enthusiastic about what we termed 'work experience days', which were the sessions on each other's farms to examine and discuss the management methods of others (Plates 1 and 2).

Plate 2 PLEC work experience day on Linval Hazel's farm

Linval Hazel (right) explains to other farmers his rationale for maintaining a high level of biological diversity on his banana agroforestry land.

Characteristics of the expert farmers

Farmers were identified as 'expert farmers' on the basis of two main criteria:

- management practices and especially the biological diversity of their farms;
- their acceptability in the community to impart and disseminate information, and thus be effective demonstrators of agricultural management practices.

Five expert farmers were eventually selected, drawn from three communities. They were all distinguished by their mixed farming practices, including the combinations and configurations of plants on their farm. They represented the various communities in terms of political affiliation and it seemed that they would all be effective communicators of farm practice. The eldest, Linval Hazel, was highly respected by the other farmers and is the local representative to the Jamaica Agricultural Society. It was also important that some female farmers be identified as expert farmers so that the influence on the wider community would be better balanced in terms of gender. The group has therefore been expanded to include three women.

Table 1 gives information on the initial group of five farmers.

There was a strong negative relationship between age and level of education attained. The younger farmers (Smith and Cuthbert) were those who had received some vocational training, and Campbell had been to secondary school. Hazel and McKenzie had received only a primary education.

Table 1 Characteristics of the expert farmers

Farmer	Age	Education	Household size	Years in farming	Other income generating activities	No. of family overseas
Ewart Mckenzie	39	Primary	7	24	None	0
Neville Campbell	43	Secondary	5	20	None	0
Duke Cuthbert	32	Vocational training	4	3	Yes	1
Linval Hazel	60	Primary	3	45	None	1
Henry Smith	38	Vocational training	3	15	Yes	1

The demonstration farms

The size of farms of the expert farmers ranged from 5.5 to 12 acres and each farm was comprised of either two or three plots. The farmers selected the plots for the demonstration that took place on the 'work experience days'. Characteristics of the demonstration plots are illustrated in Table 2.

The dominant crop was the chief income-generating crop on the farm in all cases. In the land-use stage 'agroforest' (Plot 1 in Table 2), banana was the dominant crop on McKenzie and Hazel's farms. There was a possible connection with level of education, reflecting a dependence on the export crop promoted by the agricultural agency among those with least education and no alternative or additional livelihood to farming. The younger and more educated farmers, Smith and Cuthbert, both of whom had alternative income-earning strategies, depended on non-traditional crops. The dominant crop on Smith's farm was plantain, and on Cuthbert's callaloo (spinach). Campbell's main crop was pak choy. Only Campbell and Cuthbert grew income-generating crops on their house gardens (Plot 2 in Table 2). The other three farmers grew various plants of value for household consumption, including fruit trees in single stands, bushes for tea, spices and plants for medicinal use, and ornamental plants.

All the expert farmers used agrochemicals. The cost was high in relation to the profits derived from farming. This was particularly true of bananas for export. The chief chemical fertilizer used on all the expert farmers' plots was sulphate. Second in terms of usage was potash. The commonly referred to 'Miracle Grow' was comprised of nitrogen, phosphorous and potassium in a ratio of 15:5:35. At least two and in some cases four different types of chemical fertilizers were regularly used.

Table 2 Characteristics of the chosen farms/plots

Farmer	Farm size (acres)	No. of plots	Main income generating crop		Additional labour use	Market	Agrochemical usage (100 lb bags)
			Plot 1 Agroforest	Plot 2 House garden			
Mckenzie	10	3	Banana	None	Yes	Local	25
Campbell	12	2	Pak choy	Banana	Yes	Local	60
Cuthbert	11	2	Callaloo	Breadfruit	Yes	Local	13
Hazel	5.5	2	Banana	None	No	Export	14
Smith	6	2	Plantain	None	Yes	Local	2

Campbell, the vegetable farmer, used 60 bags, where each bag contained 100lb (45.4kg).[1] Methods of pest control included chemical pesticides as well as mixed cropping combinations and the removal of pests by hand. The farmers indicated that things had changed from the past. They had all adopted 'modern' techniques in their farming practices. All felt that agrochemical use was essential for successful food production.

The PLEC researchers had noticed the lack of peas and beans on the farms. The farmers were surprised and keenly interested to learn from the team that peas would fix nitrogen in the soil. They could reduce the use of chemical fertilizers if peas were intercropped with other plants. The farmers became convinced of the additional benefits of growing peas, as desirable components of the diet, as well as for their market value. Due to the interruption of work on account of severe flooding in late 2001, planting was postponed and it has not yet been possible to evaluate the results.

[1] There was a high level of awareness on the part of the expert farmers of the dangers of improper handling of the agrochemicals. Only Mckenzie used broadcasting method of applying chemical fertilizers to the crops; the others used a 'ringing' method. Protective gear used by the farmers included gloves, respirators and masks. Unused agrochemicals were either buried or burned.

Market-orientation and agrodiversity

Markets for crops fluctuated significantly from one year to another. Banana export was controlled by BECO and had declined in recent years. The domestic market for crops such as pepper and plantain was unpredictable. The market and cash sales were the prime motivating force in the decisions concerning the selection of crop combinations. This was particularly the case among the younger farmers, who were more adept at accessing markets than were the older farmers.

