Agricultural Biodiversity in Smallholder Farms of East Africa

Edited by
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Agricultural biodiversity in East Africa: Introduction and acknowledgements

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Introduction

Throughout eastern Africa, broadly taken as extending from the Horn of Africa down through the former British colonies of East-Central Africa to Mozambique, there is a large diversity of farming systems, human societies, and ways of managing complex external pressures on sustainable land use. In Ethiopia, for example, Konde *et al*. (2001) document how in the highly populated parts of Wolataya, farmers have created intensive gardens, based largely on intricate soil fertility management practices. Biographies of change in attitudes and activities of farmers reveal complex forcing mechanisms that have resulted in today's pattern of land use, with many important implications for the development of policy and future practice.

This example from the northern part of eastern Africa is but one of many accounts of the complex interactions between land users and their broader environments from the whole region. This book focuses attention on the central part of eastern Africa. It is primarily about the investigations and experiences of colleagues and farmers in three countries – Kenya, Tanzania, and Uganda. These countries were chosen not because they have the best examples, but because they were clustered together by one project, People, Land Management, and Environmental Change (PLEC), in a so-called ''hot-spot'' of biodiversity, where the international community as represented by the Global Environment Facility felt that

additional attention was needed. The researchers have sought an understanding of the role of biodiversity on the agricultural lands of smallholder farmers. This opening chapter sets the scene by first providing an overview of what is meant by ''agricultural biodiversity'' (or what this project has termed ''agrodiversity''). Then the chapter provides some definitions of terms, which many find confusing. Thirdly it describes the global PLEC project, with its East African cluster, that provided the funding as well as the methodology for the work. There is then an overview of the book. Finally, acknowledgement is made of the many people who contributed to the research, without whom this book could not have been written. Fidelis Kaihura wrote this last section of this chapter in his role as the nominated new cluster leader of PLEC for East Africa.

Agricultural biodiversity

Agricultural biodiversity is a topic that has only within the last decade come to the fore as an issue worthy of special attention, study, and research. It describes the situation of biological diversity in areas of agricultural activity and land use. Since land use – or perhaps more exactly, land abuse – is considered by most observers to be the major threat to biological diversity, it may appear to be something of an enigma that agricultural biodiversity should exist at all. If agricultural activities deplete biodiversity, then surely efforts to protect biodiversity should focus on non-agricultural areas – forest reserves, wildlife sanctuaries, national parks, and wilderness areas?

Yet because biodiversity is a global concern and because most productive areas of the world, which contain most of the globe's biodiversity, are in areas of land use, agricultural biodiversity is far from being the contradiction that narrow ecologists would see it to be. Indeed, on the grounds that most of the ''hot-spots'' of biodiversity are intensively used and support large and growing populations, an alternative argument should prevail. It could be argued that agricultural biodiversity (or agrobiodiversity) is far more important than, say, conservation of protected areas or of remnants of natural habitats in areas of land use (Wood and Lenné 1999). Equally, there is probably more intrinsic biological diversity in areas of land use than in all the protected areas put together – a claim that is probably impossible to verify, but nevertheless useful to support the importance of agricultural biodiversity. Ecological and conservation purists might counter that argument by saying that this is unnatural biodiversity, full of alien and invasive species. Land use has destroyed the natural habitats, created biological seas of uniformity, and even eradicated small niches of interest such as hedgerows and field

boundaries. They would have a point if one concentrated only on areas of commercial farming and forestry, where monocrops and single varieties prevail and single-species stands of trees line up in rows. However, the agricultural biodiversity dealt with in this book is under the guardianship of smallholder farmers, with diverse practices, interests, skills, and needs. They manage landscapes rich in species and intricate in their organization. Furthermore, they do not just protect many indigenous species, they conserve and manage plants and animals important to human beings. Yes, it is not the natural biodiversity of species and varieties, many of which have not yet been discovered and named. The authors of this book would claim it is a far more important and immediate biodiversity that also consists of indigenous skills, knowledge, and management. It involves plants and animals with use and non-use values, such as medicinal plants, local food crops, ornamental trees, and domestic animals.

