LEISA
ILEIA NEWSLETTER FOR LOW EXTERNAL INPUT AND SUSTAINABLE AGRICULTURE

# Leisa in perspective
## 15 years ILEIA

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We would like to dedicate this Jubilee publication to all those individuals and organisations who have contributed to the ILEIA Newsletter over the years and in this way helped put LEISA on the agenda of farmers, development and research organisations, policy makers and funders. Their names appear on the cover of this book.

Coen Reijntjes, Marilyn Minderhoud-Jones, Peter Laban

# Leisa in perspective
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## Table of content

# Foreword

Fifteen years is not long considering agriculture has been practised for some 10,000 years, but during the fifteen years of ILEIA's existence some 500 million people have come to our Blue Planet and claimed it their home. Today, the global human population approaches the 6 billion mark, a major biological success for any large species of mammal.

1998 is an important year for ILEIA but there are other notable anniversaries too. I would like to remind the Reader that it is 200 years since Malthus made his unduly pessimistic predictions about our chances of coping with human population growth and 50 years since the Universal Declaration of Human Rights which, in retrospect, seems to have been unduly optimistic about our ability to meet the challenge of providing everyone with food.

A learned Indian friend recently reminded me that, when his country became independent, 50 percent of its population lived below the poverty line and 7,000 tons of chemical fertiliser was used each year. India, like many other countries, is now home to many more people and presently uses 13 million tons of chemical fertiliser every year. It is also one of the excellent examples of how food needs can be met by a remarkable change in agricultural production methods in selected areas and particularly in the Indo-Gangetic Plain by the move to high-external-input agriculture. India is also an excellent example of social consciousness about the consequences of the Green Revolution. Although it was benign in intent, the Green Revolution evolved into a massive social experiment in which safety nets for many social groups and for many women were full of holes and our understanding of the holistic character of Nature was revealed to be far from complete.

Although we may feel a certain satisfaction at meeting the nutritional needs of many millions, we cannot overlook the challenges posed by high-input agriculture. We do have an obligation, as concerned citizens, to develop additional solutions that can contribute to the elimination of the disgraceful food insecurity still experienced by about 900 million people in the world today.

Against the setting of the need to feed more people in balance with their natural environment, many diverse interests have come together to explore the potentials of low-external-input agriculture. During the last 15 years, ILEIA has become a vehicle for many who saw this as an imperative. Their approaches were highly varied, sometimes contradictory, often controversial, but never dull, and their ultimate motives reflected the views of a fair section of concerned global citizens. LEISA, in fact, is nothing more than a refinement of the age-old wisdom of farmers and herders who exploit their knowledge on how to secure adequate harvests according to their meagre means with the addition of our scientific understanding of the nature of things. Probably the majority of the world's farming families are LEISA farmers, not by design but by default. Whatever their intellectual attitudes to external inputs, such as agro-chemicals, hybrid seed or genetically engineered animal vaccines, their limited purchasing power has put this type of alternative out of reach.

This simple fact may, surprisingly, be a fruitful meeting place for people whose development philosophies seem to be at opposite ends of the spectrum. There is consensus about the need for poverty eradication and improved living standards. There is at least near-consensus that food must be traded, in order to feed those who are not farmers themselves but who contribute significantly (often much more per capita) to national capital through urban-based activities. There is consensus that all food, whether traded or consumed on the farm, must be safe. And there is probably consensus that we, as a species, still want to prove Malthus wrong and appreciate that this means that we must sustain our Total Capital over generations and that Nature Capital is an important and inseparable part of this.

By looking for consensus we also open ourselves to the idea of peaceful co-existence between alternative agricultural production methods as we strive towards the overarching goal of food for all. High-input agriculture is at the bases of the development of the modern technological state and its riches. If you do not like the modern technological state, you probably do not like high-input agriculture. And even if you live and thrive in a rich environment, your concern for other aspects of food production, including your perception of health, may make you opt for LEISA-produced food, and you are willing and able to pay a premium for doing so. There are many poverty stricken people who would dearly like to join the modern state but, at the moment, have no realistic chance of doing so. They must concentrate on feeding their families without access to high input agriculture and the ambition of many is to use their low-input setting better in order to improve the quality of life for themselves and their surroundings. Many development strategies aim at creating individual and national wealth that will ultimately allow farmers to make a choice about the level of external inputs they want to use.

But there is a second meeting place for adversaries: the shift in the agricultural science paradigm. The emergence of ecology as a genuine science, and its contribution to our understanding of the nature of things, is moving agricultural science to a platform much more compatible with the philosophies that have underpinned LEISA-based agriculture. Modern technological agriculture involves the notion of manipulating the growing environment of crops and livestock to create optimal conditions for them to reach their maximum genetic potential and to raise this genetic ceiling by breeding for even higher yields. Inorganic fertilisers, irrigation water, herbicides, pesticides, animal medicines and vaccines are all agents in ameliorating imperfect food production environments. The corollary is to attempt to live within the given constraints. Instead of relying on massive inputs of lime to correct the acid soils of Brazil and Zambia, the challenge is to develop maize and pasture species that can produce something under these unfavourable conditions. Instead of relying on expensive medication in the fight against trypanosomiasis in livestock, or large-scale bush clearance to eliminate the tsetse fly as vector, the use of naturally tryptotolerant cattle such as the West African N'Dama are important alternatives. Some lime and transfer of relevant N'Dama genes represent intermediaries between old and new paradigms.

Integrated Pest Management and Integrated Nutrient Management are examples of intelligent low-external-input systems that were originally advocated by LEISA protagonists and later found a natural home in mainstream agricultural science. The massive efforts to preserve indigenous germ plasm not only as a resource for advanced plant breeding, but also for their intrinsic value as landraces, again illustrate the meeting of minds. In recent years, there has been a flurry of mainstream publications advocating "a doubly green revolution", "an evergreen revolution", and "a new green revolution" all of which reflect this merger of paradigms. These debates will continue and there will be protagonists who will not change their position. However, from a distance it seems obvious that the foundation laid by LEISA advocates is proving of tremendous value as we all try to operationalise the challenges of sustainable development.

Closely associated with the technological aspects of LEISA has been the challenge to the traditional development paradigm. The "trickle-down" assumptions, on which so much development strategy has depended for almost thirty years, were explicitly and implicitly challenged by LEISA concepts. Popular participation, the key role played by women in development, and the need to champion indigenous peoples' rights, have been cornerstones of LEISA activities. Recognition of the integrated approach that LEISA represents in development thinking is long overdue. As concerns for democratisation grow, it perhaps needs to be made clear that LEISA activities have often been closely linked to the building of community spirit and community organisations that encapsulate the ambitions of marginalised people and give them a stronger platform from which to claim their rights. The extensive use of Participatory Rural Appraisal and related methods often associated with LEISA projects has put LEISA in the forefront of methodological development and testing.

The role of information has been central in much LEISA work, more so perhaps than in many other development activities. With LEISA often considered counter culture, the information tool has been of paramount importance in generating and spreading knowledge on alternatives to the farming advice given by the commercial sector and by more conservative government agencies. The contribution made to information dissemination methods by those working on LEISA has been significant.

Fifteen years ago, the Dutch Ministry of Foreign Affairs institutionalised LEISA work in ILEIA through generous and long-term support. Its choice of a novel institutional anchorage in the form of ETC, a non-profit consultancy firm, the project's mandate, its governing structure, the links to non-governmental organisations and the willingness to build bridges between philosophies that seem to be miles apart, are all examples of the creativity and daring of the approach adopted by Dutch development assistance. Before the Den Bosch conference in 1989, before UNCED in 1992, before the Biodiversity Convention and the Desertification Convention, ILEIA was already exploring alternative pathways to sustainable agricultural development.

Today, ecologically grown food appears more frequently on the shelves of Dutch supermarkets, a reflection of the growing appreciation of Dutch consumers and taxpayers for the rationale of alternative agricultural production methods. Equity-conscious coffee and banana brand names offer serious competition to traditional brands and give the public a wider choice.

At home and abroad 15 years of ILEIA has resulted in the elaboration and consolidation of a pathway to development. Once considered revisionist, weird and unrealistic, it is now widely accepted, not simply as a panacea, but as a valuable and appropriate alternative. Some see ILEIA as a heretic, others see it as the devil's advocate, but there are more and more people who turn to ILEIA as the carrier of a wide-ranging family of methodologies and approaches. The relevance of these approaches will become more and more important as we struggle towards meeting the challenge of feeding every member of the human family in a sustainable way, as is their right.

An international Board of Trustees has had the privilege of guiding ILEIA through its last phase as a project. The trustees now look forward to the work of LEISA continuing in a setting of broad support from developing and developed countries alike, for we trust a New ILEIA will evolve. The many staff members who have guided ILEIA through its 15 years deserve our praise for their efforts and enthusiasm, as does the long-term devotion of ETC, a small consultancy firm, who took on the task of supporting the ILEIA project. Above all, the stamina of the Dutch donor deserves the greatest of respect from the international community.

This Jubilee publication sums up the 15 years of ILEIA's experience with LEISA in practice. Good reading!

Stein W. Bie
ILEIA Board Chair 1997-98

# ILEIA: a project in development

*"No term is less appropriate than 'resource poor' when speaking of knowledge rich peasants"* (A.Gupta)

In the later half of the twentieth century, unprecedented population growth threatens food security in the developing world. Farmers who, for generations, have relied on agricultural systems using low quantities of external input have been urged to adopt modern agricultural technologies to increase food supplies. Today, many small, subsistence and market-orientated farmers are unable to produce enough food or cash crops to meet their needs. In addition they are experiencing the negative effects of Green Revolution or high input agriculture (HEIA) strategies.

ILEIA (Information Centre for Low External Input and Sustainable Agriculture) was amongst the first to identify this crises and suggest that low-external-input agriculture (LEIA) might be one way of tackling the problem of declining yields and rural poverty. An initiative of Kees Manintveld and Hay Sorée, the ILEIA project was established in 1984, and funded by Dutch development assistance. The project - to document and provide information and advice on LEIA - was implemented by the ETC Foundation. Its primary concern was to make the information collected available to small farmers, agricultural development workers and extensionists.

HEIA technology supported agricultural decisions made in Western capitals and on the commodity markets. Cash-poor farmers in ecologically fragile areas were vulnerable and disadvantaged in this context. Many found it difficult to compete on strongly export-orientated national markets. As David Millar, an early member of the ILEIA network observed:

"Small farmers have very limited control over their environment. The choice of what varieties to grow, what crop-crop, crop-livestock combinations to adopt, where to grow and the timing of farm operations are all dictated by their need to work with the environment rather than control it" (David Miller, ACDEP, Northern Ghana, Newsletter...)

### Getting started in 1984

"From our Information Centre we want to supply and exchange information about low-external-input agriculture... this needs people who will gather information and people who need information". (ILEIA Newsletter 1984).

An initial inventory of documentation and experiences confirmed that there were elements of LEIA in farming systems in the developing South as well as the more industrialised North. In the first ILEIA Newsletter - which appeared in the winter of 1984 - LEIA was conceptualised as "a system that minimises, rejects or is unable to use chemical fertilisers, high-yielding varieties, chemical pesticides and mechanisation brought from outside the farm, locality or region". Many of the strategies and technologies used by LEIA farmers were not well understood. It was necessary to collect information, insights, ideas and experience on LEIA and, to highlight its potential, these had to be evaluated, systematised and exchanged.

## 1980 Inventorisation

### Taking stock

### Taking stock: HEIA and LEIA in the early 1980s

The Dutch Government's willingness to finance an inventory of low-external-input agriculture reflected the more critical approach to development issues of the 1980s. In the two decades following World War Two, shifts in political power, the consolidation of old colonial relationships in international trade and development agreements, and continuous economic growth had lead to rapid increases in transport and urban infrastructure and a far-reaching exploitation of natural resources. In agriculture, these changes were fuelled by a science-based agro-technology capable of supporting intensified and selective agricultural production. The power and size of consumer demand grew as the market economy spread and Green Revolution technologies became a familiar feature on small farms throughout the world.

Many development workers, extensionists, local leaders, health workers and farmers who had seen the effects of HEIA in practice, questioned its ecological sustainability. They were alarmed at its human cost, particularly the marginalisation and increasing powerlessness of small farmers and their agriculture-dependent communities. Water pollution, health risks, degraded soil structures, declining bio-diversity, indebtedness and a loss of self-reliance were the price many paid for these relatively expensive inputs. HEIA propaganda was everywhere, persuasive and difficult to counter. Although fertilisers and pesticides were costly and difficult to obtain, they nevertheless exerted a powerful influence on local farming. Writing in the ILEIA Newsletter Elsie Ayeh noted that, in Ghana, farmers were putting more trust in commercial pesticides that cost 30,000 cedis per gallon than in those that could be prepared locally for the price of a bar of soap.

For this process to be effective, the ILEIA documentation centre had to ensure it built up a comprehensive collection of literature on LEIA and make its essence accessible, relevant and widely available. In the period 1984-1991, the main channels in this process were the ILEIA Newsletter, the ever expanding ILEIA network, publications and workshops. After 1994, ILEIA collaborative research also became important. Through these activities, and the network they supported and stimulated, it became possible to exchange experiences and compare and integrate elements of LEIA and agricultural sustainability (LEISA) approaches from different parts of the world.

### Information Centre for Low-External-Input and Sustainable Agriculture

The ILEIA documentation centre has collected information that would probably not have been brought together had it not been for the ILEIA project. Reports, research findings, informal newsletters, journal articles, books and conference proceedings on LEISA technologies have been supplemented over the years by publishers' information, addresses, photographs, videos and slides. With the introduction of research, the character of the collection changed slightly as more formally published material was added. Throughout the years, the ILEIA documentation centre has been one of the project's most important resources. It has supported the ILEIA Newsletter, workshops, publications, and many other project activities. The collection has been an important resource for ILEIA team members, local and foreign students, researchers and development workers. It remains a first resource in answering the questions that readers submit to the ILEIA Newsletter and in meeting requests for literature searches and bibliographic information. During the project's third phase, the collection was systematised and its accessibility increased. A comprehensive and uniform system of key words was introduced and ILEIADOC, a database that today contains 8000 documents on many subjects important to the development of LEISA, was made available on disc and can also be accessed through AGRALIN (Agricultural Bibliographic Information Systems of the Netherlands), via the ILEIA homepage.

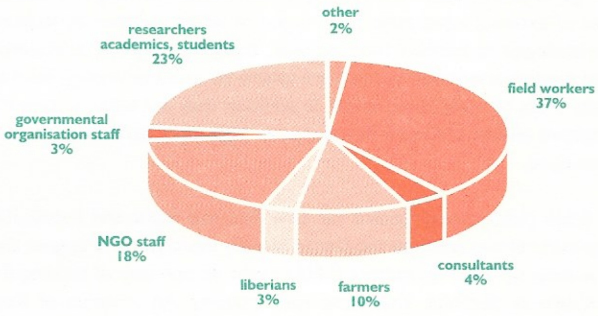
To make the published material available on LEISA more widely known and available, selected bibliographies of LEISA materials appeared in 1987 and again in 1995 when a handy, easy to use, well-annotated booklet – the LEISA Top 138 - was published. With similar ideas in mind, a small "library" project was initiated in 1991 to provide grants to some 135 organisations in the South to enable them to buy key books and periodicals on LEISA-related topics.

Throughout the years, ILEIA has maintained close contact with other organisations involved in assembling and publishing information on sustainable agriculture such as TOOL, AGRECOL, GATE and AGROMISA. This has sometimes lead to joint publications. ILEIA was also active in EULEISA - the European network on low-external-input and sustainable agriculture that included AGRECOL, GATE, GEYSER, IFOAM, GRAIN, AGROMISA, ODI and RDP (UK).

Today, ILEIA's work of collecting information on LEISA continues in an electronic age. The ILEIA documentation centre is on the mailing list of an ever increasing number of groups concerned with the issues of agro-ecological sustainability and, as the project's "collective memory", it continues to provide ILEIA with tools and legitimacy.

The Newsletter brought these ideas across to its target audience of field-level development staff, middle- and higher-level agricultural technicians, and those working in agricultural information services, research, and policy making. Today, although the Newsletter is read by a wide range of agricultural professionals, these groups continued to be the Newsletter's main constituency.

*Figure 2 Distribution of ILEIA Newsletter readers by function*




Information in the Newsletter has always been presented in a language and style designed to make the issues discussed as accessible as possible. Each edition is full of facts. A questionnaire sent out with the first Newsletter tried to identify readers' interests and was accompanied by a

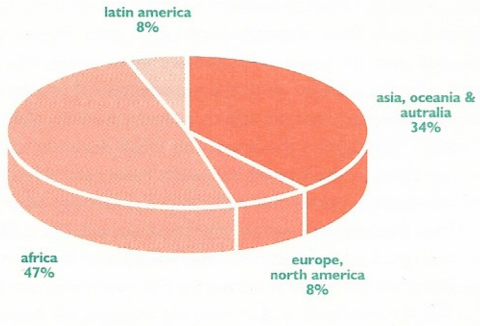
# 1984 : Documentation

## The ILEIA Newsletter

### The ILEIA Newsletter

The first, eight-page newsletter was sent, free of charge, to 1000 people. Few of the original team would have predicted that, 15 years later, the ILEIA Newsletter would have touched and brought together so many individuals and organisations or documented and integrated such varied strands of knowledge. By 1998, the Newsletter was being read by some 15,000 subscribers and a readership questionnaire revealed that each copy of the Newsletter was read by at least two or three people - an estimated 30-40,000 readers per issue. Through its editorials, case studies, and book reviews, the Newsletter - published four times a year – has continued to refine thinking on LEISA.