The work experience days included demonstration and discussion of the indirect value of certain crops, for example in pest control, mitigation of the effects of flood and landslide hazards, nitrogen fixing, reduced competition for soil nutrients by varying the rooting systems of the crop combinations as well as their increased soil-binding effects. The different expert farmers were able to demonstrate and relate different experiences on these issues to the others.

Agrobiodiversity characteristics of expert farms

The identified expert farmers represented a variety of land-use stages and field types and displayed a range of species diversity on their farms (Table 3).

Land-use stages

Common land-use stages included agroforest, house gardens and edges. House gardens were dominated by multi-tiered configurations involving food trees such as breadfruit, an array of fruits including bananas for local consumption, root crops such as dasheen, herbs and medicinal plants.

Agroforests were banana dominant, since the Rio Grande valley is one of the leading areas for the production of export bananas in Jamaica. Although the monopoly BECO discourages the intercropping of bananas with other crops except coffee, and encourages the removal of undergrowth from banana farms, all expert farmers maintained a diverse system of interplanting, including the maintenance of medicinal species among the undergrowth.

While the configuration of edges varied among expert farmers, edges were extensively used for the production of grass as fodder for farm animals as well as the maintenance of medicinal plants. This was because the location was free from the

Table 3 Land-use stages and field types of expert farmers

Farmer	Land-use stage	Field type
Mckenzie	1. Agroforest	Mixed field of banana interplanted with dasheen and coco intercropped with other food crops such as yams, corn and pumpkin; random occurrence of fruit trees
	2. House garden	Multi-storeyed mixture of staple crops: *Musa sapientum* (banana); *Colocasia* (dasheen); *Xanthosoma sagittifolium* (coco); *Artocarpus altilis* (breadfruit); herbs/medicinal plants; *Aloe vera*; fruit trees; *Mangifera indica*; ornamental plants; *Croton spp*.
	3. Edge	Grassy verge around agroforest containing a variety of grasses, ornamental plants and fruit trees
Campbell	1. Agroforest	Dormant banana plantation with actively cultivated vegetable gardens
	2. House garden	Multi-storeyed mixture of staple crops: *Musa sapientum*; *Colocasia*; *Xanthosoma sagittifolium*; *Artocarpus altilis*; herbs/medicinal plants; *Aloe vera*; fruit trees; *Mangifera indica*; ornamental plants; *Croton spp*.
	3. Edge	Grassy verge around agroforest, containing mixture of grasses, ornamental plants fruit trees and food crops such as *Musa sapientum* and *Xanthosoma sagittifolium*
Cuthbert	1. Agroforest	Mixture of banana, plantain and vegetables
	2. House garden	Multi-storeyed mixture of staple crops: *Musa sapientum*; *Colocasia*; *Xanthosoma sagittifolium*; *Artocarpus altilis*; herbs/medicinal plants; *Aloe vera*; fruit trees; *Mangifera indica*; ornamental plants; *Croton spp.*
	3. Edge	Grassy verge containing mixture of shrubs (e.g. *Sida acuta*—broomweed) and medicinal plants (e.g. *Aloe vera*)
Hazel	1. Agroforest	Mixed array of export banana, dasheen, coffee, cacao, dasheen, coco along with a variety of fruit trees
	2. Edge	Grassy verge along with mixture of shrubs and medicinal plants
Smith	1. Agroforest	Dominated by plantains interplanted with dasheen, coco
	2. House garden	Mixture of food crops such as banana, plantains, root crops, herbs, fruit trees and medicinal plants
	3. Edge	Grassy verge around agroforest, containing mixture of grasses, ornamental plants fruit trees and food crops such as *Musa sapientum* and *Xanthosoma sagittifolium*

pesticides and weedicides utilized in banana production. Although species on the edges had personal value for farmers, most did not have significant market value and were therefore less vulnerable to praedial theft than other land-use stages. Edges therefore function as protective barriers for more market-valuable crops.

Species abundance and richness

Species abundance and richness within the area sampled on expert farms are indicators of the level of species diversity (Zarin, Guo and Enu-Kwesi 1999) and are shown in Table 4.

Although species richness and abundance were generally higher for house gardens and agroforestry than for edges because of larger sampled areas, diversity per unit area sampled tended to be greater for edges. This was due to proliferation of medicinal species and the 'natural' state of most edges.

The effect of PLEC activities

Despite the social networks that existed in the communities, they had generated little social capital in the context of agricultural knowledge and management strategies. The PLEC team found a local culture of conservatism among farmers whereby it was felt that one ought not to walk onto other farmers' plots or ask questions about other farmers' activities. What farmers planted and what techniques they employed were their business and no one else's. This had largely prevented the sharing of ideas and hindered the development of any openness about new market opportunities or strategies for dealing with problems faced by farmers in the area.

The PLEC demonstration activities, in particular the field-based work experience days, gradually broke down these barriers for the farmers who participated. The increase in the sharing of information and knowledge, and the eagerness to host work experience days, were remarkable. They were highly enjoyable days as lunch and drinks were provided and the atmosphere became convivial. Tasting of fruit, and giving and receiving plant clippings and roots for planting, contributed to the spirit of sharing that became characteristic of these field days.

Lessons learned

Lessons were learned by PLEC scientists and farmers alike. Among the specific areas of learning on the part of the farmers is, for example, the rationale for intercropping in the agroforesty land-use stage. Linval Hazel's approach to banana cultivation was particularly instructive. Another element of increased biodiversity on plots related to the planting of peas and beans around or between the existing crops in both house gardens and agroforestry plots. Many of these and other issues discussed in the field were later brought up by farmers at a PLEC seminar at the University of the West Indies, involving scientists, policy-makers and farmers.