To illustrate, one of the PLEC farmers in Arumeru believes in *matatu*, or growing three types of plant together. There seems to be no particular scientific rationale for these threesomes – he has many of them – but they work for him. He chooses the species carefully and he has a management strategy. It is important to document both the biota being managed and the way that land users have learnt how to manage it if we are to provide for food security, sustainable livelihoods, and human development and well-being. Sometimes we may have secretly believed what we are told to be myth. Sometimes scientists may add their formal knowledge, unavailable to local people, to create new approaches and new technologies. However, the whole assemblage of what is here termed ''agricultural biodiversity'' or ''agrodiversity'' is vital to be documented, examined, and understood. This book does this for demonstration sites set up under the PLEC project in three countries of East Africa: Kenya, Tanzania, and Uganda. Before outlining the structure of the book and describing the project itself, it is important briefly to define the key terms used.

A question of definition

The headline term used in the title of this book and this chapter is ''agricultural biodiversity''. The authors wanted to use ''agrodiversity'', because this means all aspects of biological diversity in areas of agricultural land use, plus the diverse ways that farmers manage the biota. However, ''agrodiversity'' is still not widely in use. In October 2002 the internet search engine Google came up with 561 references to ''agrodiversity'', many of which emanate from the PLEC project, and 274,000 for ''agri-

cultural biodiversity'': nearly 500 times greater recognition for the second term than the first. The publisher of one of the previous books from the project (Brookfield *et al*. 2002) persuaded the authors at the last moment to change part of the title of the book from ''agrodiversity'' to ''agricultural diversity'', on the grounds that the preferred term lacked resonance with most people. The authors acquiesced then, and do so again now. However, the question of definitions needs to be made explicit.

Agrodiversity

Agrodiversity (also termed ''agricultural diversity'') is ''the many ways in which farmers use the natural diversity of the environment for production, including not only their choice of crops but also their management of land, water and biota as a whole'' (Brookfield and Padoch 1994: 9). The PLEC project has seen agrodiversity as essentially to mean ''management diversity''. This is related to ''agricultural biodiversity'' but encompasses much more. It includes the management of fields and soil fertility, as well as farms and landscapes. It takes in the application of agricultural technologies, crop rotations, soil and water conservation techniques, and weed and pest management. As Brookfield (2001) employs the term, agrodiversity also includes adaptation to resource degradation, and the employment of indigenous, adapted, and introduced knowledge to farming. Conceptually, ''agrodiversity'' is the broadest of the terms used to capture biological diversity and the diversity of management and organization at a variety of temporal and spatial scales.

Agricultural biodiversity

Also written in shorthand form as ''agrobiodiversity'', agricultural biodiversity means the diversity of useful plants in managed ecosystems. It has been defined as ''the variety and variability of plants, animals and micro-organisms at genetic, species and ecosystem level'' (Cromwell 1999: 11). Definitions of the term usually include the aspect of managing agricultural biodiversity and the importance of human intervention in the creation of an agriculturally biodiverse assemblage.

The global PLEC project and its East African cluster

Most biodiversity worldwide is managed by farmers and communities. While a large amount of crop genetic diversity is now collected and preserved in *ex situ* gene banks, farmers continue to conserve planting materials *in situ* in response to changing natural and social conditions.

This management of biodiversity in agricultural landscapes is receiving growing recognition and attention. However, the understanding of what farmers and communities can do to maintain and enhance biodiversity even in intensively cultivated areas is limited. Most funding for biodiversity conservation is used to support protected areas. There is now a strong demand at local, national, and international levels for participatory models of biodiversity management in agricultural ecosystems that embrace biodiversity for farmers' livelihoods.

The adoption of a work programme on agricultural biodiversity by both the Conference of the Parties to the Convention on Biological Diversity (CBD) and the Global Environment Facility (GEF) in 2000 marked a watershed in promotion of managing biodiversity in agricultural ecosystems. Decision V/5, adopted by the Conference of the Parties to the CBD at its fifth meeting in May 2000 in Nairobi, recommends efforts to ''identify management practices, technologies and policies that promote the positive and mitigate the negative impacts of agriculture on biodiversity, and enhance productivity and the capacity to sustain livelihoods, by expanding knowledge, understanding and awareness of the multiple goods and services provided by the different levels and functions of agricultural biodiversity''.