*Figure 1 Regional distribution of Newsletter subscribers 1997*




list of subjects that showed clearly that ILEIA intended to focus on the everyday practises of small farmers. Throughout the years, in articles, interviews, announcements, project information, activities, seminar and conference reports, book reviews, and network information, the Newsletter has kept to this policy with the occasional cartoon to remind the reader that the road to sustainable agriculture is not always smooth.

In this way the ILEIA Newsletter has become one of the leading magazines on the development of sustainable agriculture, LEISA, indigenous knowledge and participatory technology development (PTD). From the beginning its critical perspective was rooted in respect for small farmers and their knowledge and it was this that dictated the choice of Newsletter articles and themes. Whilst historians in the 1980s were documenting the role of peasant communities in social and political change, ILEIA was making visible the small farmers role in the creation of agricultural knowledge and the importance of this knowledge for ecological sustainability and food security.

Newsletter articles reflected the vitality, diversity, and values of small farming communities. They confronted readers with a new image of small farmers as innovators and experimenters who were continually adapting, experimenting and exchanging ideas and breeding plant varieties for multiple purposes, taste, colour, size, yield, straw quality and site specificity. (Newsletter 1984) The Newsletter also recorded ethics very different from those that guided agricultural decision making in fully market-orientated farming communities and allowed readers to explore the ways in which other cultures experienced the pressures being put on them by the rapid commoditisation of their natural resources. **In a Message from the Heart of World**, for example, the Newsletter recorded the experiences of the Kogi people of the high Andes and the environmental changes resulting from developments taking place in the valleys below their homelands. They had no water. The grass was dead. The earth hard and dry. The Kogi express their fears for the future in poignant and questioning metaphors.

"I am the Older Brother. I look after the sun, I look after the mountains. I have done whatever I can, but before long I am going to die. Younger Brother could save me. If all the Kogi die, do you, Younger Brother think you will go on living...Younger Brother, you have already taken so much. We need water to live" (Newsletter 1&2 1991).

## Networking for LEISA

Networking is central to ILEIA activities and, in turn, the project draws its strength and motivation from the informal network its serves. As the ILEIA Newsletter gradually brought readers and contributors together, workshops designed to explore specific themes and problems put those with information to share in contact with each other and strengthened these linkages further. As the new body of knowledge - LEISA - developed, so did its constituency. The stimulus for LEISA often lay at the interface between LEIA and HEIA. This committed ILEIA to networking in the widest sense possible in order to secure its objectives.

"Obviously the sustainability of agriculture cannot be achieved without input whether internal or external, renewable or non-renewable. Yet there is a multitude of technical alternatives ranging from traditional low input, which is the prevailing situation in the tropics, to "modern" high input practices with potentially very different impacts on long-term sustainability and profitability. Unfortunately the knowledge base supporting these two extremes, although complementary, is located in different communities (farmers, researchers, extension, development workers) that do not communicate very easily" (Farrington and Stoop 1988).

ILEIA has maintained its network carefully. Names and addresses of organisations and individuals involved in low-external-input agriculture and related approaches were recorded, updated and circulated (ILEIA May 1988). In 1993, ILEIA published a register of LEISA partners aware that, without such information, groups with similar objectives could be working in the same area unaware of each other's existence and unable to benefit from the possibilities of local contact. As Pascal Badjagou of the *Réseau de Développement d'Agriculture Durable* (REDAD) in Benin reflected wryly:

"Because of lack of communication people tend to look far away for something that is, in fact, close by without their being aware of it. For instance, we learnt about the existence of agro-forestry from books and magazines, but we were overjoyed when making our initial contacts to form a network to discover the RAMR project (*Recherche Appliquée en Milieu Réel*), which practises agro-forestry in Mono province only 150 kilometres away from our community" (Alders et al 1992)

ILEIA supported regional networks in South Ghana, Tamil Nadu, the Philippines (where a national register of network members was published), Benin, India and Latin America. Within the ILEIA network there were also groups and individuals who were less formally connected to ILEIA but who nevertheless drew support from the information and recognition it provided. As the ILEIA network grew, evaluations showed that the project's networking initiatives had led to important improvements in the information circulating amongst its members (Kessler & Moolhuizen 1994).

## 1989 : Publication

Networking for LEISA — Workshops — Publications

Jan Nieuwenhuijzen

"I can tell you a lot about farming but you never asked me"

## Workshops

By 1989 the ILEIA project was setting the bio-physical aspects of the agricultural approaches of small farmers and the documentation of low-external-input agriculture technologies in a broader perspective. This move was partly stimulated by a demand for more discussion on the social, economic and political background of LEISA case studies and partly by ILEIA insistence on the importance of farmers' own knowledge and experimentation.

"Farmers, like agricultural research scientists, are experimenters. Modern agricultural science rests upon the foundation of at least 10 millennia of informal experimentation by anonymous commercial and subsistence farmers. The nature of this farmer-based, spontaneous research has rarely been systematically studied" (Newsletter 4 (3) 1988).

Workshops were used to explore and make farmers' knowledge accessible to the larger LEISA network. Internationally, regionally and locally, they were seen as "spear point activities", where existing knowledge on LEISA could be brought together and discussed. ILEIA continued to facilitate workshops at regional and local level and from 1988 important workshops were held on PTD, assessment and networking

One of the most significant of these concerned Participatory Technology Development. In 1987 the Institute of Development Studies (IDS) at Sussex University held a workshop entitled Farmers and Agricultural Research: Complementary Methods. It focused on the need for collaboration between local people and outsiders in exploring paths to sustainable agricultural development and lead to the influential book Farmers First (Chambers 1989) Both workshop and book put the small farmer and participatory research firmly at the centre of the sustainable development debate. ILEIA followed-up this workshop with an international workshop on Participatory Technology Development in sustainable agriculture, which focused on approaches to operationalising PTD in the interests of strengthening farmer experimentation. As was the case with other major ILEIA workshops, the approaches, ideas and experiences presented and developed at this workshop were collected together in a series of papers published in a special issue of the ILEIA Newsletter that appeared in English and in French and in the ILEIA Readers series (1991). PTD as a way of entering, understanding and utilising indigenous knowledge and merging the indigenous with the scientific gave rise to much activity within ILEIA both at the methodological level and in the demand for information, training and literature.

### Publications

The third phase of the project began in 1989 with an intensification of ILEIA documentation, networking and communication activities as the experiences and information discussed in the workshops were transformed into publications. The four ILEIA readers published between 1990 and 1997 by Intermediate Technology - **Joining farmers experiments**, **Let farmers judge**, **Linking with farmers**, and **Farmers' research in practice** reflect the concepts developed and elaborated by ILEIA in the last 15 years.

In 1990, ILEIA made a successful attempt to collate its experiences with LEISA. **Farming for the future: an introduction to low-external-input and sustainable agriculture** (1992) was ILEIA's most comprehensive answer to the demand from its growing network of partners and from an increasingly interested body of development workers, researchers and policy makers for a systematic study of LEISA. An immensely practical book, which has sold over 12,500 copies in the English language edition alone, it has been translated into Arabic, Bahasa Indonesia, French, Spanish, Chinese, Portuguese and Thai. **Farming for the future** contains a wealth of practical information and, as a resource guide, was typical of ILEIA's approach to publications. Designed to be of immediate use to middle-level agricultural development workers, it was based on eight years of patient collection, documentation and analysis of the scientific principles behind the various LEISA systems and techniques. Besides being a rich collection of papers and case studies covering the potentials, principles and possibilities of LEISA, it provided a comprehensive bibliography together with the names (and addresses) of organisations sympathetic to LEISA.

In the 1990s, articles from ILEIA team members started to appear more regularly in newspapers, journals and books. In addition, initiatives were taken within the ILEIA network by such organisations as Environment et Développement du Tiers Monde (ENDA) in Senegal who regularly translated articles into French for their magazine Nouvelles de Pronat and AS-PTE (Assessoria e Servicos a Projetos em Agricultura Alternativa) in Brazil, who frequently translated ILEIA articles and books into Portuguese. GATE and GTZ funded a Spanish translation of the first ILEIA reader and Consorcio Latino Americano de Agroecología y Desarrollo (CLADES), reprinted a selection of articles of interest to network partners in Latin America. One of the successes of the fourth phase was the appearance of the ILEIA Newsletter in a Spanish language edition - *El Boletín de ILEIA* - in 1996.

## 1994 : Assessment

Assessing LEISA

El Boletín de ILEIA

By 1994, ILEIA could look back on ten years of intense activity. From an eclectic beginning the documentation centre had been systematised, links with major databases had been exploited and the collection was being managed with accessibility, retrievability, quality and uniqueness in mind. The Newsletter had attracted increasing numbers of writers from the south which, together with the appointment of external editors and reviewers, had increased the quality and relevance of its presentation. Its design too had been improved by successive graphic designers and the original eight page newsletter had expanded to a 34 page "magazine". An active international network had been created and ILEIA publications were steadily introducing LEISA to an increasingly receptive world. In 1994, the project entered its fourth and last phase and a new component was added - research.

### Assessing LEISA

The evaluation of ILEIA carried out towards the end of 1993 had made it clear that if the adoption of LEISA approaches at farm and policy level was to be effective, it would be necessary to address the bio-technical and socio-economic aspects of LEISA at local and regional levels and at international and policy levels as well. Research was necessary to establish a better base for assessing the risks and advantages involved in balancing the use of external agricultural inputs. There was a need to deepen analysis, to substantiate information and be more critical of anecdotal evidence. The implications of LEISA approaches also had to be studied more carefully. The policy statements of bilateral and multilateral donors agencies, technical assistance and international research institutes left little doubt that there was a growing interest in LEISA. However, the degree to which a "general low-external-input" approach could contribute to meeting the needs of small farmers and a rapidly growing and increasingly urbanised world remained an open question.

The research mandate adopted by ILEIA reflected these concerns. The project now set out to make a participatory assessment of the viability of low-external-input and sustainable agriculture technology systems (LEISA) in different environmental and socio-economic settings which would be substantiated as far as possible by quantitative data. This participatory assessment would include an attempt to understand the processes that lead to change in farmers' livelihood and land-use strategies.

Initially, three contrasting regions - Ghana, Peru and Philippines - had been selected for the ILEIA Collaborative Research programme. At a later stage, a fourth region, India, would be added. Each region represented specific agro-ecological and socio-economic conditions and, in each location, LEISA working groups - consisting of farmer organisations, NGOs, agricultural research institutes, universities and government extension services - were established.

In keeping with this task the ILEIA project (briefly) adopted a new name and, in 1995, became the Centre for Research and Information Exchange in Ecologically Sound Agriculture. The start of the fourth phase marked a radical step forward in ILEIA aspirations and activities. In 1995, inventories of the 'agendas' of research partners were made and compared to those of ILEIA. The ILEIA team emphasised Stakeholder Analysis, Agro-Ecological Resource Mapping (AERM), electronic communication and developing scenarios for ecologically sound agriculture. In the research sites, the LEISA working groups were encouraged to describe the prevailing farming systems by using resource flow diagrams and soil classifications based on farmers' own categories of land-use types. At the same time, soil surveys were initiated with the International Soil Reference and Information Centre to correlate scientific systems with local knowledge of agro-ecological niches and land suitability (AERM). The emphasis in the project gradually shifted from assessing the potential of LEISA to stakeholder approaches to natural resource management while between 1995 and 1996, partners and other stakeholders in the research areas were trained in AERM and RAAKS.

Although interesting, this shift deviated significantly from ILEIA's original mandate. In 1996, tensions surfaced over the direction of research and subsequently a new team, together with the working groups in Ghana, Peru and the Philippines, set about the task of reformulating the research programme. As a result ILEIA returned to its roots – participatory research in LEISA.

ILEIA's partners were heavily involved in the reformulation of the research programme and its subsequent implementation. New research activities included Participatory Technology Development, quantitative assessment of ecological and financial factors and changes through FARMS, and a number of locally proposed studies of the agro-ecological, economic and socio-cultural contexts of the research sites. Other studies focussed on the technical options for ecologically sound developments and successful experiences with the adoption of LEISA techniques. There were complementary activities too, such as the strengthening of the resource facilities and information capacities of working group members.

ILEIA published its research progress in 1995-1996 in three separate issues of the Newsletter. **Mountains in balance** reported experiences from the high mountain valleys of Peru; **Farmers facing change** dealt with the dry savannah of Northern Ghana and **More than rice** surveyed the humid lowland flood plains of central Luzon in the Philippines. In the same way plans have been made to publish the results of ILEIA current research programme after an international research workshop scheduled for March 1999. This workshop will examine the results of ILEIA's joint research programme and assess the relevance of LEISA approaches. An attempt will also be made to formulate policy recommendations relevant to farmers, NGOs, agricultural extension services, agricultural research institutes and policy makers.

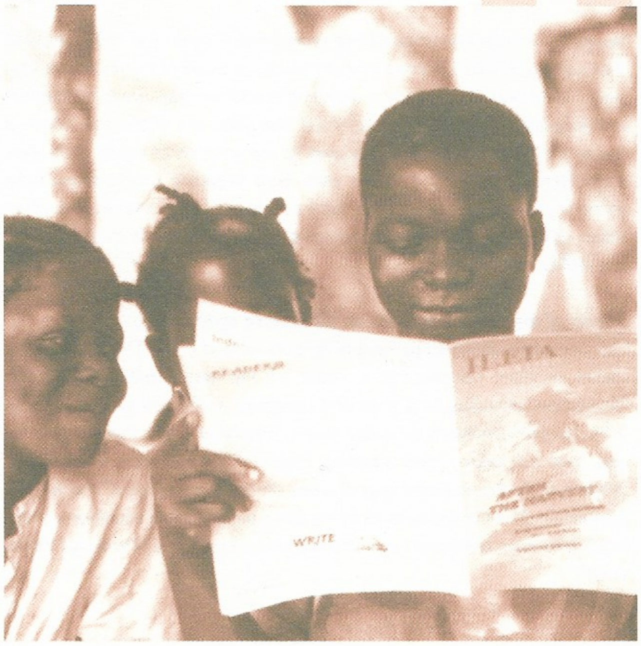
### LEISA, ILEIA and the future

At the end of 1997, ILEIA subjected itself to an external evaluation. Four independent assessors from the Philippines, Senegal, Chile, and the UK conducted a questionnaire amongst Newsletter readers and interviewed a number of strategic ILEIA partners. The central issue was whether ILEIA should continue documenting, analysing and exchanging experiences on the development of LEISA, PTD and assessment research. Those who answered the questionnaire and those interviewed made their positions clear. They wanted more information on LEISA, to be kept in touch with developments in its approaches and to hear the results of research and evaluations designed to assess LEISA's potential and effectiveness. Most of all they wanted the ILEIA Newsletter to continue. At the same time, however, they confirmed the feeling of the ILEIA team that LEISA, as articulated by ILEIA, should

## 1998 : ->

## LEISA, ILEIA and the future

In an international workshop held in June 1997, the re-orientation of the ILEIA Collaborative Research Programme was confirmed. During this workshop it was agreed that the Deccan Plateau of Southern India would constitute a fourth research site and that activities there would be co-ordinated by AME, ILEIA's sister programme in India.




reflect the fact that the livelihood of small farmers could not be defined in terms of food, shelter, and profit alone. It should also included a recognition of the fact that cultural values, human dignity and integrity had to be preserved and the need for status, security, prestige, comfort, stability, and leisure respected and fulfilled.

### LEISA in perspective, 15 years ILEIA

As the ILEIA project comes to an end and ILEIA goes through the process of moving from project to independent institution, ILEIA decided to put LEISA in a larger perspective. This jubilee publication looks back on the evolution of the ILEIA project and forward to the challenges that lie ahead in developing LEISA. It tries to combine the reflections of ILEIA staff with detailed case studies on farmer-led agricultural development towards LEISA written by those working with LEISA in practice. Thus, Part One deals briefly with the history of ILEIA, Part Two puts LEISA in perspective, and Part Three contains case studies by Ronaldo Bunch; Fidele Hien; Elske van der Fliert, Wiyanto, and Ann R Braun as well as a brief extract from Mary Tiffin's **More people less erosion**. Other short case studies illustrating LEISA can be found throughout the book.