The more general lessons will take longer to become fully rooted in community tradition. These include the notion that there is the need to develop common methodologies and strategies. These would help in dealing with the challenges of maintaining a livelihood and, at the same time, a sustainable agricultural landscape in vulnerable environments such as that of the PLEC demonstration site.

For the PLEC scientists, important lessons from the demonstration site activities are being disseminated to policy-makers. These include the importance of addressing agricultural and biodiversity issues in ways that are cognizant of the social dynamics of the community. It is important that farmers be facilitated in the process of building networks that increase social capital in the community. Demonstration site activities constitute a highly dynamic process. The

Table 4 Species richness and abundance on plots of some expert farmers

Farmer	Land-use stage	Field type	Area of plot (m^2)	Sample area m^2	Species richness	Species abundance
Mckenzie	Agroforestry	Mixed field of banana interplanted with dasheen and coco intercropped with other food crops such as yams, corn and pumpkin; random occurrence of fruit trees	38430.4	15	59	196
	Edge	Grassy verge around agroforest containing a variety of grasses, ornamental plants and fruit trees	30.0	3	15	64
Campbell	Agroforestry	Dormant banana plantation with actively cultivated vegetable gardens	12135.9	12	25	261
	House garden	Multi-storeyed mixture of staple crops: *Musa sapientum* (banana); *Colocasia* (dasheen); *Xanthosoma sagittifolium* (coco); *Artocarpus altilis* (breadfruit); herbs/medicinal plants*: Aloe vera*; fruit trees; *Mangifera indica*; ornamental plants; *Croton spp*.	24271.8	12	30	327
	Edge	Grassy verge around agroforest, containing mixture of grasses, ornamental plants fruit trees	30.0	3	21	89
Hazel	Agroforestry	Mixed array of export banana, dasheen, coffee, cacao, dasheen, coco along with a variety of fruit trees	6068.0	12	13	57
	Edge	Grassy verge along with mixture of shrubs and medicinal plants	30.0	3	15	38
Smith	Agroforestry	Mixture of food crops including banana, plantain, coco and dasheen	6068.0	12	23	74
	Edge	Grassy verge around agroforest, containing mixture of grasses, ornamental plants, fruit trees and food crops such as *Musa sapientum* and *Xanthosoma sagittifolium*	30.0	3	19	53

selection of expert farmers, and the increased number of farmers participating in work experience days, is one that is ongoing as changes occur in the communities.

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Reference

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A DISCUSSION WITH SOME CHINESE EXPERT FARMERS

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The Gaoligongshan Farmers' Association and its expert farmer members were described in the last issue of *PLEC News and Views* by Dao et al. (2001). After the Cluster and National Meetings in Kunming on 18–21 January 2002, I visited them again together with Dao and Brookfield and two of my Tokyo colleagues, and some visitors from other Chinese universities.[1] This time I made use of my fluency in the local dialect of western Yunnan to ask these leading farmers a number of questions. This led to a lively discussion which lasted more than an hour. The farmers, a photograph of whom appears opposite in Figure 1, are drawn from most of the 'natural villages' forming the administrative village of Baihualing. Their spontaneous replies to my questions should be of interest to a wider readership.[2]

The questions I asked were:

- why do they practise crop diversity?
- why do other farmers not farm like them?
- in what ways have PLEC activities in Baihualing facilitated development in Baihualing village?

Figure 1 Gaoligongshan Farmers' Association members

Why practise crop diversity?

Each of the farmers commented that there are many advantages with farming systems of perennial or annual crop diversity. Most of them laid stress on the reduction of risk, both from natural events and from the market. The diversity systems combine crops with long and short duration, and produce fruits with overlapping periods, and thus both even out the work load, and provide food and income at different times of the year. Several farmers said they liked tree crops because they could leave them to the next generation; trees also help restore the much degraded land.

Mr Li Dayi (who is largely illiterate) conducted two years of experiments in order to domesticate a preferred native timber species, *Phoebe puwenensis*, which foresters and technicians had not succeeded in domesticating. Formerly, he used to cut the tree illegally in the natural forest: now he can harvest from his own plantations, and sell his seedlings to others. Mr Wu

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[1] These were Professors Lu Baorong (Fudan University, Shanghai), Ruan Renchao (Guizhou Academy of Agricultural Science), You Yunmei (Guizhou Academy of Agricultural Science) and Wang Yunyue (Yunnan Agricultural University).

[2] Farmers in the meeting were the Chairman, Mr Wang Youshen, the Vice-Chairs Mr Li Jiahu and Ms. Yang Xiubo, the Secretary, Mr Chen Shihou, the Accountant, Mr Yang Chenwu, and the following other expert farmers: Mr Wu Chaoming, Mr Gao Dengli, Mr Yang Zhixie, Mr Mi Yunheng, Mr Zheng Jiafan and Mr Li Dayi.

Chaoming took a more personal view, and said that he loves nature and the diversity of crops and trees. Over the years he has been trying to increase diversity by conversion of his former monoculture maize fields into agroforestry.

Why do other farmers not crop in the same way?

For the second question, the farmers said that others do use diversity farming at a limited scale, but not as much as they do. Some of them pointed out that a few innovative people must take risks and lead the change. Other and more conservative people then see the benefits of new ways of farming and follow. But innovation needs resources. There is a need of initial investment for seedlings and fertilizers, and skills are needed to develop the techniques of tree planting and management, so as to develop systems of perennial crops. Some farmers said they had a sense of recognition and felt more responsible for developing and promoting conservation farming practices since joining the farmers' association. This explains partly why the membership of the association is small as only those who perform well in conservation farming are accepted.