In advance of the CBD's recommendation, the United Nations University project on People, Land Management, and Environmental Change (PLEC) has spearheaded work on agricultural biodiversity. With support from the United Nations Environment Programme and the Global Environment Facility, it has brought together a large number of researchers and smallholder farmers for the identification, evaluation, and promotion of resource management systems that conserve biodiversity. At the same time, the protection should generate income and assist in coping with changes in social and natural conditions. The PLEC project operates through a global network of clusters that have been established in Ghana, Guinée, Kenya, Tanzania, Uganda, China, Thailand, Papua New Guinea, Brazil, Peru, Mexico, and Jamaica. Demonstration sites are located in priority agro-ecosystems in the margins of forests, semi-arid regions, mountains, and wetlands of globally significant biodiversity. Information about PLEC is available at www.unu.edu/env/plec/.

The PLEC concept

For thousands of years farmers have constantly modified their use and cultivation of biodiversity for food and livelihoods through learning, experiment, and innovation. Over this long history they have nurtured and managed a diversity of plants and animals, either wild or domesticated, and developed agrodiversity to harness various plants and ani-

mals. Equally, over this long history the types of agricultural land use have diverged. Especially with pressures emerging between and after the world wars to produce large quantities of cheap food, large-scale commercialization and mechanization of agriculture has become dominantly manifest. High-yielding varieties have replaced the huge diversity of local varieties and genotypes. The pressure to produce food has been inexorable in both developed and developing countries. However, for several reasons, pockets of small-scale agriculture and land use have remained. Often this is the more appropriate land use to feed high densities of rural populations in intensive home gardens, represented in East Africa classically by the Chagga home gardens on the slopes of Mount Kilimanjaro. These gardens are both productive and diverse, but except in certain very specific commodities, such as coffee, they do not contribute to the wider market. Elsewhere, physical isolation, as in mountain communities, has buffered land use from the pressures of the market. PLEC concentrates on these pockets of mainly small-scale, intensive, and diverse agricultural systems on the premise that they are worth conserving. It is not a question of whether agricultural development should go wholly towards high-yielding uniform systems of land use or to small-scale, low-input, diverse systems. Both are important, but the latter are more under threat. They contain value in their biodiversity and wealth of knowledge – aspects which perhaps have less resonance than food security and large grain storages, but which potentially have implications for the sustainability of both large-scale commercial agriculture and small-scale diverse agriculture. The challenge that PLEC addresses is how to conserve the diversity of techniques, species, varieties, and ways of organizing land use in complex land-use systems. In other words, how can agrodiversity be conserved?

What PLEC has found is that in the current trend towards uniformity in agricultural landscapes, a significant proportion of farmers and communities continue to develop agrodiversity – a dynamic patchwork of various land-use stages (such as annual cropping, orchard, agroforest, fallow, home garden, and boundary hedges). At the smallest scale, these land-use stages are specified as field types of land management that farmers recognize on the ground. The field types may be sequential management (such as seasonal variations of crops or varieties and shifting cultivation) and concurrent management (such as mixed cropping and agroforestry). Land-use stages are not fixed, but in a constant state of dynamic flux. At a PLEC site in Yunnan, China, for example, some farmers are expanding home gardens on to former rice paddy terraces for marketable vegetables, medicinal plants, and fruits. Other farmers are converting maize fields into an agroforestry association of native tree crops. The dynamic patchwork of transitional land-use stages and field