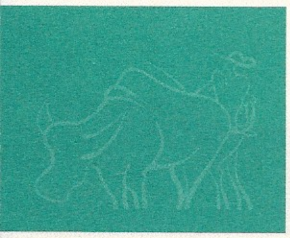
We would like to take this opportunity of thanking the many small farmers and workers in LEISA whose experiences and knowledge have provided the inspiration for this book. At the same time, we express our gratitude to those friends and colleagues who reviewed its earlier drafts with an unrelenting criticism. A book, of course, always remains the responsibility of its authors. We hope you will enjoy this one and find it both stimulating and encouraging.

# 1. In search of sustainability

The history of agriculture can be told as the history of the farmer's response to environmental and political change. The daily routine of securing land, seed, animals and labour to produce food, and the struggle to survive poor harvests, plague, drought and war are reflected in religious, cultural and literary traditions throughout the world. For generations farmers found increasingly sophisticated ways of co-operating and manipulating nature to get food and other agricultural products. Over time, distinct agri-cultures evolved that regulated people's interaction with their spiritual, social and natural environment.

To provide for household needs and avoid risk, subsistence farmers developed land use and exchange strategies that maximised self-sufficiency (Box 1.1). Where population increased and good land was in short supply, it became necessary to intensify land use. If population growth outstripped the capacity of farmers to increase production, or if natural or man-made disasters occurred, there was famine. For most of this century, the pace of economic, social and environmental change has been too fast - and sometimes too violent - for many small-scale farming communities to absorb. Unable to adapt their farming practices their capacity for self-reliance was eroded.

Over the last two hundred years, recurring cycles of population growth have given way to explosive and universal increases in birth rates and longevity. This phenomena has been accompanied by industrially based urbanisation. To meet the demand of the food-dependent but powerful consumer, an elaborate system of agricultural production, trade, processing and distribution has emerged. This now links producers and consumers from every continent in an intricate web of markets. Small farmers are facing tremendous problems in adapting to rapidly changing conditions, and many resource poor communities have found that their farming techniques, developed over centuries, are no longer able to sustain the fragile balance between production and conservation.



### A short-cut to increase production

Population growth and increasing demand for the bulk delivery of agricultural products for industrial processing made it necessary to increase supply rapidly. It was only after the introduction of agro-chemicals, pesticides and high yielding varieties on a large scale that it became possible to raise agricultural production to keep pace with these developments. The use of fossil energy based technologies such as synthetic inputs, water pumps, and fuel-powered machines increased the productivity of agricultural land and labour. In more industrialised regions, economic transformation was stimulated as labour, no longer needed on the farm, was absorbed by other economic activities. The trade and service sectors were also radically transformed.

This transformation process did not make an impact on the smallholder sector in the tropics until the 1950s. The beginning of the Green Revolution marked a definite policy shift from predominantly subsistence orientated low-external-input agriculture (LEIA) to market orientated, high-external-input agriculture (HEIA) (Box 1.2).

Where conditions of production were economically and agro-ecologically favourable and where governments had the capacity to invest in irrigation, electrification, transport, marketing, research and extension, the shift took place to the use of modern agricultural technologies. The adoption of HEIA was particularly successful where large-scale irrigation was possible.

### Sustainability at stake

Since the 1980s, however, serious questions have been raised about the economic, social and ecological problems linked to Green Revolution technologies. Many small farmers using high input technologies, have found themselves caught in a spiral of rising costs and ecological degradation. To sustain yields, increasing amounts of agro-chemicals have to be applied because soil have become degraded and pest infestation increased. This has affected human health, animal welfare and the quality of food.


The loss of complexity: a serious threat.

Research on intensive irrigated rice production (Pingali et al 1997) showed that rice yields have declined in many places because of salinity, water-logging, macro and micro nutrient deficiencies and toxicities, pest resurgence, and long-term changes in the physical characteristics of the soil. Most of these processes were directly related to the amount of inputs used (Box 1.3). Genetic diversity declined and, plant breeding programmes have found it difficult to increase the yield potential of rice, maize, and other major grains. Food security is becoming a serious concern to researchers and policy makers.

*Impact of the Green Revolution on subsistence agriculture*

Ten years ago, about 45 percent of agricultural land in the Third World was under modern varieties as a result of the dissemination of Green Revolution technologies (Lipton and Longhurst 1989). However, in areas with rain-fed conditions or in dry, steep or isolated areas, these technologies have not been widely adopted. Pretty (1995) estimates that some 2 billion people live in such marginal areas - more than a third of the world's population. Most of the farmers facing these unfavourable conditions, practice subsistence orientated agriculture and use low levels of external inputs (LEIA).

*Box 1.1* *The ecological rational of small farmers production*

Since their production is based more on ecological exchanges with nature than on economic exchanges with markets, farmers are obliged to adopt survival mechanisms that guarantee an uninterrupted flow of goods, materials, and energy from natural and transformed ecosystems. As a consequence, farmers tend to carry out a non-specialised production based on the principle of diversity of resources and productive practices. This results in the utilisation of more than one landscape unit, the integration and combination of different practices, the recycling of materials, energy, water and wastes, and the diversification of the products obtained from ecosystems. It is a strategy that can operate at household, community and regional level.

Although crop-based agriculture tends to be the central productive activity of any peasant household, it is complemented by plant-gathering, forest product extraction, fishing, hunting, livestock raising, agro-forestry and craft production. These combinations buffer the household against environmental changes and market fluctuations. This multi-use strategy, through which farmers maintain and reproduce their productive systems, constitutes an ecologically valuable characteristic that conserves natural resources by maintaining environmental and biological diversity (Toledo 1995).

Third World farmers are becoming increasingly integrated into the money economy through tax obligations and cash needs to pay for education, transport, health care and consumer goods.In pursuing cash income generating activities, many rely on a mixture of strategies and specialise in one or more cash crops combined with subsistence production. This is often expressed in the presence of HEIA and LEIA technologies side by side on the same farm.

As a result some farmers may run into both HEIA and LEIA sustainability problems: Human, ecological and financial risks as a result of HEIA practices in an effort to maintain their income cannot be avoided, whereas LEIA practices lead to land degradation, deforestation, soil erosion and nutrient depletion (Box 1.4). In such conditions farmers often choose to become migrant labourers. This has consequences for the organisation of farm and domestic productions including an increase in the household and agricultural work load of women. However, there are also some subsistence farmers, who have managed to increase production and do so in a resource conserving way (Wiggens 1995).

*Erosion of traditional 'agri-cultures'*

Land expropriation, logging, cultural domination and migration have a catastrophic impact on indigenous farming communities. Under such conditions, subsistence farmers become socially marginalised. As indigenous cultures disintegrate, invaluable indigenous knowledge about the properties and uses of indigenous plants and animals disappears. Cosmovisions that have been sources of wisdom and coherence for centuries suffer the same fate and the insights and knowledge of human and agricultural evolution are lost to present and future generations. Most policy makers and researchers see the disappearance of traditional agri-cultures as the unavoidable price of economic development and modernisation. Many farmers and indigenous people are unwilling to pay this price. As 'traditional agri-cultures' fall apart under the pressures of twentieth century agricultural science and economics, the demographic, nutritional and social consequences of this disintegration and impoverishment become apparent in hunger, dissatisfaction and political instability.

**Box 1.2 Green Revolution in India**

During the colonial period common land was privatised and put under government control. This, together with the growth of market agriculture, led to local inputs such as water and manure becoming scarce. It became more difficult to increase agricultural production to meet the demands of a growing population. After the Second World War, cheap and plentiful synthetic fertiliser from the industrialised West became available and agro-chemical companies had a vested interest in ensuring higher fertiliser consumption overseas. Government policy, inspired by international research institutes, supported the use of synthetic fertilisers through fertiliser subsidies. The policy of the Indian government strongly favoured the use of synthetic fertilisers: in its first Five Year Plan fertilisers were seen as supplements to organic manure, the second and subsequent plans gave them a direct and crucial role. The High Yielding Varieties programme was heavily dependent on high fertiliser inputs. In this way a NPK mentality was created amongst Indian experts and farmers who came to see synthetic fertilisers as a superior alternative to organic fertilisers. Regions where the Green Revolution flourished were declared "progressive" and regions of traditional agriculture were designated "primitive" or "backward". Cultural biases worked hand in hand with economic interests to reinforce the conclusion that sustainable traditional agriculture was non-viable. The addiction to external inputs resulted in environmental and social decay (Shiva 1991).

## From Awareness to Action

Today, the importance of achieving sustainability in agriculture is globally recognised. The conclusions of those who attended the World Conference on Development and the Environment in 1992 summarise this acceptance clearly.

"Major adjustments are needed in agricultural, environmental and macroeconomic policy, both at national and international levels, in developed as well as in developing countries, to create the conditions for sustainable agriculture and rural development" (UNCED 1992).

This statement is even more urgent today given the prediction that food production will have to be increased by 40 percent over the next 25 years. Such an increase can only be achieved if agricultural productivity is raised wherever possible, irrespective of whether or not production conditions are favourable (Pinstrup-Andersen and Pandya-Lorch 1994). International organisations such as the UN Conference on Environment and Development (Agenda 21, UNCED 1992) and the Conventions on Biodiversity and Desertification have drafted guidelines for developing sustainable agriculture. Although it has been put on the agenda of most governments and development organisations, it is not easy to establish, especially on a large scale.

The development of sustainable agriculture does not simply mean a shift to ecologically technologies. There are economic and social dimensions too. These include increasing production and economic profitability, securing food supplies, and ensuring social equity and cultural identity. These dimensions cannot be separated. Many processes, conditions and actors influence agricultural development. Broad and holistic approaches are necessary but are difficult to design and implement. Much work still has to be done in order to understand which conditions, technologies and approaches favour sustainable agriculture. ILEIA, in direct collaboration with many other

**Box 1.3 The limit to production growth comes closer**

Dr Cassman, head of the department of agronomy of the University of Nebraska, USA, seriously doubts if it will be possible to increase food production to feed the world's rapidly growing population. In the early nineties Cassman worked for the International Rice Research Institute in the Philippines. There, he and his colleague Dr. Pingali became aware that since the sixties researchers had failed to increase the yield potential of important food crops such as rice and maize. The yield potential is the maximum yield farmers can obtain if a crop is produced under optimal growth conditions without being affected by pests or diseases. Cassman is pessimistic about the chance that plant breeders will succeed in increasing yield potentials in the next thirthy years. The necessary increase of food production must come, he believes, from an increase in average yield levels. Where crop production is already much intensified this will not be easy. When yield levels come close to 75 percent of their potential maximum, disease and pest incidence will increase. For example, rice farmers who produce below the 75 percent mark (about 6500 kilogram per hectare) do not need to use fungicides. Where production levels are higher fungi investation increases quickly as the leaf canopy becomes very dense. Fast growing plants, especially if high amounts of nitrogen are being used, attract more insects. Where large amounts of fertiliser, water and pesticides are used it becomes difficult to keep the soil in good condition. Cassman and Pingali discovered that in intensive, irrigated rice production there can be serious yield decline, due to soil processes which inhibit the uptake of nitrogen from organic matter in the soil. In principle, this problem could be resolved if farmers would take ecological processes into account and adapt their soil fertility and water management practices in such a way that crop residues and organic fertiliser can be applied in aerobic conditions. In this way yields could be increased while saving on fertilisers. (Cassman and Pingali 1997; Heselmans 1998) organisations and people involved in the quest for sustainable agriculture, has been contributing to this goal for the past 15 years.

### Low External Input and Sustainable Agriculture

The ILEIA Newsletter has published the experiences of the many farmers, development workers and researchers who are trying to make agriculture more sustainable. They use a wide variety of approaches such as traditional, indigenous, organic, ecological, regenerative, resource conserving or integrated agriculture; permaculture; natural farming; agro-forestry; integrated pest management (IPM); and integrated nutrient management (INM). They are all bound by a common factor: the need or desire to reduce or exclude agro-chemicals and other external inputs that might threaten agricultural sustainability. In 1988, ILEIA introduced the concept LEISA (Low External Input and Sustainable Agriculture) which includes elements of these approaches. LEISA is, a large family of approaches whose corner stones are:

- Agro-ecology - the scientific knowledge base to apply ecological concepts and principles to the design and management of sustainable agro-ecosystems;
- Indigenous knowledge - the knowledge of farmers living in a certain area, generated by their own and their ancestors' experiences and including knowledge originating from else where that has been internalised. Indigenous knowledge is holistic and encompasses all aspects of rural life;
- Scientific knowledge - the knowledge base developed by scientists;
- Participatory learning, planning and action - participation of development supporters in local development process to strengthen farmers' and own capacity to adapt to changing needs and conditions and towards sustainability;
- Social justice and cultural integrity - economic development should not be pursued at the expense of the cultural and social values of those segments of the population that have little influence over economic and political decision making.

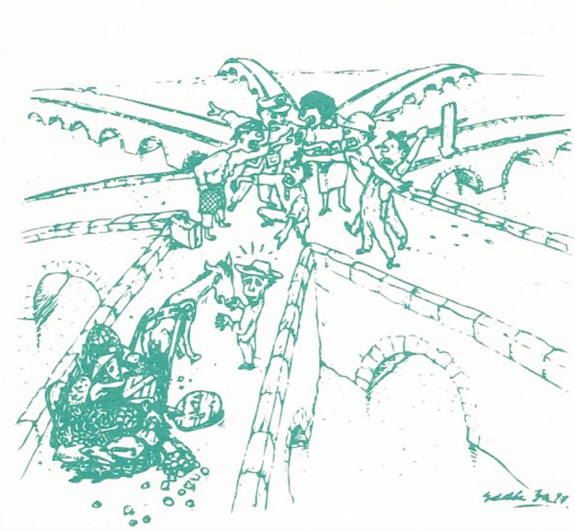
ILEIA sees LEISA as dealing with the technical and social options open to farmers who want to improve their productivity and income in an ecologically sustainable way.

*Box 1.4* *Understand ecological degradation*

**Almost 2 billion hectares of land have been degraded since the 1950s. About 300 million hectares have suffered strong to extreme degradation and their original biotic functions have been so damaged that reclamation is costly if not impossible. Worldwide since 1945, overgrazing and deforestation accounts for 65 percent of degradation; fuel wood collection 7 percent and faulty agricultural practices 28 percent. There is a close relationship between poverty and lack of intensification, and land degradation. Very little solid empirical information is available on the dimensions, causes, and location of environmental degradation. It is essential that such information be collected so that informed debate and decision making can take place (Pinstrup-Andersen and Pandya-Lorch 1994).**

LEISA builds on the optimal use of local resources and natural processes and, if necessary, acceptable, and feasible, on the safe and efficient use of modest amounts of modern external inputs. LEISA systems, which are highly situation specific, build on indigenous and scientific knowledge of agro-ecology. In its social and political dimensions LEISA is concerned with empowering men and women who are using their own knowledge, skills, values, cultures and institutions to build up their farming future.

LEISA involves participatory methodologies to strengthen the capacity of farmers and other actors to adapt to changing needs and conditions and to make agriculture sustainable. Creating a conducive environment for sustainable agricultural development involves making LEISA effective at the policy making level. Sustainable agriculture is the long-term, and constantly changing objective of LEISA. LEISA as a concept and knowledge base provides direction, practical options and methodologies for development towards this objective. LEISA is not a blueprint for sustainable agriculture, it is a development approach with a strong political message.
LEISA builds on three dimensions of sustainability: ecological soundness, economic viability and social justice. These are further articulated in a set of criteria (Box 1.5) that can be used to assess the extent to which a particular agricultural system or practice is sustainable.




Debating sustainability, but what is the real problem?

*Matching ecological and economic dimensions*
LEISA embodies the challenge to match the ecological with the economic and the economic with the social and cultural. It finds itself at the crossroads of often contradictory objectives. In each situation balances have to be found in matching different criteria for LEISA.

For example, financial competitiveness ensuring the continuation of farmers' enterprises and sustaining their livelihoods is apparently difficult to combine with pure ecological goals aiming at the preservation of the natural resource base. The economic criterion of "low relative value of external inputs" envisages striking a balance by minimising the cost of external inputs without jeopardizing output levels. By taking into account ecological concerns and principles, a strategy of applying a minimum level of external inputs can be pursued which enhances the financial viability of the farming enterprise by reducing costs.

### LEISA in perspective

In its information centre, ILEIA has collected many publications detailing experiences with developing LEISA. In this Jubilee publication, we want to discuss some of the issues that have emerged from these documents and other publications in the past 15 years. In putting 'LEISA in perspective' we have chosen to consider those issues that deal with the feasibility of developing agriculture towards LEISA in various situations. Most of these issues centre on the need for agricultural intensification and local food security.