How has PLEC helped?

There was a chorus of replies that the best single thing PLEC scientists have done for them has been to show the benefits of agroforestry in contrast to monocropping. By setting up model farmers and providing training, they have facilitated the expansion of agroforestry systems. They also stated that farmers now have more cash for expansion of production and increased farm inputs. By these, they specifically meant fertilizers and pesticides; with increasing income, chemical inputs are becoming more affordable.

They were not however ignorant of the dangers of dependence on chemicals. Therefore, there is a need to promote effective and practical biological ways of fertility maintenance and pest control as alternatives to chemical inputs. One farmer remarked that orchards with mixed fruit trees suffer much less from pests than those with only one variety of fruit tree, and therefore these orchards need little application of pesticides.

The farmers also made the point that the market should reflect the real value of products from the orchards with little or no application of pesticides. This point was taken up by the visiting scientists who suggested that the association could become a vehicle for certification of its members as organic farmers, so that their products might fetch a better price in the market.

Discussion

Baihualing is a remote and poor community, where few farmers have incomes above about RMB 10,000/year, and none have advanced education. But the expert farmers are thinkers about what they do and why they do it. In their own terms, they understand many of the competing scientific advantages of different cropping systems, as described in the large literature summarized in Brookfield (2001: 271–76). They are proud of their knowledge and skills.

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PLEC ON STEEP SLOPES: THE 'SUSTAINABLE LIVELIHOODS' APPROACH[1]

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Introduction

PLEC work in its demonstration sites has the betterment of people's livelihoods as a major concern. Many of the sites are in mountainous or steep slope areas, which present particular problems for sustainable livelihoods. Hillside dwellers face distinct environmental and social challenges. Management of their environment and of biodiversity is one way they cope with these challenges. In so doing, they develop land use and farming systems that are resilient, sustainable and productive. The conditions that lead to the emergence of sustainable rural livelihoods (SRL) are examined here, using and assessing the formal SRL approach described by DFID (1999).

PLEC on steep slopes

It is no coincidence that a large number of PLEC's demonstration sites are in areas with steep slopes, high mountains or highlands. PLEC has sites in: the Gaoligong Mountains in western Yunnan, China; Arameru District, northern Tanzania, on the slopes of Mount Meru; the Fouta Djallon Highlands, in the Republic of Guinée; and in the Central Highlands of Mexico. Other steep land sites are in Thailand, Jamaica, Kenya, Uganda and Papua New Guinea. Why is it that so many good examples of the management of biodiversity, the development of interesting techniques and the employment of elaborate indigenous technologies are found in such areas?

Society, economy and environment of hillslopes

Economically, hillside communities tend to be amongst the poorest. The opportunities for productive enterprises are few. Yet even within this context, some practices that maintain adequate depths of topsoil on steep slopes have demonstrated their economic potential (Stocking 2001).

Because communities are poor, their strategies for coping have to be more complex and diverse, while the reality in which they live continues to be dynamic and unpredictable (Chambers 1997). Rates of degradation and environmental change are at a maximum in mountainous terrain (Messerli and Ives 1997), and change can be both incremental (soil erosion) and catastrophic (landslides).

Societies who live in these challenging environments can provide us with important lessons and empirical examples of how to survive and live sustainably in an uncertain world. This is far from the earlier views of many writers. Jack Ives (1985: 428) lampooned such views:

> Nepal, for instance, was doomed to fall over the environmental precipice by the year 2000. The collapse would be caused by continued uncontrolled population growth among subsistence farming societies propelled to cut down more trees

[1] This paper is an amended version of a presentation given to the UNU *International Symposium on the Conservation of Mountain Ecosystems* on 1 February 2002.

> for fuel and fodder and to make way for agricultural terraces on steep slopes for growing food. This, in turn, would lead to rapid acceleration in landsliding and to increased soil erosion in general under the intense downpours characteristic of the summer monsoon. The spectre of mountain desertification was raised with the end result being the devastation of the Ganges and Brahmaputra plains and a major opportunity for Dutch polder engineers in the Bay of Bengal.

Many elements of what has been called the 'myth of Himalayan environmental degradation' have since come under scrutiny (Gilmour 1988; Ives and Messerli 1989). Despite former dire predictions, most upland land use is remarkably enduring.

The PLEC sites on Mount Meru, Tanzania, mirroring their more famous but no more agrodiverse counterparts on Mount Kilimanjaro, the Chagga home gardens, have some of the earliest and most productive multi-storey and multi-purpose land uses in Africa. Even more striking are the terraces of Nepal, Andean Peru and the Mountain Province of the Philippines. The people who have guarded these structures and practices are a repository of technical expertise; from them the development community could derive vital answers to fundamental global concerns, such as how to conserve biodiversity, protect against soil erosion and fashion sustainable livelihoods out of limited natural resources (Brookfield 2001).

Ethnic diversity can be important, maintaining a multiplicity of agricultural systems, conserving agrobiodiversity and evolving complex landscapes that are linked to food security and livelihoods. In Yunnan province, the focus for PLEC's activities in China, there are 27 distinctive ethnicities, from Tibetan minorities on the snowy mountains of the northwest to the Hani minority in the steep lowland valleys of the southeast. This diverse ethnicity and its reflection in the many land-use stages is a major contributor to the sustainability of agriculture (Dao et al. 2001). In addition, "Yunnan owes its wealth of ecosystems to its position at the junction of three geological plates and six floristic regions" (Guo et al. 2000: 28). This mix of social, cultural, biological and geological factors accounts for diversity in all aspects.