Table 1.1 Four elements of agrodiversity

Agrodiversity categories	Description
Biophysical diversity	The diversity of the natural environment including the intrinsic quality of the natural resource base that is used for production. It includes the natural resilience of the biophysical environment, soil characteristics, plant life, and other biota. It takes in physical and chemical aspects of the soil, hydrology, climate, and the variability and variation in all these elements.
Management diversity	All methods of managing the land, water, and biota for crop and livestock production, and the maintenance of soil fertility and structure. Included are biological, chemical, and physical methods of management.
Agrobiodiversity	All species and varieties used by or useful to people, with a particular emphasis on crop, plant, and animal combinations. It may include biota that are indirectly useful, and emphasizes the manner in which they are used to sustain or increase production, reduce risk, and enhance conservation.
Organizational diversity	This is the diversity in the manner in which farms are operated, owned, and managed, and the use of resource endowments from different sources. Explanatory elements include labour, household size, capital assets, reliance on off-farm employment, and so on.

Source: Adapted from Stocking (2002)

types mimics various stages of vegetation succession, maintains diversity of habitats, and harnesses biodiversity in space and time.

Agrodiversity emphasizes farmers' resource management of the whole landscape. It covers four elements: biophysical diversity, management diversity, agrobiodiversity, and organizational diversity (see Table 1.1), and their interactions. Farmers select and manage crops, but also choose, modify, and create the suitable microenvironments and soils for production. For example, natural or artificial forest is managed and conserved for raising snails, butterflies, or medicinal plants. Both domesticated and wild species are used for livelihoods. Farmers protect wild species through selective weeding and transplantation of wild tree seedlings.

Agrodiversity contains considerable potential for conservation of biodiversity, protection of important land-use systems, and control of land degradation as well as enhancement of food security and rural livelihoods. The role of agrodiversity in conserving biodiversity is demonstrated through a patchwork of various cropping systems, agroforestry systems, and forest systems that use and harness crop diversity. Evidence

is accumulating that not only is there a wealth of good practice in many previously overlooked local systems for biodiversity conservation, but also such systems reduce land degradation risks and support local livelihoods. Agrodiversity practices provide nutrition and safe food, reduce production risk, and enhance the ability to cope with changes and mitigate disasters. Even under pressure for uniform production, many small farmers worldwide continue to practise agrodiversity for viable livelihoods. PLEC deliberately dwells on those ''sustainable adaptations by small farmers to varied environments under growing population pressure and all other forms of stress ... principally through the high degree of structural, spatial and trophic, as well as species diversity that is involved'' (Brookfield 1995: 389).

PLEC methodology

As agrodiversity is complex, it has taken time for PLEC to develop an effective methodology based on local expertise for identification and promotion of the agrodiversity in small farmers' agricultural systems (Liang 2002). Details of PLEC principles, working guidelines, and case studies on agrodiversity are described in Brookfield *et al.* (2002), Coffey (2000), and Stocking and Murnaghan (2000). The key components of the methodology are detailed below.

Demonstration sites

While the PLEC theme centres on agrodiversity, the approach to the theme began to change from research-oriented work to demonstration and capacity building in some of the clusters of the PLEC network in 1996, and subsequently in the whole network (Liang *et al.* 2001). Site selection is mainly based on regional biodiversity importance; threats to biodiversity by rapid change and land-use pressures; critical ecosystems based on national priorities and potentials; known examples of agrodiversity; and existing partnership with communities and availability of historical information. Some sites were those in which project members had previously worked, or were still working in connection with other projects.

However, setting up viable demonstration sites was difficult because the PLEC approach to ''demonstration sites'' was quite different. These sites are not so much physical places but rather people-centred processes, and coalition and partnership between scientists, farmers, local communities, and other stakeholders searching for sustainability on the ground. Some clusters before early 1999 had carried out essentially reconnaissance work along large transects extended over many kilometres and several agro-ecological zones. Some were overwhelmed by their own re-

search agendas, and were unable to create genuine coalition with farmers and other local stakeholders. Those clusters were quickly advised to concentrate their work in more narrowly defined areas, and to benefit from the experiences of other successful clusters.