We begin, in Chapter Two by examining the macro processes that influence agricultural development and affect sustainability. In Chapter Three, we draw on practical experiences to examine the potentials and constraints involved in intensifying agricultural production in both subsistence and market agriculture. Situations vary and consequently LEISA finds expression in a variety of ways. Not all approaches to LEISA are necessarily sustainable, therefore, monitoring and assessing the impact of agricultural development is important. From the experiences and the case studies in Part 3, it is clear that what has to be sustained is the process of adaptation and innovation (Bunch and Lopez 1994). Therefore, in Chapter Five we turn to participatory methodologies. These aim at strengthening and facilitating concerted

*Box 1.5 Criteria for LEISA*

**Ecological criteria**

- Balanced use of nutrients and organic matter
- Efficient use of water resources
- Diversity of genetic resources
- Efficient use of energy sources
- Minimal negative environmental effects
- Minimal use of external inputs

**Economic criteria**

- Sustained farmer livelihood systems
- Competitiveness
- Efficient use of production factors
- Low relative value of external inputs

Source: ILEIA Research Workshop, June 1997

**Social criteria**

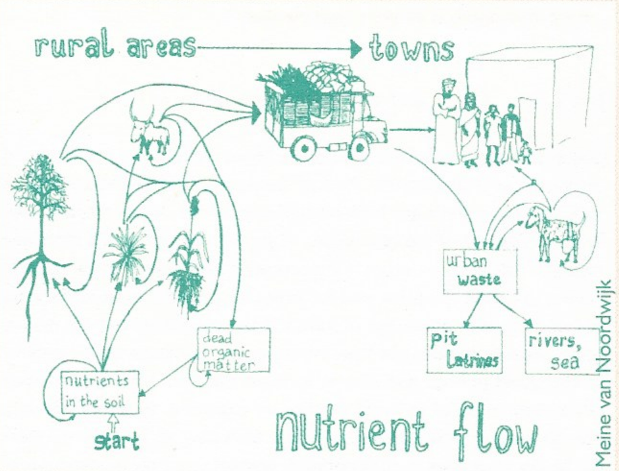
- Wide-spread and equitable adoption potential, especially among small farmers
- Reduced dependency on external institutions
- Enhanced food security at the family and national level
- Respecting and building on indigenous knowledge, beliefs and value systems
- Contribution to employment generation

action towards sustainable land use. They draw together actual experiences with LEISA in considering what actions should be undertaken in the future and what role ILEIA should play in this process.

# 2. Processes that cause change and affect sustainability

In this chapter we will examine some of the macro processes that influence farmer-led autonomous agricultural development and affect sustainability. As farmers become more closely incorporated into national and international markets, radical changes take place at farm and community level. These affect farmers' capacity and willingness to alter their agricultural practices. In economic analysis these effects are generally studied in terms of the production and financial costs and benefits of the more powerful groups involved. The economic effects on marginal farmers have not always been well analysed or 'externalised'. As a result, the economic as well as the social and cultural marginalisation of important groups of male and female farmers and the degradation of the natural environment have continued unrecognised (Chambers 1983).

Why does agriculture continue to develop in an unsustainable way? The answer lies in the workings of these macro processes. It is, therefore, important to understand the factors that influence agricultural development and determine its direction either in a positive or a negative sense. Their impact is not always the same for all small farmers. Nor, as you will see from the specific situations documented here, does everyone argue from the same perspective.




Plant nutrients leak away when markets and towns grow!

## The shift to market agriculture

The introduction of Green Revolution technologies speeded up the transition to market agriculture particularly in parts of India and Southeast Asia, for example, where production conditions were good and population densities high. The transformation of relatively closed subsistence economies into open market economies enhanced the exchange of products with other sectors of the economy. This change has been accentuated by the strong development of urban markets (Cour 1998). However, these changes have had a negative effect on stocks and flows of products and such factors of production as capital, labour, plant nutrients, genetic resources and indigenous knowledge.

*Loss of soil fertility*

When agricultural products are sold on the market, plant nutrients leave the farm. The replacement of these nutrients with synthetic fertilisers is often inadequate and unbalanced. Whilst nitrogen and some phosphate and potassium fertilisers are applied, the loss of micro-nutrients remains uncompensated. This is particularly the case when farmers do not use organic fertilisers, do not have money to buy fertilisers, or when important plant nutrients are lost because of soil erosion and leaching.

As increasing distances separate producers and consumers, there is less recycling of organic waste. Plant nutrients often end up as organic waste in cities, rivers and lakes. The high processing and transport costs involved in recycling urban organic waste could mean that agriculture remains partly dependent on synthetic fertilisers. Many HEIA farmers return too little organic matter to the soil and this not only affects soil fertility but also has a serious impact on plant health and resistance to drought. This situation is exacerbated by the fact that synthetic fertilisers are often less expensive than organic ones. In the longer term, these factors can lead to a fall in productivity, rural poverty and fouled urban environments. Moreover, it will no longer be possible to meet the criteria for sustainability proposed in Chapter One.

*Loss of genetic diversity*

In the shift to market agriculture, the rich genetic diversity nurtured by traditional subsistence agriculture is lost. Large numbers of land races are being replaced by a few, high yielding crop varieties. Similar changes occur when highly productive exotic breeds are introduced. These high yielding varieties are all closely related and, because they have a very small genetic base, are a threat to the ecological and economic stability of agriculture.

Products made from natural materials that have been collected from the wild or made from cultivated materials are gradually being replaced by factory-made products. This contributes not only to a loss of skills but also to a loss of knowledge about the properties and value of local resources such as herbs, grasses, and livestock. In some areas, however, poverty and population pressures have resulted in over exploitation of natural resources such as wood and organic waste. Both processes contribute to the loss of natural vegetation and wild life. As a result, genetic diversity in and around

### Box 2.1 Free trade and Mexican agriculture

Trade liberalisation in Mexico under the North American Free Trade Agreement (NAFTA) provides a striking illustration of the threats facing vulnerable rural communities. Under NAFTA, duty-free imports of maize from the United Stated has increased from less than 1 million to 2.5 million tons. As many as 2.5 million households in Mexico depend on maize production and the majority of these farmers cultivate fragile hillsides. Two-thirds of the rain-fed area, 6 million hectares in total, are under maize and the poorest producers are concentrated there. Four million hectares of this maize land is no longer competitive under open market conditions. Only the large-scale irrigated sector has prospects for long-term survival. Farmers in the hillsides are being forced to adopt desperate survival strategies including labour migration. Shortages of farm labour makes maintenance of traditional inter-cropping and terracing systems impossible, intensifying environmental problems (Watkins 1996).

farms is declining rapidly. Rural poor and women are particularly affected by the loss of bio-diversity. They often depend on subsistence crops and natural products for their food, health and income.

*Loss of economic viability*
The shift to market agriculture has increased farmers' dependency on cash income for household necessities and external inputs. Small farmers often do not have enough cash to meet their needs. In most tropical countries, the price of industrial products and external inputs rise faster than the prices farmers get for their products. An additional financial burden for many small, market-oriented farmers are expensive credits that not only increase production costs but also lead to further indebtedness. However, equally vulnerable are those small farmers, many of whom are women, with no access to affordable credit. In today's market economy, many farmers are unable to be competitive and keep pace with economic growth and become marginalised (Box 2.1) If there is no other source of income available they may be forced to leave farming for urban areas that are often ill equipped to absorb them.

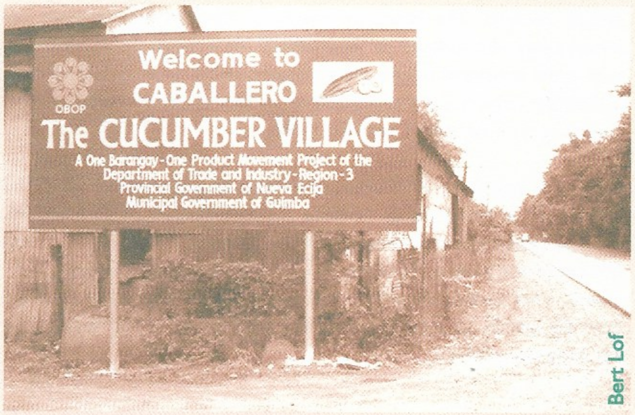
## Liberalisation and globalisation

Sustainability of agriculture can be assessed in terms of the LEISA criteria mentioned in Chapter One. Apart from the social and ecological dimensions of sustainability, LEISA should also be competitive in comparison with other production options in order to be of interest to farmers. The macro processes of globalisation and liberalisation discussed below are thought to be of benefit to agricultural producers because they create "more free markets" but they create problems for small farmers as well.

*Liberalisation*
In line with the General Agreement on Tariffs and Trade (GATT), it is argued that making use of comparative advantages and, for example, specialising in cash crops that give a good profit, farmers can maximise their income and increase their consumer power. By eliminating subsidies and protective measures that distort competition, international markets are being liberalised. GATT is expected to provide benefits for countries engaged in agricultural trade by improving the predictability and stability of international commodity markets. It should also allow agricultural prices to rise by reducing subsidies to prevent over-producers in the European Union and North America exporting their subsidised surpluses. Some groups of farmers and consumers will indeed benefit from this market liberalisation. However, for most small farmers, the trend towards stimulating export crop production, deregulating subsidies and concentrating export agriculture in regions where production is most cost efficient, has serious implications for their livelihood systems. Large-scale producers and transnational corporations are in a better position to take advantage of liberalisation and the GATT agreements.

*Structural adjustment*
Today, many heavily indebted Third World countries are tied to the conditions of structural adjustment programmes. Reductions in government expenditure, cut-backs in extension services, and the stimulation of export production are typical features of these programmes. Structural adjustment is also synonymous with the reduction of subsidies for agro-chemicals or irrigation water that have led to steep price increases in these sectors. Structural adjustment could give farmers an incentive to use both external inputs and local natural resources more efficiently. Those who want to find cheaper ways of maintaining soil fertility and controlling pest damage, for example, could become more alert to the advantages of organic fertilisers, traditional varieties and natural pest management. This would, in principal, favour development towards LEISA. However, many small farmers do not have access to sufficient amounts of organic fertiliser or have lost their knowledge of traditional organic agriculture. Those producing commodity crops such as groundnut, cotton, rice, or potatoes and who cannot afford unsubsidised synthetic fertilisers find themselves depleting soil fertility in an effort to retain some cash income. These farmers eventually find themselves trapped in land degradation and economic marginalisation (Box 2.2).

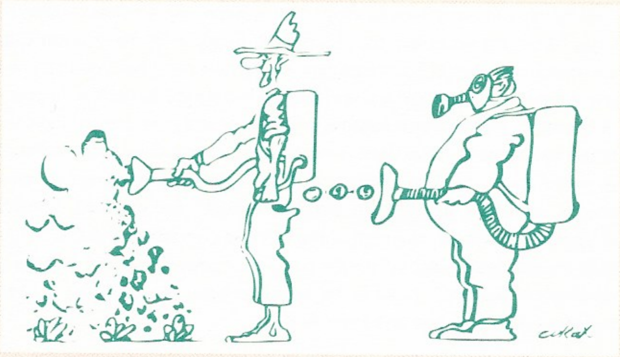
*Getting involved in export production*
The drive towards liberalisation and globalisation aims to create a favourable climate for export production. For small farmers, however, it is not easy to enter the export sector because they need international connections, know-how, processing facilities and capital. In countries that have a relatively favourable economic infrastructure such as Thailand, the Philippines, India and Central America, many small farmers are being contracted by agri-business to produce specialised export crops like baby-corn, ginger, bananas, and pineapple. This often means that although they have little choice in what they grow, they still have to shoulder the production risk. Large amounts of agro-chemicals are needed to produce crops of export quality and these are being used with little consideration




Rural communities in the grip of agri-business.

### Box 2.2 Export and subsistence agriculture in India

Shahji Sarwate is a farmer who owns about 30 acres in the semi-arid southeast of Maharashtra. Part of Sarwate's land is irrigated by a motorised bore-hole and here he cultivates wheat, sugarcane, and vegetables. The rest of the land is used to grow millet during the monsoon season. The price of crops for processing and export have risen in recent years but the price paid for millet has stayed the same. Sarwate is unable to take advantage of India's structural adjustment-led export drive because he does not have money to buy fertilisers. India's recently liberalised policies and cuts in fertiliser subsidies have led to steep price rises. In order to avoid reliance on expensive fertilisers, Sarwate has taken up organic farming. Although trials have so far been successful, he does not have enough domestic animals to supply the amounts of manure he needs. At present the family ekes out a living from the irrigated plot. Sarwate's son does not intend to farm (Woodward 1995).



The agro-industrial pull

for individual health or the condition of the land. The prices small farmers receive for their products are often low and fluctuate unpredictably. If new export production and markets are monopolised by a small number of trans-national corporations, it will be hard for most small farmers to remain competitive. As these trans-national corporations are difficult to control through national law, unfair economic practices can result.

*Agricultural policies, research and information*

Most governments in developing countries strongly favour development of market and export oriented agriculture based on Green Revolution technology. Reductions in government research expenditure in many countries has lead, in recent years, to the private sector taking over research into HEIA agriculture. Large multinational corporations are particularly active. Although the need for sustainable agriculture is now widely accepted, attention tends to concentrate on increasing productivity and profitability by using technologies such as genetic engineering. This is a further step in the manipulation of nature and the control of production and trade by large (trans-national) companies (Box 2.3).

Trade in patented seeds is a particularly lucrative activity and has far-reaching implications for bio-diversity and the food chain (Box 2.4). The long-term consequences of genetic modification are, as yet, unclear, but recent experiences with mass produced food have made many consumers with information and choice more wary of these types of irreversible development. It is clear that genetic engineering will have an effect on genetic diversity, food quality and the competitiveness of small farmers. Moreover the livelihoods of many small farmers are at stake. What will be the effect on human beings of eating genetically modified food? Are the risks affordable? Should genetic engineering be initially limited to certain types of genetic modifications, such as increasing resistance to pests and diseases, which have known and important beneficial effects? Or, should genetic engineering be avoided at all costs? Whilst this debate has yet to take place, genetic engineering continues to develop rapidly.

Meanwhile subsistence and organic agriculture as well as indigenous crops, animals and products receive little attention. Agricultural information and advice focus heavily on HEIA while information on alternatives to HEIA and on subsistence agriculture is limited and difficult to get. This is a serious constraint to the development of LEISA.

## Population growth and urbanisation

As income opportunities are growing fast in urban areas, many marginalised farmers including rural youth are drifting away from farming in search of work and a better future. Poor farming conditions are often accompanied by heavy outflows of labour. Estimates suggest that 50 percent of those living in the tropics will eventually settle in urban and peri-urban areas. Rural migration and urbanisation are having a profound influence on agriculture. Extensification and de-agriculturalisation are both responses to labour scarcity (Box 2.5). When men migrate, the workload of women can increase to unacceptable levels. Despite making extra efforts, women may not be able to maintain the ecological infrastructure of the farm. In more favourable agricultural conditions, labour migration may be insignificant and there might be an inflow of migrants from less well situated areas. In these areas intensification, specialisation and modernisation will be relatively strong. (Cour 1998; Snerch 1994).


Rural and urban development are inextricably entwined

There are some areas where farmers are facing marginalisation and where large companies are buying up land cheaply. In India and Thailand, for example, plantations of teak and orchards of fruit trees are being developed

*Box 2.3* *TRIPs and the growing control of the seed market by patents*

The agreement on Trade Related Aspects of Intellectual Property Rights (TRIPs) was signed at the end of the GATT Uruguay Round in 1994. The TRIP agreement sets out compulsory, uniform standards for intellectual property protection throughout the world by patents, copyrights and trademarks. At the moment, countries are allowed to exclude plants and animals from patent laws. However, all countries must grant intellectual property rights (IPRs) to 'inventors' of micro-organisms, micro-biological processes and products, and plant varieties. Plant varieties must be either patentable or subject to 'an effective sui generis system'. In principle, developing countries must implement this provision by the year 2000 and the least developed countries must do so by 2005.

What does this mean in practice? Today, there are already more than 160 biotech patents on rice. Most of these patents are held by trans-national companies in the United States and Japan. The top 13 rice patent holders have just over half the biotech patents covering Asia's staple food. Farmers who want to buy improved seeds protected by IPRs must pay royalties. As there is a potentially huge market for patented, improved seeds, genetically engineered rice is an attractive investment. Experience shows that IPR detracts research away from peoples' needs and focuses on patentable and marketable outcomes. It is also likely that public sector research will de-emphasise bio-intensive approaches to Integrated Pest Management programmes that provide farmers with the knowledge and techniques to breed their own improved varieties (Pimbert 1998).

IPRs also create opportunities for international companies to co-opt indigenous genetic resources. Recently, RiceTec, a company in Texas, took out a patent on (slightly modified) Basmati rice, a famous traditional rice variety found in India and Pakistan. Farmers in the poor northeast district of Thailand are afraid the same will happen to their Jasmine rice because its quality and taste is attracting international interest (BIOTHAI 1998).

on what were once smallholdings (Fatimson and Keshav Rao 1996). Once plantation owners or livestock companies move in, those who have sold their lands no longer have a buffer against recession and unemployment.