Characteristics of mountain-side communities and environments

Characteristics and challenges for mountain-side communities include:

- ***inaccessibility***

  Mountain sides are difficult to reach, leading to physical isolation, poor communications and weak infrastructure. Yet isolation can generate successful coping strategies. The diversity of upland rice and wild vegetables in Baka Village of Xishuangbanna, Yunnan, is an example (Fu and Chen 1999). The 18 varieties of upland rice and 55 types of vegetables mean that there is year-round availability of food. The farmers plant an intricate mix of cereals, vegetables and other crops in order to exploit the complex local environment;

- ***poverty of resources***

  The quality, abundance and accessibility of natural resources, such as soil, water, and growing season, are often minimal in steepland areas. But from these restrictions come interesting indigenous technologies.

  In Embu-Meru districts around Mount Kenya, the poorest social groups practise some of the most effective and low-cost soil conservation practices. Typically, these are trashlines made up of weeds, scraped together into contour ridges. Not only do these practices conserve soil, they also provide an extremely low-cost way of retaining water and nutrients. Studies of trashlines have shown their economic benefit, in contrast to the cost of many imported techniques (Kiome and Stocking 1995). Out of necessity has arisen effective environmental protection;

- ***landlessness***

  Usable tracts of land are usually few, and land tenure arrangements insecure. Highland areas often have large areas nominally under state control as forest or reserve. The paper on the PLEC demonstration site at Pah Poo Chom in northern Thailand (Thong-Ngam et al. in this issue), gives an example of this;

- ***fragility***

  Steeplands are vulnerable to catastrophic environmental events, such as landslides, hailstorms and loss of infrastructural assets. Fragility is related to sensitivity and resilience, and hillsides are particularly vulnerable to both. They are sensitive in the sense that only small 'shocks' or perturbations may have an exceptionally large effect, such as landslides or rockfalls. They lack resilience in that these shocks are a common occurrence. Unpredictable and severe disruption to livelihoods is endemic; nevertheless some communities manage this fragility for long-term benefit.

  At the PLEC demonstration site in the steep valleys of north Jamaica near Moore Town, old landslide scars are evident everywhere and new slips occur regularly during the 'hurricane season'. 100 mm of rainfall may sometimes fall in less than an hour. Houses collapse, fields slip, and trees and perennial crops are destroyed. Yet over two or three years, the landslide scar is replanted, fields organized and new homesteads built. Scars are recognized as relatively stable and the newly exposed soil has more weatherable minerals and is generally more fertile. The scar line is usually better-watered, with springs, giving access to small-scale irrigation possibilities and greater production opportunities;

- ***marginality***

  This affects most aspects of mountain life—most obviously physically, but also socially, economically and politically. Long distances are involved, travelled usually on foot, to the nearest town and source of information exchange. In so far as external relations are concerned, hill communities are often ignored and rarely prioritized in development plans.

  Nevertheless, such isolation often brings a willingness (and maybe a necessity) to innovate (Quiroz 1999; Rhoades and Bebbington 1988). In Mexico, Chávez-Mejia, Nava-Bernal and Arriaga-Jordán (1998) note individual examples of innovation and experimentation in the PLEC sites.

  It is difficult exactly to account for innovation, but clearly the fact that marginality reduces the likelihood of advice from elsewhere throws farmers much more on to their own initiative;

- ***diversity and complexity***

  There is great dynamism and change in hillside environments and a diversity of conditions, often over very short distances. The quality of soils may vary from excellent in small pockets where a barrier has retained good depths of sediment, to very poor, thin, stony soils on eroded slopes. Other aspects of the biophysical environment may change rapidly over time and space. Diversity is often compounded by a complexity of ethnic groups, minority tribes, languages and cultural practices. It means that blueprint solutions, blanket forms of aid assistance and simple extension messages cannot possibly be appropriate to more than a very small percentage of steep slope farmers.

  The related attributes of complexity and diversity in small-holder farmers' livelihoods have been well described in a number of recent books on natural resource management: in the context of agricultural experimentation (Prain, Fujisaka and Warren 1999); plant genetic resources (Almekinders and de Boef 2000); and soil fertility (Scoones 2001). Diversity acts as an insurance and provides farmers with options to respond to change (Brookfield 2001). This can be seen in the interactions between soil fertility management, weed and pest control and crop diversity at PLEC's Tanzanian demonstration site (Kaihura, Ndondi and Kemikimba 2000).

Resource endowments

In order to understand how and why people can live in challenging environments such as mountains, it is necessary to understand the resources they have at their disposal, often termed their 'resource endowments'. Endowments are not just material assets—they include everything that people can access and transform into a livelihood outcome. Because the physical environment is deficient or hazardous it is often concluded that livelihoods are inevitably insecure, and that sustainable management of natural resources is effectively impossible. Is this necessarily so?

To concentrate solely on the biophysical is to ignore a wealth of other resources. It seems from anecdotal evidence that there is compensation for the lack of physical resources in a greater abundance of attributes related to society, local economy and human resources. This is implicit in the many case studies in the UNEP volume on *Cultural and Spiritual Values of Biodiversity* prepared for the Global Biodiversity Assessment (Bernbaum 1999). There is a spiritual, cultural and social distinctiveness, which cannot simply be explained by isolation or inaccessibility.