Participating clusters are selected on regional biodiversity importance. Most PLEC clusters overlap with ''biodiversity hot-spots'' in South-East Asia, East and West Africa, Central America, and South America. For viable demonstration site work, most clusters started with a few large areas of national priority and later narrowed down to a few defined sites. PLEC-Tanzania, for example, narrowed demonstration site areas to two landscape units, which were selected from an initial five units they had identified on both the windward and leeward slopes of Mount Meru in Arumeru district, Tanzania. To date, a total of 21 demonstration sites in eight GEF-supported countries (Brazil, China, Papua New Guinea, Uganda, Kenya, Tanzania, Ghana, and Guinée), and six sites in four UNU-supported countries (Peru, Mexico, Jamaica, and Thailand) are now established and operational. Further demonstration sites are in development, some of which are in response to popular demand from nearby communities.

Agrodiversity assessment

Since agricultural practices and their products vary in time and space and between households, PLEC assessment of biodiversity and its management in these production landscapes is based on land-use stages in the individual farms of sampled households. Traditional surveys of land use cannot catch the full picture of relay or rotational cropping and land-use management often practised by small farmers to maintain soil fertility and suppress pests. For example, farmers at the PLEC Tumam demonstration site, East Sepik province, Papua New Guinea, divide land management into two main periods. The first is the garden stage while the second is the fallow stage. The garden stage is further divided into three substages according to months after the initial clearing: *wah* (seven months), *yekene* (20 months), and *nerakase* (33 months). The fallow period consists of four substages according to years after the garden stage: *nerakase* (up to five years), *banande* (10 to 15 years), *loumbure* (15 to 20 years), and *loutinginde* (20 to 50 years). As the management passes from stage to stage, the species richness and species composition change. Land-use stages and their management as well as crop diversity are in constant flux in this dynamic mosaic. Temporal diversity is as important as spatial diversity.

The household is the basic unit of small-scale farming, though there is much cooperation between households, relatives, and the wider community. Variations between households in labour, resource endowments,

and other conditions give rise to different approaches to managing their resources even within the same community. Some ''expert farmers'' manage resources much better than others. A general community-level survey would have failed to detect the difference in biodiversity and its management between households, as well as failing to spot expert farmers and their exceptional practices of agrodiversity.

As a result, the basic principle of the PLEC agrodiversity assessment is to stratify the landscape at demonstration sites. This is achieved through identifying land-use stages and field types so as to detect differences between land-use stages, field types, and households, especially when finding biodiversity-friendly and economically profitable systems for demonstration. In most cases clusters began transect surveys for identification of land-use stages and field types across the community and landscape, and sampled representative households and field types in their landholdings. Once a sample of representative households and field types in the community was selected, researchers with farmers conducted detailed inventories of plant species and household economy, monitored changes in plant species and household economy, and entered the information into a database for analysis.

Each component cluster of the PLEC network adapted the PLEC guidelines to their local situations. PLEC-Thailand, for example, employed different methods when the research moved from the reconnaissance stage to the detailed investigation stage. Details are provided in Table 1.2.

Promotion of agrodiversity

Since agrodiverse practices are well integrated with local ecosystems and livelihoods, they are site and household specific and cannot simply be copied to other environments, households, or communities. Promotion of these agrodiverse practices cannot be done through the conventional extension model of ''transfer of technology''. Moreover, farmers often obtain new ideas and technologies from exchanges with other farmers and prefer to see concrete results on the farm. As a result, PLEC promotes successful agrodiverse practices through on-farm demonstration and ''farmer learning from expert farmer''. In a typical on-farm demonstration, an expert farmer is facilitated to teach his or her practices to other farmers on his or her farm. Participating farmers are welcome to comment on the expert farmer's practices, and assimilate, change, or adapt those practices for their specific farms. The practices taught and formality used in a farmer-to-farmer demonstration depends on the choice of expert farmers as instructors. The formality may range from informal occasions to formal meetings. The informal occasions include family gatherings and labour exchange. The organization of demonstra-

Table 1.2 Field methods, tools, and approach with respect to expected outcomes of field activities of PLEC-Thailand

Field methods/ tools and approaches	Outcomes of field activities				
	Village landscape	Farming systems	Production systems	Household	Fields/plots
Mapping and PRA	Identification of land use and patterns of natural resources. Defining major production systems and identifying biophysical and organizational components of agrodiversity.				
Guideline ''field type''		Characterizing the existing (distinct) farming and forest management practices with diverse crops and cropping systems. Grouping of common management practices.			
Agrodiversity checklist		Identifying sample plots as representative of the field type for direct observation and measurement.			
Household survey/field interview				Selection of sample households based on field types and potential for future demonstration. Collecting information on household socio-economic status and management of agrodiversity.	