*Box 2.4 Gene firm tightens grip on food chain*

Monsanto, the multinational company powering the growth of genetically modified organism (GMOs), is edging closer to controlling the food chain. Recent acquisitions have enabled it to gain a stake in every stage of food production from the farm to the market place. The company owns the patented genes to develop new seed varieties resistant to herbicides and insects. It is also heavily investing in "terminator technology" which genetically alters seeds so they will not germinate if replanted. From patented genes to a global seed distribution network, its influence is now so extensive that aid agencies have voiced concern about its role, in particular its claims to be able to solve the problems of famine and poor harvests in the Third World. Biotechnology companies such as Monsanto have come under fierce attack from MPs, retailers and pressure groups over their development and marketing of genetically modified crops and food. These companies claim that there is no evidence that these foods are unsafe. Also, genetically modified seeds could produce higher yields without the need for lots of environmentally damaging chemicals. However, aid agencies argue that poor distribution of food – and not any absolute shortage - is the main problem with feeding people in the Third World. Most small farmers cannot afford to buy the genetically modified seed package that includes expensive herbicides and synthetic fertilisers. They cannot compete with large farmers using these types of seed. Therefore, it could well be that these multinational companies will become a threat to food security world-wide (Jury 1998).

*Box 2.5 No other choice than leaving their land fallow*

In our study on socio-economic and gender aspects of sustainable land use we studied amongst others changes in land use patterns over the past twenty years in a village in Mahabubnagar District Andhra Pradesh, India. In this village we observed that 10 to 15 years ago the major part of the land which was owned by the village was cultivated with dry-land crops. Now, about 50 percent of the land lies fallow; about 30 percent is under a lift irrigation scheme; and about 20 percent is still cultivated with dry-land crops.
Why have these changes taken place? Why has so much land been left fallow? And who left it fallow? We found out that mainly the small and marginal farm households that had no access to irrigation left their land fallow. In these households, most men migrated for labour for 6 months or more each year. Women mostly stayed behind and they found it more and more difficult to produce something on their own land. Due to erratic rains and degradation of their land, dry-land had become a more and more risky enterprise. Returns to their labour were reduced and became more and more insecure. Moreover, women faced additional constraints: whereas the access of men farmers to agricultural extension, credit and inputs is limited, the women are completely cut off from these. Apart from the fact that agricultural extension tends to focus on irrigated agriculture with a high level of external inputs and not on dry-land agriculture with a low level of inputs. So many women had no choice but to leave their lands fallow and to become labourers on other people's irrigated farms (ICCO 1994).

This movement away from farming to other economic activities is referred to as 'structural economic transformation'. In some of the economically successful countries of Southeast Asia, the turning point has been reached and the number of people active in farming has started to decline. In poorer countries, the rural population is still growing and pressure on land continues to increase. In the West, where industrialisation and urbanisation is far more advanced, the number of people engaged in farming has fallen sharply in recent decades. In the Netherlands, for example, farmers account for less than 3 percent of the working population and their numbers are still decreasing. When the number of people engaged in farming declines, it becomes possible to increase farm size and this further enhances mechanisation and intensification.

### Global warming

Many factors are associated with global warming. These include urbanisation, the growth of fossil energy-based economic systems, deforestation, the tendency to cultivate extensive areas of land, the burning of tropical forests, the expansion of intensive paddy production and those practices that reduce the amount of organic matter in the soil. Although its impact is still not well understood, it has been suggested that global warming is destabilising and changing global climate. If this is the case it will have far reaching consequences for agriculture. Increases in carbon dioxide levels may mean slight increases in agricultural production. Rainfall patterns will change dramatically, with some regions receiving more and others far less than they do at present. The risk of floods, droughts and storms is increasing, as phenomena such as 'El Niño' illustrate. Global warming is expected to cause a significant rise in the sea level. This will have disastrous consequences for countries with densely populated coastal zones, such as Bangladesh and the Netherlands. Climate destabilisation in some regions will be more serious than in others. Where it results in less predictable conditions, farming will become more risk prone. Farmers confronted with such variability will have to adapt their farming practices and diversify their livelihood strategies. If this process is too slow, many farmers and their natural environment will be seriously affected.

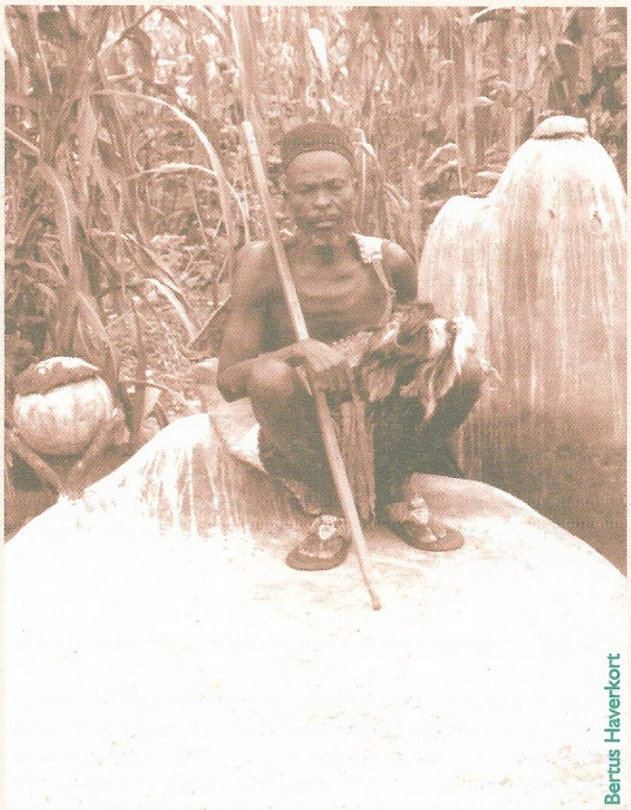
### Changing world visions

The processes we have referred to above have led to and been reinforced by changes in the world vision and values of those involved. This has had far reaching effects on the way agriculture is practised and on its sustainability. Indigenous economies were often based on the exchange of a wide variety of goods and services, and much of this exchange had a social and spiritual dimension (Vel 1994). In traditional world-views there is a strong integration of the spiritual, socio-economic and bio-physical (Box 2.6). This can be seen in an example drawn from the Philippines. The Mangyan of Mindoro see land as "a blessing and gift from God. It is sacred and constitutes the peoples' source of life. Land is the symbol of an identity rooted in history, it is an ancestral heritage and must be defended and preserved for future generations" (Nayahangan 1993).

Religious ceremonies, rituals and taboos ensure the security of the community. The spiritual world has a crucial function in regulating the farmers' relationships with nature and communal resources and hence the sustainability of the way land is used.

*Spread of a new dominant culture*

In this century, the consumer culture, created by a globalising market economy, has penetrated everywhere. Mass media and education systems, predominantly urban in focus, have affected world visions and values on an unprecedented scale. New expectations have been created and the market economy is presented as the way that these promises will be fulfilled. In this new culture nature is demystified and seen as a free resource. The economic and spiritual are separated and individualism, expressed in materialism, is encouraged at all levels. The pressure and temptation to be part of this culture is changing economic, social and cultural life all over the world. It intrudes deeply into the thinking of indigenous people and traditional farmers and affects the way they practise 'agri-culture'.



In Northern Ghana the earth priest or Tindana is an important factor in agricultural development.

**Box 2.6 Learning lessons about indigenous world visions**

In April 1996, the partners in COMPAS, a platform for intercultural dialogue on 'cosmovision' and 'agri-culture', came together in the Bolivian city of Cochabamba in the Andes. They exchanged experiences and documented cosmovisions and traditional agriculture. The partners confirmed that indigenous cultures, knowledge and cosmovisions are being eroded in all countries. At the same time, however, despite the apparent acceptance of other more dominant technologies, beliefs and values, a core of indigenous culture persisted beneath the surface and was rich in indigenous knowledge on natural resource use.

The COMPAS partners concluded that there are many similarities in the cosmovisions of indigenous farming communities and that they are based on holistic concepts. The reality in which farming takes place encompasses the physical world, the human world and the spiritual world. Mankind, the spiritual world and nature are seen as having a reciprocal relationship. If Nature is not treated well, she will react with plagues, droughts and bad harvests. If the spirits are respected, they will ensure that life is kind to all living creatures. People, therefore, look upon farming not only as an activity in the natural world, but also as an activity in the spiritual world. Many development activities and conventional systems of education and research neglect or reject the importance of cosmovision, culture and indigenous knowledge.

There is no reason to romanticise indigenous cosmovisions. They do not always have the answer to problems, and they cannot prevent ecological degradation or social friction. Nevertheless, for development organisations to be effective they should participate in the endogenous development of local communities. This means development from within a community's own cosmovision and indigenous land use system to a dialogue with the outside world (Haverkort & Hiemstra 1998).

A free market economy ensures that factory-produced commodities are readily available. The externalised costs of such production are hidden and large. They must be calculated in terms of the negative effects on the environment, social cohesion and indigenous, cultures. Although, in general, material prosperity is increasing, some 900 million people stay on the margin of economic development, on the move between rural and urban, traditional and modern, and local and global. In pursuing 'progress' they loose their past and their future (Norberg-Hodge 1996).

*Loss of indigenous knowledge*

Protagonists of modern market agriculture have little interest in understanding traditional 'agri-culture' and indigenous knowledge. Many development professionals and scientists have lost contact with the reality facing the majority of small farmers and have become estranged from any feeling of accountability for the ecological and cultural sustainability of agriculture.

In many places traditional 'agri-culture' has also lost its status with farmers and particularly with the younger generation. Indigenous knowledge is no longer transferred from the old to the young. Traditional 'agri-cultures', as knowledge systems built up over centuries, are dying away with the memories of the old. Holistic knowledge and wisdom that incorporates the spiritual world and binds it to the physical realities of everyday life is also passing away. Indigenous knowledge and local varieties and breeds are becoming part of this lost heritage. Ecological, genetic and cultural diversity are mutually dependent. In traditional agriculture this diversity is at the foundation of ecological sustainability.

*Loss of accountability*

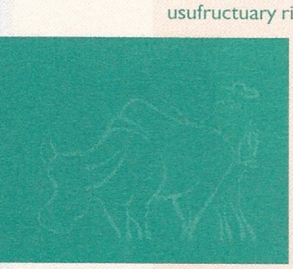
Traditionally, land management was a communal affair in the hands of the village, the clan council or the chief. They mediated its allocation and determined the way it should be used. In our century, collective land tenure has gradually been transferred to individuals and governments. Everywhere the State has tried to take over the management of natural resources and the way land is used by enacting land and forest legislation. Most administrations, however, have neither the physical

A wealth of indigenous knowledge reflected in a richly diverse Andean harvest capacity nor the logistical capability to assume the role of promoters and managers of environmental capital. Organisational structures, based on sectors and departments, block a holistic approach to environmental management. They also aggravate the vacuum created by the incapacity of governments to exercise control over natural resource management and the declining power of traditional village authorities (Leener and Perier 1989).

The erosion of customary traditions and laws has a particular consequence for the agrarian poor. When small farmers turn to cash cropping, natural resources assume a new economic value. Communal access to common pasture, water and firewood, for example, is transformed into access regulated by individual property rights. The rural poor become the major victims of this social stratification. The enclosure of the commons finds an extension in the increasing influence exerted on indigenous knowledge by international corporations and the way natural resources are used (Box 2.7). Short-term economic and political interests including corruption in and outside the civil administration are factors that frequently conflict with the conservation and just exploitation of natural resources.

*Box 2.7* *Enclosing the Commons*

Equity is built into usufruct rights since ownership is based on returns to labour. The poor have survived in India in spite of their lack of access to capital because they have had guaranteed access to the resource base needed for subsistence - common pastures, water, and bio-diversity. Sustainability and justice are built into usufructuary rights since there are physical limits on how much work one can do. Inequity is built into the concept of private property based on the ownership of capital since there is no limit to how much capital one can own, control and invest. Not only are juridical systems based on usufruct more equitable, they are also more sustainable because usufruct implies resources are held in trust for future generations. It is not possible, therefore, to exploit the rights of future generations for short-term profits. As the nation state developed, commons were enclosed and community power undermined. Water and forests became state property and alienated from communal ownership. For many the result of state enclosures and detachment from their resource base meant poverty, ecological destruction, inequity, social disintegration and political dis-empowerment. In the present era of "globalisation", the commons are being enclosed still further and the power of communities is being undermined by a corporate enclosure in which life itself becomes the private property of corporations (Shiva et al 1997).



In most rural communities there are inequities in gender relations, for example, in relation to property, decision making, work load, social roles, food habits, health, and marriage. The above macro processes often aggravate these inequities and undermine women's rights and responsibilities in agriculture. In marginal and degraded conditions, this contributes to the disruption of family and social life. Both households and village communities become crippled. Gender equity is a critical issue in resource conservation and regeneration, and sustainable agriculture.

The loss of trust in indigenous knowledge, the loss of indigenous rights and institutions, incorporation in the market economy and poverty mean that many farmers have lost control over the management of their natural resources. They are not consulted and they have little decision-making power. They can no longer be held accountable for ecologically sustainable land use.

### Farmer-led agricultural development

The above macro processes are changing the conditions in which agriculture takes place and have provoked responses from those farmers who actively want to improve their situation. As each case is unique in its combination of conditions, processes, actors and historical developments, farmers' responses vary widely (Raynaut 1998). These responses have both positive and negative effects on the economic, ecological and social performance of agriculture. They can also provoke new adaptations (Box 2.8)

Facilitators of agricultural development must take both macro processes and farmers' responses into account. Together they determine the direction of agricultural development. They also determine what interventions are needed and indicate whether it is feasible to guide agricultural development in a more sustainable direction. Technical adaptations alone may be inadequate to increase agricultural sustainability and may not be feasible because macro processes create situations unfavourable to development.

Agricultural sustainability depends to a large extent on those farmers, policy makers, educators, researchers, bankers, agri-business and consumers who are prepared to work concertedly to influence the direction of change in the interests of agricultural sustainability. A better and more participatory assessment of macro processes will help stimulate the momentum for change and the effectiveness of action.

*Box 2.8* *Agriculture in the Sahel: significant and varied change*

For many years, land use in the West African Sahel has been considered to be in permanent crisis. Recent research, including the West Africa Long Term Perspective Study (Cour 1998), requires that we adjust this view. Close observation of the facts demonstrates that the Sahel, far from stagnating, is undergoing profound changes. This is the direct result of population growth and the incorporation of the region into the world market, factors that have radically altered West African systems of agricultural production. Although production is still mainly for personal consumption, most farms are involved in some market production. The proportion of farm added value brought to the market has risen during the last thirty years from 20 percent to 40 percent of total output. Most of this is supplied to the regional market. With the exception of drought years, food production has almost kept pace with consumer demand despite rapid population growth and urban development.

Since the mid-sixties, both governments and development agencies in the Sahel have believed that agricultural change – and especially intensification – should be encouraged by massive investment in integrated projects, irrigation schemes, and 'new land' projects, implemented in the context of appropriate policies. Today, although the role of financial, technical knowlegde and policy is still accepted, the complexity of rural areas is being taken more into account. It is clear that farmers' behaviour and reasoning have often been underestimated. These need to be carefully examined in order to reveal what can and what cannot be done. The message has penetrated well at the local level, where the repeated failure of top-down action has led to a greater emphasis on 'local-level natural resource management. In this approach local people have a major role in designing and implementing the development operations that concern them. (See for example Laban 1994 for Gestion des Terroirs Villageois approach).

It is recognised now that human geography, the distribution and density of population, the emergence of markets that allow specialisation, diversification of crops and tasks, and indeed trends in world markets, are major determinants of long-term agricultural change. Past performance can only be assessed properly if it is seen against this shifting background. From this perspective, we can see that farming in the Sahel is indeed changing. In some areas and for some activities, we may even speak of a silent farm revolution (Cour 1998).

# 3. Is agricultural intensification ecologically sustainable?

World food supplies are under pressure. Accelerated population growth means urgent measures are needed to secure present production, ensure the effective distribution of foodstuffs and increase future supplies. However, sustainable agriculture depends on halting ecological degradation and improving the quality of the natural resource base. Food production can be increased by extending farm land, intensifying agricultural productivity, or by increasing the amount of food crops in relation to total agricultural production. Most land with agricultural potential, however, is in use and most subsistence and small, market-orientated farmers are already concentrating on food crops. Therefore, to increase security, it is necessary to intensify agricultural production. This chapter focuses on the ecologically sustainable intensification option available to subsistence and small, market-orientated farmers.

### Intensification in high input agriculture

HEIA strategies include applying synthetic fertilisers, using external nutrient inputs to increase soil fertility, spraying with pesticides and herbicides, and planting high yielding varieties. Mono-crop cultivation of high value crops, pump irrigation, motorised mechanisation, and extensive specialisation instead of diversification, are also typical of high input agriculture. In time, as we have seen in Chapter Two, HEIA strategies often create ecological problems that make further intensification difficult and cause declining yields. However, it might be possible to reduce problems and expense if external inputs were efficiently used or complemented by way of Integrated Pest Management or Integrated Nutrient Management.

HEIA is not always an appropriate option. Where farmers work in complex, diverse, risk-prone and often isolated conditions, HEIA technology is either unavailable or an unrealistic option. Moreover, the efficiency of synthetic fertilisers applied to land degraded by soil erosion and HEIA misuse has often been too low to be profitable. Subsistence farmers do not rely on expensive HEIA strategies but use their knowledge of indigenous intensification practices to ensure their harvests. Below, these indigenous and more recent integrated approaches are identified and their limitations and potentials explored in the context of agricultural intensification and local food security. Whilst some of these indigenous and integrated approaches may not necessarily be in line with LEISA concepts, they may well contain lessons that can be used in developing LEISA further.