How can these compensatory mechanisms be addressed within one framework that brings together all the resource endowments at a society's disposal? One answer has been the development of the Sustainable Rural Livelihoods (SRL) framework. It balances what are called the five 'Capital Assets' and provides a framework for analysis. It shows how livelihoods may be constructed by any combination of different assets and how dynamic societies trade off one asset for another according to immediate and longer-term needs.

Capital assets

The five capital assets and their manifestation in mountain environments are described in Table 1. Essentially the sustainable livelihoods approach is concerned with people and understanding their strengths (assets or resource endowments); and how they endeavour to convert these into positive livelihood outcomes (DFID 1999). The approach is founded on a balance of assets required in order to achieve a positive livelihood outcome. This can be constructed as a pentagon (Figure 1a) that presents information about the diversity of assets that may be combined in order to construct a livelihood.

The shape of the pentagon may then be used schematically to show the variation in the combination of assets for any particular situation. The centre of the pentagon represents the situation of zero assets, while the outermost points are maximum access. In mountain environments (Figure 1b), social and human capital may be high (good social networks and available labour, for example), while physical and financial capital may be somewhat deficient (poor climate and growing season, and poverty). Pentagons such as these can be a useful focus for "debate about suitable entry points, how these will serve the needs of different social groups and likely trade-offs between different assets" (DFID 1999, Section 2.3). In other words, they encourage holistic thinking about the real-life building of a sustainable livelihood by using the resources at local

Table 1 Capital assets in the Sustainable Rural Livelihoods framework, with particular emphasis on areas prone to land degradation (adapted from DFID 1999; Stocking and Murnaghan 2000)

Natural capital	"The natural resource stocks from which resource flows and services (e.g. nutrient cycling, erosion protection) useful for livelihoods are derived." Included here are aspects of the natural environment such as soils, topography and water, and the livestock, crops and other plants that together support livelihoods. In hilly areas, these stocks of natural resources may be quite vulnerable—e.g. deforestation and loss in biodiversity; land clearance and erosion.
Human capital	"The skills, knowledge, ability to labour and good health that together enable people to pursue diffierent livelihood strategies and achieve livelihood objectives." Innate and learned skills in hilly areas include physical fitness and ability to carry heavy loads on steep slopes.
Physical capital	"The basic infrastructure and producer goods needed to support livelihoods." Infrastructure includes accessible transport, secure shelter and buildings, adequate water supply and sanitation, affordable energy, and access to communications. Producer goods include tools and equipment to enable people to exploit the natural capital. Hilly areas are usually deficient in physical capital, except water.
Social capital	"The social resources upon which people draw in pursuit of their livelihoods." These social resources are developed through networks, membership of more formal groups, allegiances and relations of trust, reciprocity and exchanges. Social capital is probably the key transforming and 'safety-net' capital for poor, mountain societies.
Financial capital	"The financial resources that people use to achieve their livelihood objectives". It comprises access to cash (including remittances from migrants) or to credit, which enable the land user to make choices about investments in natural or human assets (e.g. building a terrace, or hiring labour).

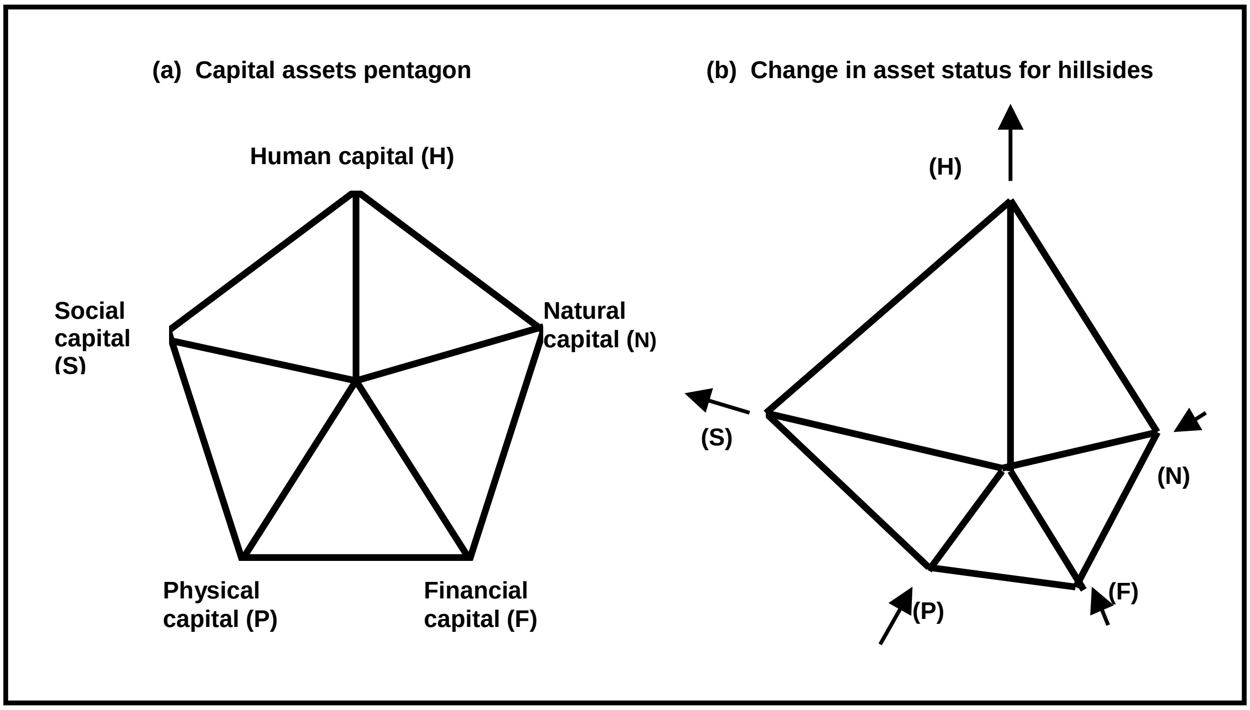

Figure 1 Capital assets pentagon (a); and a possible representation of dynamic change in hillside environments (b)

people's disposal. The SRL framework and the pentagon are tools for assembling relevant information and assigning it to useful categories. It is not a panacea for either full quantification of all factors or for solving intractable problems.