Source: Adapted from Rerkasem *et al.* (2002)

tion activities can be facilitated directly by field researchers or through farmers' associations.

PLEC in East Africa

This subsection is based upon Kaihura *et al.* (1999). East Africa is renowned for its high natural biodiversity. From the forested mountains of western Uganda with its remnant populations of gorillas to the lush highlands of central Kenya with intensive agricultural systems and the remarkable endemism of Tanzania's equatorial mountain chain, the whole region has a wealth of flora and fauna as well as a rich natural

biophysical diversity. Sharp contrasts over short distances in altitude, climate, vegetation, soils, and hydrology contribute to this diversity. Rainfall variability and soil fertility change markedly between villages, as shown in Embu in semi-arid Kenya (Tengberg *et al.* 1998), which has implications for the practices that local people follow, such as terracing or trash lines.

Diversity is also depicted in society and demography, with widely different ethnic groups such as the Masai, Kikuyus, Arumeru, and Mwizi peoples. Population growth is rapid, and densities vary from over 2,000 per km^2 to less than 20 in drier parts. Consequently, East Africa is a natural candidate for the study of how local agricultural and land-use systems interact with this natural biodiversity and how, in turn, the biodiversity contributes to local livelihoods. This mutual support between land use and livelihoods on one side and biological diversity on the other is a particular feature of East Africa. In the face of considerable external pressures, such as declining areas of land per person and rapidly changing market economies, land users are coping by exploiting biodiversity while at the same time demonstrating their protection of it if the circumstances are right.

East Africa PLEC's original objective was to examine the interaction between increasing population pressures, the intensified use of land, and associated effects such as migrations and rapid urbanization, and the various aspects of agrodiversity. East Africa is famous for the Machakos (Kenya) study entitled *More People, Less Erosion* (Tiffen, Mortimore, and Gichuki 1994), in which it was argued that intensification leads to more sustainable land-use practices and improved livelihoods. EAPLEC is now working on demonstration sites (see Figure 1.1), using the PLEC framework, from which it will be possible to gain detailed insights into farmers' strategies of managing biodiversity. The PLEC goal is to help farmers develop and conserve productive, sustainable, and biodiverse land-management systems. In East Africa these systems consist of a wide range of managed land uses from forests to agroforestry, dryland cropping to intensive vegetable production, and stall-fed livestock to rangeland.

Farmers' perspectives

Working closely with farmers, learning from them to find entry points for improvements on existing resource management models, and developing sustainable management techniques that also conserve biodiversity are all central to PLEC's work.