### Indigenous intensification

Over the centuries, farmers have learned to increase production and secure their livelihoods first, by making better use of natural processes, and later by consciously managing these processes. In many communities this has meant a shift from extensive practices to those that conserve labour, land and natural resources and are knowledge intensive. One common example is the shift from burning fallow vegetation to systems that seek to reproduce soil fertility by fallow intensification using legumes and agroforestry, and by facilitating nutrient transfer through livestock integration and the recycling and composting of organic waste (Netting 1993).

Subsistence farmers are obliged to adopt an approach that maximises the variety of goods they produce for their recurrent household needs. This is an important agricultural objective and one reason why they are able to maintain a relatively high degree of self-sufficiency. Multi-use strategies allow farmers to manage different geographical units of varied biotic and physical components. In contrast to current rural modernisation initiatives, farmers traditionally avoided specialisation in productive activities, space and time.

Agriculture makes demands on the environment. If this pressure is not managed well and farmers do not allow nature time to recover or are unable to afford the inputs necessary to complement the process of regeneration, there will be ecological degradation. In subsistence systems, fallowing is an example of how farmers have learned to move beyond taking from nature to using natural processes to manage it. Subsistence farmers combine knowledge-intensive practices with resource conservation and are often highly skilled in making optimal use of natural processes and ecological diversity (Box 3.1 and Box 3.3).


The potential of indigenous fallow management is being recognised.

Boserup's hypothesis that these indigenous intensification measures raise the productivity of land and maintain production has been confirmed by many authors (Boserup 1965; Ruttan and Hayami, 1984; Tiffen et al 1994 (a); Meertens et al 1995; Netting 1993; Mortimore 1993; Mortimore and Turner 1993; Turner et al 1993; Fairhead & Leach 1996; Harris 1995; Wiggens 1995; Jiggens et al 1996). Their studies show that indigenous intensification strategies that make little use of modern inputs are still widely used and are effective in sustaining production and protecting the natural resource base. The case of Machakos (Part 3) provides an example and shows the socio-economic conditions under which indigenous intensification can take place. In Part Three of this book other case studies from Burkino Faso and Central America illustrate how indigenous intensification processes based on indigenous knowledge of low-external-input technologies work in practice and can be used in the development of LEISA.

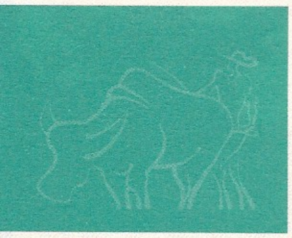
Indigenous intensification, however, can also mean that farmers have to work longer and harder while yield increases become smaller and smaller (Boserup 1965). Although this is not always the case, it shows the critical role labour plays in intensification. Techniques that make heavy demands on labour, such as composting, may only be suitable in intensive agriculture and appropriate mechanisation may be needed if resource conserving techniques, such as cover crops (Box 5.1) are to be incorporated into existing farming systems.

Many authors warn that there are signs that an increasing number of small farmers, despite their efforts, are becoming caught in a vicious circle of poverty and ecological degradation and enter a cycle of low input - low yield - low income from which it is difficult to escape without external investments. It is important to understand why farmers become entangled in this downward spiral and why they do not or cannot invest in ecologically sustainable intensification.

Agricultural intensification is a complex process. Over time, technical innovations have been complemented by the evolution of supportive social institutions. Geertz (1963), in his study of 400 years of paddy rice culture in Indonesia, found that as the system developed from less intensive modes of agriculture, productivity was increased by building dikes, terraces and irrigation canals. Weeds and nutrients were managed and, as irrigation technology developed, institutions appropriate to common property and collective action emerged. Collective decision-making and resource management was established because the maintenance of irrigation work and securing food production depended on the co-operation of all participants. Technical and institutional evolution could only take place if it was in harmony with a cultural evolution that reflected world vision, spirituality and indigenous knowledge (Gadgil and Guha 1992) and if farmers were aware of the need and possibility for investing in intensified land use. Many factors can impede the complex process of co-evolution.


Traditional intensive farming systems are ecologically and socially complex.

Historical routes taken in intensifying land use are shaped by many variables and each is unique. Recent studies on indigenous intensification by Fairhead and Leach (1996) in Guinea Conakry (Box 3.1) by the members of the Network on Indigenous Fallow Management in Southeast Asia initiated by ICRAF (Cairns 1997), and by scientists from CATIE/IFPRI/World Bank (Scherr and Current 1997), have come to important conclusions on the potential of (indigenous) agro-forestry strategies for intensification and the way such strategies are often 'misread' by scientists. Strategies that build on natural processes of succession, recycling, nutrient pumping, nitrogen fixation, phosphate mobilisation and ecological diversity (Box 3.3) can, for example, be used to replace more extensive 'slash and burn systems' and to regenerate degraded land wasted by mono-cropping and agro-chemicals. More research is needed to document and better understand indigenous intensification strategies and the way they fit into different and changing ecological, demographic, economic and cultural conditions.



## Intensification using integrated approaches

Recent integrated approaches to reduce agriculture inputs are attracting more interest. They not only have the potential to cut costs and increase production but can improve the natural environment as well. Integrated Pest Management, Integrated Nutrient Management, minimum- or no-tillage systems, the use of water-saving techniques in irrigation and new approaches to soil and water conservation have been successful and are widely accepted. These approaches are frequently combined because they are of mutual benefit to each other. IPM is now evolving into integrated crop management (ICM) where INM is also an important element. IPM and INM provide important strategy components for the development of LEISA and are examined in more detail below.

### *Integrated Pest Management*

Integrated Pest Management began in the 1970s in an attempt to counter the damage inflicted by synthetic pesticides. Today, IPM is practised in more than 50,000 communities throughout the world. There are over 30,000 competent IPM trainers, many of whom are small farmers. Agriculturalists using IPM have shown they can increase their seasonal profits by as much as 30 percent, raise yields per hectare from 1 percent to over 10 percent and reduce the amount (and cost) of the synthetic pesticide used by between 30 percent and 95 percent. Most of the communities practising IPM grow rice, but IPM is also used by farmers growing maize, soybean, cabbage, tomato, groundnut, coconut, cacao, coffee, peppers, sweet potato, cotton, mango and cucumber (Kenmore 1997).

There were two important stages in the development of IPM. First generation IPM projects focused on reducing the amounts of insecticide used. The idea of an economic threshold was introduced and above this it was considered justified to apply pesticides. Pest control methods were also combined and key pests were attacked using strategies that included biological control, host plant resistance, cultural control, and selective chemical control. The approach was a curative one and focused on pesticide reduction. However, IPM packages based on developments in research stations and under controlled field conditions were often rejected at farm level because the pest control technologies they contained did not meet farmers needs (Pimbert 1993).

Second generation IPM projects targeted more pests and included diseases and weeds. They addressed farmers' crop protection problems more generally. It was realised that some agricultural practices encouraged pest development and that crop intensification by HEIA strategies often did so as well. Control measures that fitted into overall crop and farm management were designed and IPM evolved into Integrated Crop Protection (Box 3.2). The emphasis shifted to preventing pest outbreaks by using such self-sustaining methods as functional bio-diversity, biological control and the conservation of natural predators. Indigenous knowledge and traditional cropping practices were studied, adapted and incorporated in the development of IPM programmes.

**Box 3.1** *Indigenous agroforestry strategies: potential for intensification*

Kissidougou in Guinea Conakry exemplifies the patchy, mosaic landscape of West Africa's forest savannah transition zone, with its striking contrast between the dense, semi-deciduous forest 'islands' encircling the villages and the savannah. It has been possible to document the course of vegetation change during this century with reasonable certainty using oral evidence and archives for the earlier periods. While there have been changes in the quality of the tropical semi-deciduous forest vegetation surrounding Kissidougou's villages, it cannot be argued that forest patches have become smaller in the course of this century. On the contrary, the area of forest cover around villages, the area of secondary forest fallow relative to savannah, and the density of tree cover in the savannahs all appear to have increased since the turn of the century. Strikingly, during this same period, colonial, national and modern ecologists and policy-makers have considered Kissidougou's forest to be disappearing rapidly because of destructive local resource management. Reading forest history backwards, repressive laws were created to 'reverse' this trend, thus restricting rather than enabling the local practices that were actually enhancing forest cover.

In this region, ecological processes involving air and water (climate), soil and fire make conditions marginal for forests, often leaving a precarious balance between forest regeneration and pyrogenic savannah. The Kissidougou case suggests that people's manipulation of these processes can tip the balance and that villagers are highly aware of, and able actively to direct ecological processes to promote a greater proportion of forest vegetation in the landscape when they have reasons for doing so. Forest savannah dynamics prove to be closely linked to social dynamics as villagers adjust their agro-ecological management techniques to changing conditions. Thus forest patches, often owing their existence to local management and the social use of landscape,, come and go in relation to shifting use and settlement patterns (Leach and Fairhead 1994; ILEIA Newsletter 12 (3) 1996, pp 6-8).

The natural and social sciences are coming closer together. Experience has shown that fixed prescriptions cannot solve agricultural problems especially those confronting subsistence and small farmers who must seek solutions in more site-specific, agro-ecological, and socio-economic approaches. In dealing with the problems of pests, weeds and plant disease, farmers must be able to choose from a basket of technologies. Existing extension systems such as 'Training and Visit', that depend on transferring technology, are too inflexible. In recent years, a growing sensitivity to farmers' own knowledge has made a reversal of roles and locations possible and today researchers and extension workers are realising the value of learning with and from farmers in farmers' fields. In IPM, the choices farmers' make, their analysis and their experiments are receiving more support from researchers and extensionists. In this way, the detailed, intimate knowledge that farmers have of their local agro-ecologies can be usefully combined with more general, scientific knowledge.

A more dynamic extension model - the Farmer Field School (FFS) - has been developed in recent years (FAO 1996). FFSs combine training with field-based, location-specific research to give farmers the skills, knowledge and confidence they need to make ecologically sound and cost-effective decisions on crop health. Participatory learning and experimentation are combined with the transfer of technology (TOT) training and extension methods (see Part 3, Fliert). The relevance of second generation IPM projects goes, therefore, far beyond crop protection.


FFS training in the Eco-lab, Zimbabwe Institute of Permaculture.

### *Integrated Nutrient Management*

The basic concept underlying Integrated Nutrient Management is the potential for maintaining and increasing soil fertility by optimising the use of all available sources of organic and inorganic plant nutrients. INM is implemented in an integrated and ecologically sound way that is appropriate to the specific economic, ecological and social production conditions of each farming system (Roy 1991). The focus here is the farming system rather than the crop. The conditions for sustainable agriculture are defined as balanced nutrient and carbon flows in and out of fields and farms, and ensuring that soil life functions optimally.

INM can reduce dependency on synthetic fertilisers and minimise the loss of nutrients to the wider environment. INM can increase the effectiveness of synthetic fertilisers and raise yield and income levels. In this approach, synthetic fertilisers can be replaced by organic fertilisers to some extent. Using effective INM strategies, it is possible to increase the profitability of synthetic fertiliser use and bring it within the reach of subsistence farmers. It may then be possible for them to make a more sustainable switch to market-orientated agriculture. Several factors, however, influence this process including the availability and cost of labour, mechanisation and the relative costs and benefits of external synthetic and organic nutrients. Each farming situation demands a unique combination of soil fertility management techniques.

Soil fertility management is an integral part of farm management. The efficiency of fertiliser use depends on the type and combination of fertilisers applied, the way they are handled, and soil, water, crop, animal and pest management practices (Girt et al 1998). INM does not simply involve using organic fertilisers as substitutes for synthetic fertilisers. INM should be based on ecological concepts (Woomer and Swift 1994). There is still a great deal to be learnt about the impact of synthetic fertiliser on soil function and how this type of fertiliser can best be combined with other soil management practices.

*Box 3.2 IPM in Indonesia*

**Between 1977 and 1987, Indonesia's rice crops were threatened by three outbreaks of Brown Plant Hopper. As a result, in 1986, a presidential decree banned 57 brands of rice pesticides and established a national IPM programme. Subsidies for remaining pesticides were abolished. Between 1987 and 1997, there have been no national outbreaks of Brown Plant Hopper. A survey of 2000 Farmer Field School graduates carried out in Indonesia in 1993 found that rice yields had increased by an average of 0.5 ton per hectare and the number of pesticide applications had fallen from 2.9 to 1.1 per season. The cost of pesticide application had been reduced by more than half. Eliminating pesticide subsidies has saved the Indonesian government more than US$1 billion in the past ten years. Participatory IPM has significantly reduced farmer and public health hazards in rural areas. Rice fields under IPM are being re-colonised by plant and animal species previously suppressed by pesticide use. Last but not least, the impact on farmer self-confidence and self-reliance has been very significant and has encouraged farmers to continue taking an active part in IPM groups (Fliert 1993).**

### *On the way to integrated farming*

The integrated approaches referred to above initially focused on how external inputs could be used to the best effect within farming systems that, nevertheless, remained essentially unchanged in structure and function. Today, these approaches make better use of ecological concepts to optimise the way farming systems function. The movement towards integrated farm and landscape management comes closer to more radical ecological approaches such as organic agriculture, permaculture (Mollison 1988), natural farming (Fukuoka 1978) and agro-ecology (Altieri 1987; Gliessman 1998) which optimise reliance on internal resources and the management of ecological and biological processes and interactions. However, integrated approaches such as IPM and INM cannot yet be assimilated into these ecological approaches, neither are they necessarily in line with LEISA concepts and approaches as the latter combines economic and ecological objectives with social objectives of social justice and equity.

In general, proponents of HEIA do not consider that these radical approaches have much to do with the reality of everyday farming. They are seen as unprofitable and only appropriate where farmers have access to adequate organic inputs. However, as the price of external inputs rise and ecological degradation threatens yields and incomes, farmers, scientists and governments become more ready to investigate integrated approaches. This may open the way to dialogue, mutual learning and co-operation between conventional and alternative farmers and ultimately lead to the transformation of mono-cultures into more diversified and integrated farming systems able to function well economically, socially and ecologically. Agro-ecology should be very helpful in this conversion process.

## Agro-ecology in LEISA

Agricultural science has ignored the complex ecological functions and processes involved in agricultural production for too long. Little account was taken of the negative effects agriculture can have on the natural environment. Recently, a more holistic approach to agricultural science has developed. This approach, known as agro-ecology, is defined as the application of ecological concepts and principles to the design and management of sustainable agro-ecosystems that are both environmentally sound and productive (Gliessman 1998). It is an approach that builds on modern ecological science and farmers' knowledge and it can be considered as the scientific basis for LEISA. Agro-ecology involves:

- adapting agriculture to the specific local environment by site specific soil fertility, water, and pest management and the use of site-specific genetic resources, crops, animals and perennials, that make optimal use of locally available natural and human resources;
- securing favourable soil conditions for plant growth by enhancing soil life through the management of vegetation and organic matter;
- optimising nutrient availability, balancing nutrient flow and optimising the recycling of nutrients through the management of organic matter in the soil, nutrient pumping, nitrogen fixation, effective micro-organisms, soil macro fauna and the complementary use of external, natural or synthetic fertilisers;
- minimising losses due to flows of solar radiation, air and water by way of micro-climate management, water management and the control of soil erosion.
- minimising losses due to plant and animal pests and diseases by enhancing the self-regulating capacity of the system and safe treatment;
- exploiting complementarity and synergy in the use of genetic resources by combining integrated systems with a high degree of functional diversity;
- developing strategies that induce minimal changes in the natural ecosystem to protect the environment and minimise the use of fossil energy driven technologies in manipulating the agro-ecosystem (Pimentel et al 1989; Reijntjes et al 1992; Altieri 1995).

These guidelines can be applied to a wide variety of techniques and strategies of traditional, ecological and conventional origins that vary both in effectiveness and strategic value. When external inputs are expensive, subsistence farmers should be able to draw on strategies and techniques that make optimal use of local natural resources. When farmers are engaged in market-oriented agriculture, the high opportunity costs of land and labour may make it necessary to rely on the complementary use of synthetic fertilisers.

Well-functioning, indigenous agriculture is a rich source of knowledge for those wishing to practice agro-ecology (Box 3.3). When the ecological features of indigenous agriculture are better understood, it will be possible to obtain important information useful in developing appropriate agricultural strategies tailored to the needs of specific agro-ecosystems (Altieri 1995). Such information might include the production efficiencies of symbiotic crop mixtures, recycling of organic matter, the reliance on local resources and germ plasma, and the exploitation of micro-environments. The science of agro-ecology can provide insights into the ecological basis of traditional practices and contribute to the improvement of modern farming strategies. Integrated agriculture (IPM, INM) and organic agriculture have already benefited from these developments.

Leguminous crops are essential to INM.

### Limits of ecologically sustainable intensification?

From the experiences discussed in this chapter, it can be concluded that both in subsistence and market agriculture there is the potential for increasing yield while, at the same time, improving the ecological sustainability of farming. But what are the limits of such intensification?