Assets and social capital

As the guidance notes of DFID (1999) describe, there are important relationships between assets categories that should be investigated before interventions are proposed.

Assets combine in many complex ways. There is **substitution** between assets. For example, a lack of financial capital in mountains may well be compensated for by enhanced social capital. Understanding this may then encourage further development of these strengths in recognition that there may be little that could be immediately accomplished in the way of financial assistance. In the course of time, a reverse substitution may occur, as the communities become more financially secure through the exploitation of other assets (e.g. tourism).

There is also **sequencing** between assets. An escape from poverty may need a recognizable sequence of use of other assets. So, the natural capital of mountains and scenic advantage could be identified as an entry point to overcoming the lack of financial capital. Then human capital in providing, say, tourist guides, and social capital in knowledge about the natural environment, could then secure the ultimate goal of increase in financial capital or wealth status of the community.

Social capital has been described as a 'resource of the last resort', and is therefore of especial interest in understanding the transforming processes in mountains and how coping structures are built to deal with the hazardous environment (Grootaert 1998). It makes a particularly important contribution to people's sense of well-being through giving identity, honour and a sense

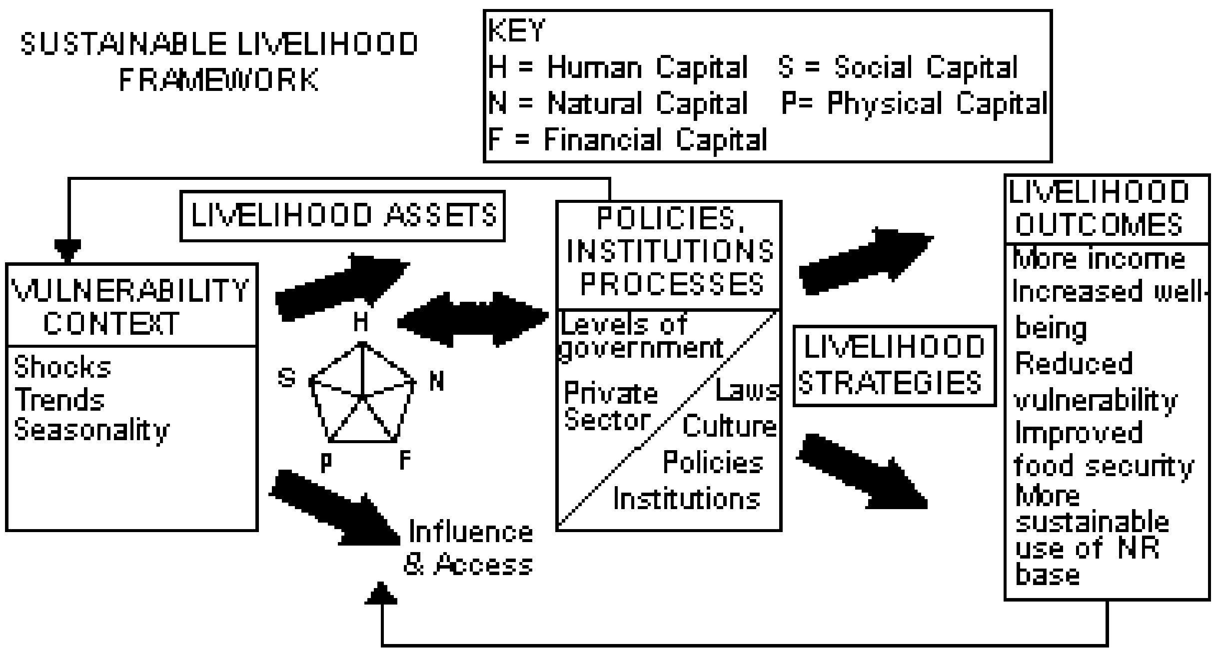

Figure 2 The Sustainable Rural Livelihoods framework (Source: DFID 1999)

of belonging to a group. Social capital is at the heart of strong groups in civil society, and the formation of new organizations and institutions. It is a resource especially used by the poor and vulnerable, providing a buffer to cope with external shocks (DFID 1999; but see also Thomas-Hope and Spence, this issue). Social capital is important because social networks, mutual trust and reciprocity lower the costs of working together. Social networks facilitate innovation and the sharing of this knowledge. Of all the 'capitals', it holds the key to the distinctiveness of mountain societies, their colourful nature and their ability to endure hardships. When it is under threat or breaks down, perhaps because of political instability, social capital can decline rapidly or be driven underground, thereby excluding the more vulnerable groups.