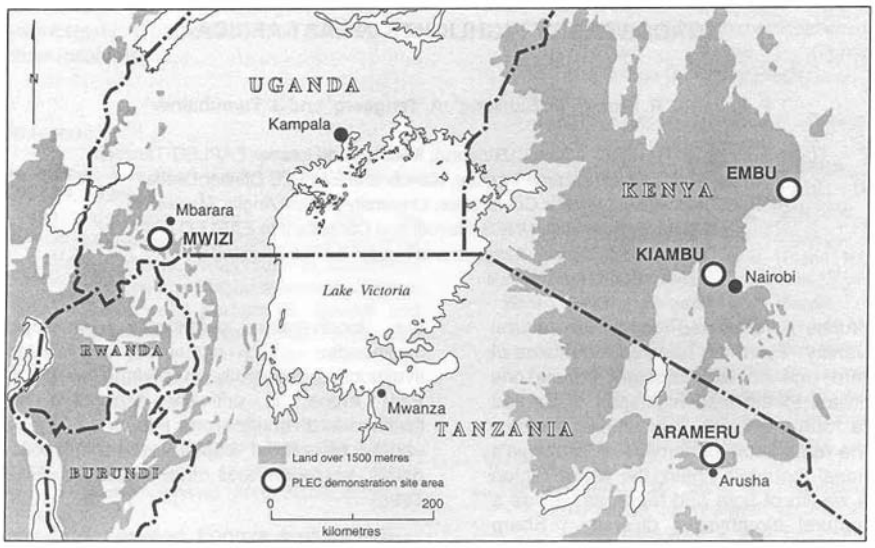

Figure 1.1 Location map of PLEC demonstration sites in East Africa

While approaches may vary between countries, farmer empowerment is always an ultimate objective in order to achieve lasting change and improvement in the management of the natural resource base. Activities towards this objective are necessarily diverse. They must be based on differences in land-use systems, management constraints, socio-cultural situations, and other related elements of agrodiversity. For Tanzania, Kenya, and Uganda, PLEC's sites were in a range of agro-ecologies, from the semi-arid to sub-humid and on to humid. While this set a natural bio-physical diversity and contrast in approaches to natural resources management, there were many other aspects that were much more similar. Demographic, cultural, economic, and social factors are all surprisingly similar between the three countries, but again with differences which are brought out in Part III of the book through the eyes largely of farmers.

In all cases, farmers were key participants at workshops and meetings and their input was encouraged and valued. For example, at the last East Africa PLEC workshop in 2001, farmer representatives from the three countries shared their experiences as PLEC farmers with other workshop participants. Part III of the book is therefore a collection of the perspectives of those farmers on PLEC's work. The overarching message is that, while there may be many similarities in driving forces and factors, there is no one blueprint approach to conservation and sustainable land management.

This book

Part I of this book introduces agricultural biodiversity in East Africa, and includes typical overview accounts from Uganda (Chapter 3) and Kenya (Chapter 4). Chapter 2 introduces the management of biodiversity and its position in current agendas. Following this introductory Part I, the book has three substantive sections. Part II looks at the components of agricultural biodiversity. These vary from a very detailed study of rainfall characteristics (Chapter 5) to three chapters on various aspects of botanical knowledge and plant management (Chapters 6 to 8), and a chapter on the role of livestock (Chapter 9). Also relevant to the components of agricultural biodiversity are Chapters 11 (socio-economic factors), 12 (production factors – in this case of bananas in Uganda), and 13 (land-use change).

A key feature of the book is the inclusion of a number of chapters either inspired by farmers or actually written by them. Chapter 14 covers the development of a methodology to capture the farmers' perspective. Chapters 15 to 18 are all by farmers. These have been very lightly edited to bring clarity, but they are kept largely in their original form in order to demonstrate how farmers feel about the subject and their interaction with researchers. Chapter 19 concludes Part III by reporting on farmer-led evaluations of soil management practices from Uganda.

The final Part IV of this book is on policy recommendations. The teams in Tanzania (Chapter 20) and Uganda (Chapter 21) devoted considerable efforts towards including policy-makers, inviting them whenever possible to visit the demonstration sites and participate with local people on understanding local needs. The results of these interactions between farmers, scientists, and politicians throw a fascinating insight on to how the work on agrodiversity may move forward to bringing real livelihood and food-security benefits to local people.

Acknowledgements

This book is dedicated to smallholder farmers of the PLEC demonstration sites of Embu in Kenya, Bushwere in Uganda, and Arumeru in Tanzania. The information in this book is a result of farmers' cooperation and the contribution of their invaluable time, knowledge, and experience in training other farmers, researchers, and extension staff, including policy-makers and other stakeholders, in diverse ways of managing agricultural biodiversity at farm and landscape level. They have also demonstrated the value of agricultural biodiversity in contributing to food

security and rural livelihoods. Without this principal stakeholder, the farmers of East Africa, PLEC could not have operated.

The book is based on the proceedings of the East Africa Annual General Meeting in Arusha, Tanzania, held in November 2001, that convened PLEC farmers, researchers, extension agents, policy-makers, and other stakeholders to discuss experiences and lessons from working with farmers in the field of agricultural biodiversity in East Africa. The time and commitment of researchers, extension agents, and other stakeholders from different institutions, universities, and departments in contributing to field and office work and their tireless and continuous visits and interactions with farmers are greatly appreciated.