**Box 3.3** *Succession farming lessens the need for external inputs*

In nature, plant associations succeed one another in a dynamic, on-going process called natural species succession. Destroyed, depleted or leached-out sites are colonised by pioneer species. These pioneers are succeeded by secondary forest species to be succeeded in turn by primary species. By learning from nature, traditional farmers have developed ingenious agricultural systems that make use of the dynamics of species succession. The traditional coffee-cultivation system used in some parts of Central America and Columbia provides a good example of how indigenous farmers make use of species succession.

In the canopy of this type of agro-forest, there are deeply rooted trees that normally lose their leaves about the time the coffee is harvested and which then remain leafless for two or three months. Underneath these trees, there are dense stands of Inga sp. and Erythrina. Every year, at the end of the coffee harvest, these fast growing trees are pruned. At the same time, the banana plants, cultivated between the coffee trees, are also cut back until only the young shoots are left. Coffee trees and fruit trees, such as citrus and palm that are integral to the system, are also pruned. This organic material is finely cut and evenly spread. Six weeks later, the whole system bursts out in new growth, culminating in the prolific flowering of coffee and fruit trees. Regular and high yields of coffee and fruit are obtained over many years in this multiple-crop system without the use of external fertilisers and even steep hillsides show little trace of erosion. Diseases and weeds are not a problem and control is unnecessary.

An important characteristic of this cultivation system is that the deep rooting canopy trees of the local primary forest are used in combination with fast-growing trees. An additional factor that contributes to the success of the system is the refined employment of synergetic potentials achieved by a congenial plant consortium. Coffee and citrus grow more vigorously when cultivated in consortium with banana, and banana is less vulnerable to diseases such as sigatoka or panama disease when cultivated in consortium with citrus. Coffee and citrus need abundant light if they are to flower well. When the fruit is maturing, shade is needed to deter pests and improve the quality and size of the fruit.

Today, this traditional system has nearly disappeared, although the advantages of 'coffee-under-shade' have been rediscovered recently by modern science. Some crucial elements, however, have been neglected including the introduction of different crop species and their allopathic interactions. Static amounts of shade are provided for the de facto mono-culture of coffee. This means that in the modern 'coffee-under-shade' system, large amounts of synthetic fertilisers, pesticides and herbicides are still needed if reasonable results are to be obtained.

Gotsch writes that, on his own farm, he successfully uses pioneers to recover soils in the initial phases of new agro-forestry plantations. At a later stage, he uses the dynamics of natural species succession to ensure the health and vigour of the crops and trees being cultivated. If farmers were to use these natural processes, extensive tracks of degraded land could be brought into use again and fewer agro-chemicals would be needed (Gotsch 1995).

Ecologically sustainable intensification, just like HEIA intensification, requires investments of time, money and labour. Small farmers are willing to invest in intensification if they are convinced it is necessary, are certain of the benefits and have access to and control over resources. To engage in intensification, farmers need the knowledge and skill to experiment in adapting land use to changing conditions and needs. Information on effective and ecologically sustainable strategies and technologies suitable for use in specific local situations must be available. Strong local leaders and institutions with the authority to claim and defend the rights of farmers and capable of approving and stimulating innovation are able to create an environment conducive to investments. The availability of infrastructure and favourable policies are also important prerequisites (Scherr and Hazell 1994; Batterbury 1996; Kessler and Laban 1994; Kieft and Laban 1995).


*Socio-economic preconditions of accountability for sustainable land use at the farm-household level (Laban 1994)*

Where these conditions prevail, intensification often takes place as a more or less autonomous process. However, ecologically sustainable intensification often has to compete with ecologically un-sustainable intensification and economic activities that contribute to ecological degradation. There can be serious social and economic limitations to ecologically sustainable intensification. For example, farmers may be less prepared to invest in ecologically sustainable intensification if it involves too much work or competes with current resource use (see Box 3.5). They will also not take this step if it is not socially accepted or if HEIA intensification strategies, labour migration, handicrafts, or education seem to offer a more reliable and faster way of obtaining cash. Having to increase labour productivity may force farmers to use such HEIA strategies as synthetic fertilisers, specialisation and mechanisation.

*Box 3.4 Women and the soil competing for the same resources*

In Yemen women tend the cattle and sell cattle produce. This provides them with an important source of revenue. Crop residues of the locally grown intercrop of cereal and legumes are an important and cheap form of cattle feed. In addition, the manure is processed by women into "dung cakes" because there is a shortage of fuel. These are used as fuel in the kitchen or sold. The use of organic fertilisers and crop residues to fertilise the soil would mean that women would loose an important resource (DHV 1990).

There is also an ecological limit to intensification. Normally, either for economic or ecological reasons, intensification will stagnate at a level below this limit. However, if farmers take too much from the land and fail to use technologies appropriate to the intensity with which land is being used, ecological degradation will take place even if the ecological limit has not been reached. Rehabilitating ecologically degraded HEIA or LEIA systems and creating productive and ecologically sustainable LEISA systems may well require heavy investments of time, money and labour. To understand the limits and possibilities for intensification, there must be a broad participatory, socio-economic and environmental assessment of the situation, including an analysis of gender relations. (See Chapter Five)

*Box 3.5 Farmers list eco-farming 'musts'*

In 1989-90 ETC's Agriculture, Man and Ecology (AME) Programme in Pondicherry, India studied the transition experiences of 12 ecological farmers in South India (van der Werf). These farmers worked in semi-arid conditions with an average annual rainfall of about 600mm. The farmers' listed the following essential points.

- The amount of organic matter in the soil must be increased in order to reduce dependence on synthetic fertilisers. This can be achieved by cultivating nitrogen fixing fodder crops and green manure and by increasing livestock numbers so supplies of manure are increased.
- Soil tillage should be minimised and where possible replaced by mulching, cover crops, inter-cropping, and the inclusion of trees in the fields.
- Weeds can be used as (living) mulch to prevent the evaporation of soil moisture and can also be used in preparing compost.
- A variety of selected trees should be planted to provide cattle fodder, improve the soil, supply green manure and serve as wind breaks.
- Drought resistant species are preferable to annual crops and trees.
- Erosion control by contour bunding and soil cover is essential.

A transitional phase is necessary when the change is being made from unsustainable HEIA or LEIA practices to LEISA. During this investment period, the farm and the agro-ecosystem has to recover its ecological balance in order to function optimally in an ecological and economic sense. This transition period may last longer in areas of low agro-ecological potential than in area of high potential. To overcome an often unavoidable dip in production or income during the transition phase, specific strategies are necessary (Van der Werf and de Zeeuw 1992; Kieft and Laban 1994; Kessler and Moolhuijzen 1994). These transitional strategies must be appropriate for local conditions, processes, needs, resources, and the way land is being used locally. Using models that have been successful elsewhere often does not work because they fail to reflect local realities. Nevertheless, certain location specific agro-ecological guidelines for transition can be identified (Box 3.5).

Key strategies are often needed in the short term to increase income from production, to prevent the common dip in income that sometimes occurs during the transitional phase and to ensure that there is an improvement in the ecological functioning of the system. Therefore, it is important to increase bio-mass in and above the soil and ensure that water is available. This can be done by creating vegetative bunds that can be used in combination with green manures/cover crops (Part Three, Bunch) or by using grass mulches in combination with compost enriched planting holes (Part Three, Hien). To speed up the process of rehabilitation, external nutrient inputs are often needed, especially where soils are poor (Breman 1990). Small farmers will only be able to afford investments of labour and cash if additional sources of income (Box 3.4), appropriate mechanisation (Box 4.1) or cheap loans and subsidies are available. When making the transition to LEISA and embarking on intensification, small farmers often spread the investments involved over several years so they can meet their incosts and avoid a dip in income.

During the process of participatory learning, planning and action for LEISA (Chapter Five) farmers can design and experiment using strategies they have developed themselves and which they feel are appropriate to the conditions they experience on their own farms (Chapter Two). Such participatory processes promote empowerment and accountability. The processes of rehabilitation, transition or further intensification can evolve gradually depending on what resources farmers have available. As the experiences of many development organisations show, strategies that support the transition to more intensive and sustainable land use and the empowerment of resource-poor farmers in developing countries go well beyond technology development and may include institutional building, market development and advocacy to secure a conducive policy and economic environment (Laban 1995; Kieft and Laban 1995).

Sustainable agriculture is knowledge intensive and the provision and exchange of information is of particular importance. In order to understand the opportunities and limits for ecologically sustainable intensification and rehabilitation and the way they are influenced by the macro processes discussed earlier, there is an urgent need for further documentation, systematisation and analysis. In Chapter Four, we will examine a number of LEISA approaches that may contribute to developing agricultural intensification strategies that are sustainable in economic, ecological and cultural terms.


What does contour farming need to be successful?

## 4. Different expressions of LEISA

The macro processes discussed in Chapter Two have changed the conditions in which agriculturists operate and forced them to make adaptations. Over the years the ILEIA Newsletter has provided a glimpse of the way farmers, sometimes in co-operation with development organisations and research institutes, have tried to improve their livelihood and farming systems. However, although many of these adaptations involve approaches towards LEISA, there has been little analysis of these developments in respect to their contribution to sustainability.

In 1995, Pretty presented data on successful examples of regenerated and rehabilitated agriculture in both the west and the tropics. Amongst the examples in the tropics were successful initiatives in both HEIA and LEIA_conditions. Most cases involved large numbers of farmers and describe important steps in the transition process towards LEISA and the intensification of agriculture. Pretty concluded that transition to more resource conserving agriculture leads to:

- stabilised or lower yields in industrialised countries, coupled with substantial environmental improvements;
- stabilised or slightly higher yields in HEIA conditions with environmental benefits;
- substantially increases in yields in LEIA conditions.

Various strategies and approaches are being followed to develop LEISA. These reflect the history of the farming communities concerned, their market or subsistence orientation, the opportunities available, and the needs, objectives, and preferences of farmers. To secure a sustainable agricultural future, LEISA is, in our view, necessary. However, LEISA is not a blueprint and will find multiple expressions in different socio-economic and ecological settings. Schematically, and accepting that this is not a complete overview, the following trends of LEISA can be identified. It should be

*Box 3.6* *Transition to organic contour farming*

Alayon sa Banika (ALAB), a Filipino farmers' co-operative, has been experimenting over the years with organic contour farming. During the 1970s, farmers adopted almost every aspect of the Green Revolution package. By the early 1980s, their harvests were declining rapidly and their expenses were increasing. They started to look for alternatives. They visited farmers who had adopted contour farming. Most 'contour' farmers used napier grass (*Pennisetum purpureum*) and ipil-ipil (*Leucaena diversifolia*) for contour hedgerows. The grasses and ipil-ipil were used to feed livestock and the dung from these animals was then used as fertiliser. Some 'contour' farmers also made compost. When the visitors returned home, they began to experiment to find a transition strategy that would suit them. Today, there are several hundred farmers supported by ALAB practising contour farming. Most of these farmers have between 0.5 and 0.75 hectares of hilly land with slopes of between 30 to 45 degree. They grow three crops: maize inter-cropped with beans, a vegetable cash crop, and, in the last season, maize.

Farmers found that 740 person days are needed to establish a one hectare contour farm. Provided weather conditions are favourable, contour hedgerows take about three months to develop. During this period, farmers have to check contour lines and repair any damage they find immediately. At the same time they have to fertilise them with compost and additional synthetic fertiliser (14-14-14). This work takes up about two person days a week. Once the farm is established, one person day every two weeks is enough for maintenance. Hedges are lopped every six weeks, a task that takes about 64 days each year. Organic farmers, in contrast to those who use synthetic fertilisers, also have the additional task of hauling the twenty 50 kilogram bags of chicken droppings and manure they need to fertilise one crop. The equivalent quantity of synthetic fertiliser would be six 50 kilogram bags. This means four days extra work each cropping season. However, the organic farmer no longer has to buy and spray synthetic pesticides. This represents a saving of three person days per maize crop when highly resistant traditional varieties are used. Vegetables require one spraying of home made herbal pesticides a week. Eventually, a new insect balance develops making spraying largely unnecessary. During the first two years, an extra six person days a year are needed to prepare the herbal spray.

Organic farming involves more weeding. When mulch is applied to vegetable plots (coconut and banana leaves), however, this task can be reduced by as much as 75 percent. Mulch on contour hedges decays too fast and means almost no reduction in labour. Harvesting also takes more time on a contour farm because the contours must not be damaged.

The extra labour demanded by contour farming is 230 to 270 person days per hectare per year. After the first two to three years this decreases to 120 to 160 days per year. Using the same amount of labour, a family can obtain a similar amount of cash income from a one-hectare organic contour farm as from a farm family that uses chemical inputs. When farmers use chemicals they must pay for them and this means money has to be earned somehow. An organic contour farm achieves higher net cash profits per hectare and the need to borrow money, which has ruined so many farmers dependent on chemical inputs, is less.

Although farmers have generally accepted the system of organic contour farming, only a few have implemented it fully. The main complaint is that it is too labour intensive, particularly in the first few years. Those farmers who take up organic contour farming are either very young and have no family to support, or are older couples whose children have left home. Farmers with children at home cannot afford the initial reduction in farm income. ALAB is now looking for effective strategies to raise income during the first difficult years (Remonde, Villamore and Simonides 1992).

recognised in many cases that it is only possible to speak about trends towards LEISA and that, in these cases, some of the criteria that define LEISA have not yet been met. In many instances ecological, economic and social dimensions may be contradicted and therefore balances need to be found in matching them as far as possible.

### LEISA in subsistence-oriented agriculture

The increasing cost of fossil energy based technology and the weak competitive position of marginal areas mean that subsistence farmers have little chance of taking part in the market economy. Where subsistence farmers do not succeed in intensifying agriculture, ecological degradation and poverty are widespread.

Many subsistence farmers, however, succeed in intensifying agriculture using indigenous strategies (Chapter Three). Heavily dependent on the use of local resources and natural processes, they employ practices that fit in with the local economy and build on indigenous knowledge, social relations and experience. Depending on local conditions and the degree of intensification (extensification), a wide variety of indigenous strategies are used. These include integrating crops and livestock, improved fallow management, the recycling of organic waste, green manure, cover crops and mulches, soil and water conservation, natural and preventive ways of pest management, natural animal health care, and the conservation and introduction of improved indigenous genetic resources adapted to the local situation.

Minimising nutrient loss by finding an economically and ecologically satisfactory balance between subsistence and market production, is a crucial issue in LEISA subsistence agriculture. Generating income from off-farm activities is often an important way of providing farm households with the necessary cash income. In LEISA agriculture, diversifying and integrating crops, trees and animals not only ensures that basic needs are met and help optimise productivity, it also helps prevent the loss of scarce nutrients and gives the agricultural system a chance to regenerate. Maintaining or increasing bio-diversity and bio-mass is another important element in LEISA strategies (Box 4.1).

*Box 4.1. Bio-diversity, the basis for sustainable subsistence agriculture*

Those associated with the Navdanya agricultural bio-diversity conservation initiative are mainly farmers who have kept the option of cultivating diversity. They are marginal farmers and peasants in mountainous or drought prone ecosystems. Here, Green Revolution mono-cultures have not yet displaced local diversity. Many farmers chose bio-diversity conservation because of the high costs involved in shifting to intensive agriculture, others because they had been unsuccessful with Green Revolution technologies. For each of these farmers the choice became a political statement - a symbol of their struggle for self-reliance and independent control over their lives. (Shiva et al 1995).

For many farmers in India, indigenous bio-diversity is a symbol of their struggle for self-reliance.

Where population growth and urbanisation are increasing the demand for agricultural products, and marketing costs and the price of external inputs are favourable, it becomes profitable to use synthetic fertilisers and pesticides in the transition from subsistence to market production. In these conditions, NGO and GO programmes that support the development of market agriculture and the use of synthetic fertilisers and pesticides in an INM and IPM perspective are relatively successful. However, if farmers then fail to earn enough income or are unable to return sufficient nutrients to their fields and there are no subsidies to support them, they will either have to operate in the niche market of organic agriculture, return to subsistence production, or look for an income elsewhere.

LEISA has often been identified as an approach that can make LEIA more sustainable in areas of low agricultural potential. However, LEISA has also potential in areas where conditions are more favourable.

### LEISA in market-oriented agriculture

In areas with high potential for agriculture and where urban markets are close at hand many farmers have adopted HEIA intensification strategies. Increasing needs, costs and (international) competition force farmers to increase production and keep costs down. As we have seen earlier, there are many factors that encourage the adoption of HEIA, including market liberalisation and globalisation, population growth, urbanisation, and the stimulus of an international consumer culture.

In a bid to maintain the production of marketable surpluses, farmers are turning to the more integrated approaches of INM, IPM, agro-forestry, watershed management, and soil and water conservation (Chapter Three). The case of Santa Catharina in Southern Brazil illustrates how the introduction of cover crops and appropriate mechanisation has helped conserve soil and water and has resulted in increases in both production and income for local farmers (Box 4.2).