The Sustainable Rural Livelihoods (SRL) framework

The capital assets pentagon is a useful means of organizing the many types and pieces of information that relate to building livelihoods. However, the important dynamic and transforming processes in rural environments cannot be displayed. That is why the Sustainable Rural Livelihoods Advisory Group at DFID developed the SRL framework (Figure 2).

The framework is a versatile tool which improves our understanding of the livelihoods of the poor, and of how transforming processes and structures lead to livelihood strategies and eventually to outcomes. These outcomes then feed back to the assets. Stocking and Murnaghan (2000) give worked examples of the application of the capital assets pentagon in the context of land degradation at PLEC's Bushwere site in Uganda. They show how changes in assets can be qualitatively described as contributing to a change in livelihood outcomes. Land degradation is an important issue of global concern, yet it can be controlled with a good understanding of the appropriate interventions. The SRL framework itself is now common in many publications from the leading development agencies, and examples of its application for poor and vulnerable people can be found in Bebbington (1999) and for developing countries generally in Ellis (2000).

As a tool for use in planning and management of ways in which assistance may be offered to poor people, the primary considerations taken into account by the framework are all part of the process of understanding the dynamics of rural society:

- **vulnerability**, or the danger of asset destruction through external shocks;
- **transforming structures and processes**, or the way people create assets and determine their access to them;
- **livelihood strategies**, or the way people may switch between assets and the options they have;
- **livelihood outcomes**, or the minimum needs for securing an acceptable livelihood.

The framework is not a new 'miracle solution' to age-old problems. Its proponents see it as a way of thinking about livelihoods that helps us order complexity, making clear the many factors that affect how people build a sustainable living. It enables the development analyst to see how changes in one part of the livelihood system, induced by policies or aid interventions, may affect the livelihood outcomes from the use of all resource endowments. As such, it is a platform for rural development and a major initiative in the fight to eliminate poverty in difficult areas such as mountains.

Links between livelihoods and biodiversity on steep slopes

This paper concludes with an example of livelihood analysis that could be applied to mountain communities and used to drive the transforming processes and structures in the SRL framework. One of the important issues tackled by the PLEC project and its demonstration sites in northern Thailand and SW China is how far hill tribes protect against biodiversity loss, and how far biodiversity underpins their livelihoods. The normal professional perception is that biodiversity loss is rampant on hillsides because of deforestation, cutting native species for land clearance, and unsustainable swidden cultivation. There are clear links between change in the status of biodiversity, and change in livelihoods (Table 2).

Biodiversity loss may have ambivalent effects on livelihoods according to the nature of the productive enterprises introduced in place of natural vegetation. A decline in livelihoods may arise because species important to local people are no longer available (upper-left cell in Table 2). Loss of biological resources such as timber species or non-timber products such as medicinal herbs have implications for not only natural capital but also social and human capital. This wholly extractive and usually externally controlled transforming process has extremely deleterious consequences for livelihoods that are perhaps only very modestly compensated for by temporary labour opportunities as forest workers.

Table 2 Links between biodiversity and local livelihoods in mountain areas (adapted from IUCN 2000)

	Decline in livelihoods	**Improvement in livelihoods**
Biodiversity loss	**Intensive and large-scale resource extraction:** loss of steep land forests causing erosion and loss of natural capital	**Conversion of natural habitats to agriculture**: commercial land-use systems and monocultures, such as tea estates on hill lands. Enables extraction of food and products to lowland economies
Biodiversity maintenance or increase	**Strictly protected areas**: conservation benefits gained but access to local communities denied. Predation by wild animals may increase	**Sustainable management of biodiversity:** poor and marginal communities in hill areas depend upon biodiversity; they protect it, manage it and utilize the products, often with a view to future generations

As the PLEC project is demonstrating, there is another way. It is possible to translate a loss of natural biodiversity into an increase in 'agrodiversity'; simply put, the overall management and occurrence of diversity in agricultural systems (Brookfield and Stocking 1999; Brookfield 2001). The conversion of natural habitats may go two ways: (1) to monocultures and loss in crop genetic diversity; or (2) to complex small-scale agricultural systems that maintain or increase overall biodiversity. The 'best practice' situation as promoted by PLEC is in the lower-right box of Table 2.

It should be noted, however, that the biodiversity would not be the same as that occurring naturally. It is a managed biodiversity, often consisting of complex agroforestry systems and multi-storey cropping. On the Mount Meru demonstration site in Tanzania, coffee is grown under shade trees, interspersed with many banana varieties. In the Gaoligong Mountains of SW China, farmers have converted elements of the natural biodiversity, domesticated some species, and then added a range of other species and varieties from elsewhere.

Conclusion

People build livelihoods in mountains and on steep slopes, despite the fact that these are difficult areas. It might be expected that the worst land degradation and mismanagement of the landscape would occur on these slopes; that terrace systems and other human endeavours would be transient and poorly constructed; and that societies would be impoverished in every sense. The evidence shows quite the reverse. There is a wealth of innovation, creation and knowledge in mountain areas. Substitution is happening between aspects that are truly limiting, such as growing season and soil depth, to those that have good potential, such as social networks and human expertise. The Sustainable Rural Livelihoods framework provides a good analytical tool to understand the various resource endowments or capital assets that people use to survive.

There are important lessons arising from an understanding of how mountain societies cope with a difficult biophysical environment. Capital substitution and fashioning livelihoods out of meagre natural resources by concentrating on social aspects are ways in which sustainable livelihoods are engendered. Understanding these processes can lead the international community to positive lessons and outcomes. Similar analyses may be used to design targeted interventions, not only for mountains but also for other poor rural situations.

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