The success of PLEC work in East Africa and the compilation of this book could not have been possible without the advice and encouragement of Professor Michael Stocking (PLEC associate scientific coordinator) throughout the six years of preparation and fieldwork. Clemmie Perowne, his research assistant at the University of East Anglia, provided excellent support to turn the Arusha proceedings into a book manuscript for UNU Press. Thanks also go to Beatrice E. Maganga in Mwanza, Tanzania, who compiled the first entry of the manuscript for the proceedings.

A word of thanks must go to Professor Harold Brookfield (principal scientific coordinator for PLEC) and Luohui Liang (managing coordinator of PLEC) for allowing and facilitating East Africa to have this book published. PLEC East Africa recognizes the PLEC executing agency support of the United Nations University (UNU), the financial support of the Global Environment Facility (GEF) in Washington, DC, and the GEF implementing agency support of the United Nations Environment Programme in Nairobi. It was only through these agencies that it became possible to create awareness among the international community of the importance of conserving and managing biodiversity in agricultural systems, and the positive experiences in East Africa. As the PLEC executing agency, the UNU managed cross-country activities and enabled the many and varied activities of the PLEC clusters, providing constant support, especially to PLEC East Africa. Without the continuous support of the Vice-Rector, Professor Suzuki, and the staff of the Environment and Sustainable Development Programme, especially including Masako Ebisawa (and her predecessor, Audrey Yuse), PLEC would not have worked and been the force it has been in East Africa.

Finally, it must be said that this is not strictly an academic book; it is a record of experiences and discoveries made by researchers and farmers. Many chapters have few, or no, references, for example. The farmer partners in PLEC East Africa have written of their feelings and reac-

tions, not of some well-documented experimental design or closely argued rational arguments. Equally, PLEC's developing country research colleagues, many of whom were rather narrow natural resource scientists before PLEC, have discovered ''the field''. They have spent many hours, days, and weeks working with farmers, rather than listing literature references and undertaking scientific methodologies that would stand the scrutiny of most academic referees. They have appreciated the opportunity that GEF funding provided of engaging with land users, helping to set up demonstration sites, and facilitating the formation of user groups. In many ways these were development activities rather than research. However, through this close involvement the authors would claim that the research is far more targeted to issues of real interest to society, and especially to the farmers. The authors thank UNU Press for understanding the PLEC ''voyage of discovery'' by all its participants and stakeholders. It has given the authors of this book an opportunity to show to an international audience how and why it is wise to work with farmers, and sometimes to compromise academic integrity for the sake of gaining much richer knowledge of biodiversity, how to protect it, and what benefits such protection affords to human beings.

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The rich biodiversity of plants found in smallholder farms in Africa is a storehouse of food, fuel and fibre. This biodiversity provides not only food and beverages and marketable produce, but also supports communities by producing a range of valuable resources from medicines to construction material.

Smallholder farmers are the guardians as well as the beneficiaries of a greater diversity of biological species than can be found in protected areas. The farmers' diverse practices are conserving these species for the benefit of future generations. In turn, agricultural biodiversity is a primary way for the poor to cope with difficult biophysical environments and precarious social and political circumstances.

This book documents how the smallholder farmers of East Africa - in Kenya, Tanzania and Uganda - are playing their part in the global agenda for the conservation, sustainable use and the equitable sharing of the benefits of biodiversity. The United Nations University *PLEC* project, funded by the Global Environment Facility under the provisions for the Convention on Biological Diversity, is showing how the accumulated knowledge and experience of smallholders and their diverse practices leads to clear benefits for both biodiversity and society. This book draws on lessons learned from farmers, researchers, extension staff, policy-makers and aid agencies co-operating and actively supporting *PLEC* demonstration sites in East Africa. It shows the very real potential of learning from farmers and basing policy on tried and tested ways of managing complex agricultural systems.

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