*Box 4.2 Cover crops, a really green revolution*

In Santa Catharina state in southern Brazil, soils are highly susceptible to erosion. Intensive soil movement through ploughing and harrowing has led to the extensive degradation of natural resources. The use of agro-chemicals has worsened the situation. However, increases in the price of oil and fertilisers and the withdrawal of government intervention put farmers' income at risk. Together with Agricultural Research and Extension workers they began to look for soil management strategies that would protect the soil, minimise dependence on external factors and enhance the use of local resources.

Farmers were encouraged to experiment with several green manure cover crop species. These were used more frequently and were adapted to different production systems. A recent survey carried out by EPAGRI, the NGO involved in this conversion process, shows that more than 300,000 hectares are being cultivated with some kind of green manure crop and that 100,000 farmers are involved. Most farmers incorporated green manure and crop residues into the soil using animal or mechanically driven ploughs. At present, more than 120,000 hectares are being cultivated under minimum- and no-tillage systems. Minimum- and no-tillage was first adopted in maize and tobacco cultivation after machines and equipment had been adapted. During the last four or five years, experience has shown that the use of herbicide can be significantly reduced. The system promotes effective erosion control, provides a continuous supply of fresh organic matter for the soil, and means that less labour is needed in the planting season. Increased soil fertility reduces the amount of nitrogen fertiliser required. Valdemar Hercilio de Freitas 1995.

Many NGO and GO programmes now support small farmers in developing low cost LEISA inspired technologies capable of enhancing their market position. These include making mulches from crop residues, preparing compost from manure or recycled waste, green manure, bio-fertilisers, soil and water harvesting, bio-pesticides and agro-forestry. Traditional varieties are sometimes improved and reintroduced because it is assumed that they are better adapted to local ecological conditions and are more resistant to pests and disease. Attempts are being made to improve ecological stability and overall productivity whilst reducing risks and making more efficient use of inputs. These efforts involve improving the integration of crops, soil, water, trees, animals and other components of a farm system to achieve higher synergy.

### LEISA and organic farming

Many farmers have started to experiment with organic agriculture in the belief that HEIA is unsustainable. In Shimoga, Kerala, for example, 5000 farmers have founded the Krishi Prayoga Pariwa. Drawing on traditional practices and culture, they intend to recreate and develop organic agriculture. As international demand for organic products continues to grow, market opportunities are being created for this type of farmer (Lampkin and Padel 1994; Kristensen and Hogh-Jensen 1996). National infrastructures for processing, distributing and retailing organic products are emerging in more urbanised economies. In the tropics consumer awareness and the support of NGOs and funding agencies has stimulated organic production. Organic agriculture could be considered as one expression of LEISA because it is based on the same agro-ecological concepts. As a matter of principal, no synthetic inputs are used in organic farming. Although organic agriculture fits to a large extent within the economic and ecological concept of LEISA, social criteria need to be taken into account as well.

In some countries farmers are organising themselves around the production and trade of organic export crops such as coffee, cotton, bananas, cacao and rice. Here, co-operation and international linkages are crucial for success. The International Federation of Organic Agricultural Movements (IFOAM), with national branches in most countries, co-ordinates and defends the interests of market-oriented organic farmers at the international level. Certain standards have been accepted to certify and guarantee the quality of organic products. These cover both ecological and social issues. Thousands of farmers are working in this type of export production and, as the potential market for organic produce grows, governments, large farmers and agribusiness are becoming involved. This has lead to (international) competition between organic farmers and has created opportunities for un-fair trade. Farmers marketing organic products have to stay competitive which puts a particular pressure on smaller organic farmers and the ecological sustainability of organic farming itself. Organic farming is, therefore, not necessarily a solution to improve the economic position of small-scale farmers in the long term (Box 4.3).

*Box 4.3 Organic agriculture for export*

Costa Rica is one of the world's largest banana exporters. Over 50,000 hectares of land, much of it former forest, is devoted to banana monoculture. These plantations are major contributors to the serious deforestation, pesticide contamination and solid waste pollution now affecting Costa Rica. NGOs are responding to this situation by promoting organic banana production and Fair Trade.

Traditionally, residents in the Talamanca region have kept banana stands around their homes for their own consumption and to feed their pigs. The idea of producing organic bananas for export dates from 1991 and, today, organic bananas are being cultivated over some 3500 hectares. These bananas are bought by grassroots producers' organisations and are sold to multinational companies such as Gerber and the Chiquita subsidiary, Mundimar. The producers use their earnings to buy salt, shoes, clothing, and sometimes food. For many, it is the only source of income.

Producing organic food does not protect farmers from unfair trade. Multinational trade is concerned with corporate profits and not with the security of farmers' livelihoods. Gerber, for example, repeatedly changed the amount of fruit it agreed to buy from producers. Initially the company encouraged farmers to increase production. Later, citing oversupply and lagging demand, it reduced its purchase quotas and negotiated a lower price for the fruit, leaving many farmers with little to show for their investments.

### LEISA in (peri-) urban agriculture

The urban environment provides "fertile ground" for LEISA. Small-scale urban farmers produce for home consumption, for the conventional market and for the market in organic products. In and around cities, opportunities are being created to structure organic production around the recycling of organic waste. Even if farmers do not receive a special price for their products, organic urban and peri-urban agriculture is often competitive because it is relatively productive, customers live nearby, and there is a ready supply of organic waste. Whilst recycling (sometimes toxic) urban organic waste can be problematic, it can contribute to sustaining urban agriculture and in doing so help alleviate urban poverty. Governments are often prepared to support the development and improvement of urban agriculture, gardening, tree growing, animal production and aqua-culture, because it creates income possibilities for the urban poor and helps improve health conditions. Some urban agriculture initiatives have involved hundreds of farmers (Box 4.4). Awareness of the importance of urban agriculture and international interest in its development is growing fast (UNDP 1996). In urban areas it is often not difficult to reconcile ecological, economic and social criteria for LEISA.

Urban bio-intensive gardening and recycling of organic waste go well together.

**Box 4.4** *Urban agriculture in Dakar, an opportunity for the urban poor and the environment*

In the Pikine neighbourhood, a co-operative of small entrepreneurs has succeeded in developing farming in a wetland area that was unsuitable for building houses. The farmers, who are mostly men, grow vegetables under the trees and raise livestock primarily for sale and women market them. Both men and women process and market by-products such as tanned leather and handicrafts made from palm frond. The farmers follow sustainable agricultural practices and use household, market and animal waste to fertilise the soil. Waste water is deflected from sewage pipes to irrigate the crops, or water for irrigation is lifted, by hand, from shallow wells. Animals are raised in the home compound and grazed in turn by members of the tribe on roadsides and vacant land. The women marketers buy fish from fishermen, process the fish and barter the waste with farmers for fertiliser.

The farmers' co-operative operates under an elected president who is also the tribal chief. The farmers receive political support from the city mayor and technical assistance from the Centre pour le Developpement de l'horticulture. The success of farming activity is the result of the strong organisational structure and the integration of marketing, processing and land management. UNDP 1996.

## LEISA in Community Supported Agriculture

In Western countries, Japan and some areas in the tropics, broken linkages between farmers and consumers are being reconstructed. Together, farmers and consumers have started community or consumer supported agriculture. Producers and consumers guarantee each other quality LEISA products and a secure income. They also co-operate to some extent in production, distribution and the recycling of organic waste. Other social and economic initiatives are also being undertaken to strengthen the community and local markets. Skilled, knowledge-intensive agricultural labour, local processing and direct marketing reduces the need for external inputs and increases income and self-reliance. Local money and labour exchange (LETS) systems are sometimes used to ensure that money and labour do not 'leak' out of the community (Douthwaite 1996). In this way, co-operative community economies are being developed. They maximise the benefits of sustainable (urban) agriculture and try to ensure local communities and economies do not disappear into the competitive global economic system (TRANET 1998).

## LEISA in traditional agri-culture

Co-operative community economies are nothing new, in fact most indigenous economies functioned in this way. A special case is made here for LEISA technologies in traditional agri-culture. An increasing number of farmers are coming to the conclusion that the above mentioned globalisation processes are not only threatening to marginalise them economically but also endangering their cultural and social values. Indigenous people are amongst the individuals and farming communities who have decided to step outside the market economy again because their experience with market agriculture and labour migration was one of ecological degradation, social and cultural disintegration, poverty and dependency. They started processes of endogenous development by consciously reorienting their communities to their own 'agri-culture' and indigenous farming practices (Box 4.5). In doing so, their dialogue with the outside world has become more conscious and critical. External knowledge and practices are not necessarily rejected, but have to fit within their own world vision and value system. This process of further intensifying indigenous land use systems and the development of the local economy and its crafts is motivated by the need to accommodate population growth and often includes such elements as spiritual rituals, astrology and festivals.

Some of these groups are supported by highly partisan development workers and scientists who also participate in the endogenous development process (Apffel-Marglin 1997). They believe that the market economy, consumer culture

**Box 4.5** *The Aymara of the Peruvian-Bolivian highlands recreate indigenous 'agri-culture'*

Aymara communities have lived in the isolated region near Lake Titicaca for centuries. At an altitude of 4000 metres, the climate is dry and cold and life is hard. The Aymara have developed a regional agricultural system in which products are exchanged between communities (ayllus) in different ecological zones. The products of lama and alpaca keepers from the highlands, potato and maize from the mountain slopes and vegetables, fruits and coca from the valleys provide a balanced diet and guarantee self-sufficiency. Aymara culture strives for balance at the ecological, social and spiritual level. Reciprocity and shared responsibility are basic to their social relations. Through myths, rituals, and festivals, the Aymara keep contact with and honour their ancestors, nature and the spiritual world. Pachamama, Mother Earth, plays a central role in keeping life in balance.

Over the past thirty years, under pressure from church and state to integrate into the market economy, the Aymara have largely abandoned their traditional agricultural system. They now produce cash crops, cattle and chickens. This has resulted in poverty, malnutrition, high infant mortality, social disintegration and ecological degradation.

In an attempt to reverse this situation, the Aymara organisation Chuyma Aru has tried to recreate indigenous society in several Peruvian ayllus. Central to their approach is an attempt to strengthen Aywara identity through cultural programmes. Farmers and Chuyma Aru are working together to reintroduce indigenous technical and spiritual practices. In this way they hope to improve the food and health situation, and to stop ecological degradation.

A practical and holistic approach is being followed that builds on the traditional idea of balance. Terraces are being repaired, medicinal plants reintroduced, the genetic diversity of indigenous crops such as potatoes, maize and quinua are being recreated and support is being given to lama and alpaca husbandry because these are best adapted to local conditions and needs. Local culture and indigenous knowledge on weather prediction, medicinal herbs, the traditional use of community lands, shamanism and traditional leadership are also being rejuvenated.

The Aymara have learned the hard way that they cannot produce for the market in an economically competitive and ecologically sustainable way on their marginal and vulnerable lands. To avoid having to migrate to the city slums, they are trying to recreate their own indigenous culture and make endogenous development work (Douglas, 1998).


Sustaining ecological and cultural balance.

and Green Revolution agriculture do not necessarily provide the basis for sustainable development and that traditional 'agri-cultures', the bases of sustainable development in the past, still have some relevance. For these farmers and NGOs, sustainable agriculture is more than economically viable and ecologically sound technology. It also involves cultural and spiritual integrity, social justice and self-reliance. The COMPAS programme, a project of ETC Netherlands, typifies this thinking in providing a platform for intercultural dialogue on cosmovision and agri-culture to enhance endogenous and sustainable agricultural development (Haverhort et al 1997; Haverkort and Hiemstra 1998).

### LEISA: feasible and sustainable?

The fact that many farmers are developing LEISA approaches indicates that there are many conditions in which LEISA approaches are feasible. Which approaches are followed, and which specific practices are applied depend on local conditions, opportunities, insights, skills and preferences and can be expressed in many different ways. IIED has identified some two million farms that are in transition to resource conserving agriculture or LEISA. Although there is still little quantitative data on LEISA, the fact that large numbers of farmers are using LEISA approaches is probably the best proof of their relevance. In order to convince the general public of the significance of LEISA for our future, it is important to document and analyse a large number of experiences. Long-term case studies of large numbers of farmers might provide the necessary insights into the conditions and dynamics of agricultural systems and explain why farmers follow particular approaches to agriculture in specific situations. Much work needs to be done in this domain. To increase the amount of evidence available, ILEIA supports a farmer-guided collaborative research programme with different partners in Ghana, India, Peru and Philippines. Using PTD and a stakeholder approach, it tries to identify the opportunities and constraints on LEISA in particular situations. The ILEIA Newsletter planned for Spring 1999 will report on this research programme. However, this does not mean that approaches to LEISA satisfy all the criteria of sustainability and that no further change is needed.

**Box 4.6** *"What needs to be made sustainable is the process of innovation itself".*

Bunch & Lopez (1994) took three development programmes in Central America and compared the adoption of resource-conserving practices. In a participatory comparison that involved twelve villages and 1000 families, they examined the impact of resource-conserving practices at the beginning and end of the projects. They concluded that the adoption of resource-conserving techniques continued after the projects finished. Between 80 and 90 successful innovations were documented. These included the adoption of new crops and green manure and the introduction of new species of grass for contour bunding in vegetable production. Other innovations were using lab lab and velvet bean for cattle and chicken feed, nutrient recycling in fish ponds, human waste in composting latrines, napier grass to stabilise cliffs, and home-made sprinklers for irrigation. Techniques had been developed, adopted, adapted, and dropped as markets changed, and as a result of droughts, diseases, insect pests, land tenure problems, the availability of and political instability. The study concluded that the half-life of a successful technique in these projects was 6 years. Many of techniques did not endure. Bunch and Lopez concluded that 'what needs to be made sustainable is the process of innovation itself'. They observed that the development of resource conserving agriculture has helped to regenerate the local economies and that land prices and labour rates are higher inside the project regions than outside. Families were also moving back from cities and forests also benefited because farmers no longer need to cut wood (Bunch & Lopez 1994).


Integrated Nutrient Management in Kisii, Kenya. Not necessarily sustainable.

Analysing LEISA approaches using, for example, the criteria for LEISA as formulated by the ILEIA research programme (Chapter One) may reveal that important criteria are not being given the necessary priority or that particular macro processes or policy conditions are un-supportive. Conditions, needs and insights change so farmers constantly have to look for opportunities to improve their farming system. In many of these cases ecological, economic and social dimensions may be contradicted and therefore balances need to be found in matching them as far as possible to help direct agriculture towards sustainability. ILEIA agrees with Bunch and Lopez that in the development towards sustainability what must be sustainable is the process of innovation (Box 4.6).

Many of the examples in this publication show that farmers can be creative innovators. Not only do they pursue higher production and income but they are also concerned with socio-cultural values and ecological sustainability. There are situations, however, where the process of adaptation and innovation has stagnated or has developed in an unsustainable way. Strengthening the capacity of farmers to adapt farming to change and towards sustainability is, therefore, crucial. There are many experiences with participatory development in which farmers, development workers, researchers and policy makers working together to improve agriculture have been effective. In Chapter Five, methodologies developed for participatory processes will be examined more closely.

## 5. Participatory learning, planning and action toward LEISA

Farmers everywhere experiment. They adapt, innovate and observe the results of their work. Creating knowledge in this way is an integral part of sustaining agricultural production. It is only recently that 'farmer-led' processes of agricultural development have been superseded by formal scientist-directed agricultural research. Increasing numbers of researchers and development workers are acting as facilitators and equal partners in farmer-led agricultural development. They recognised that farmers must be able to adapt to continuously changing conditions and the needs of sustainability. Thus, it becomes critical to strengthening farmers' ability to analyse, monitor, adapt and innovate (Loevinsohn and Meijerink 1998).

The following factors are important in this process.

- What works in one place, time and circumstance will not necessarily work elsewhere.
- What suits the farmer prepared to take risks, or the one committed to full-time farming, may not suit another with different ideas and constraints.

- The complexity of farmers' land use and livelihood systems, and their diversity, can radically affect the overall benefits of common sense interventions. For example, destroying crop stubble to disrupt the life cycle of a particular pest may also destroy the ratoon crop over which women or the landless have customary rights.
- The message-based approach is one of the least effective of teaching methods.

Due to rapid changes and the loss of indigenous knowledge and social cohesion, farmers and their communities have often lost the self-confidence and capacity to adapt and innovate. If they are to take development back into their own hands, they will need encouragement and support to strengthen their innovative capacity.

Today's farmers are more integrated into the national and global economy than those of earlier generations, and agricultural development itself is more heavily influenced by external processes and interests. Indigenous knowledge is often insufficient to support the sustained development of effective livelihood and farming strategies. Securing sustainable agriculture, therefore, requires not only participatory development but also concerted action on the part of farmers, development workers, researchers and policy makers. In the interests of sustainability, individual farmers and communities have to co-operate with other interest groups including land users, government officials, and consumer groups. All have a stake in agriculture and all are jointly responsible for keeping agriculture sustainable. Strengthening and facilitating farmer-led development and concerted action are crucial for development towards LEISA.

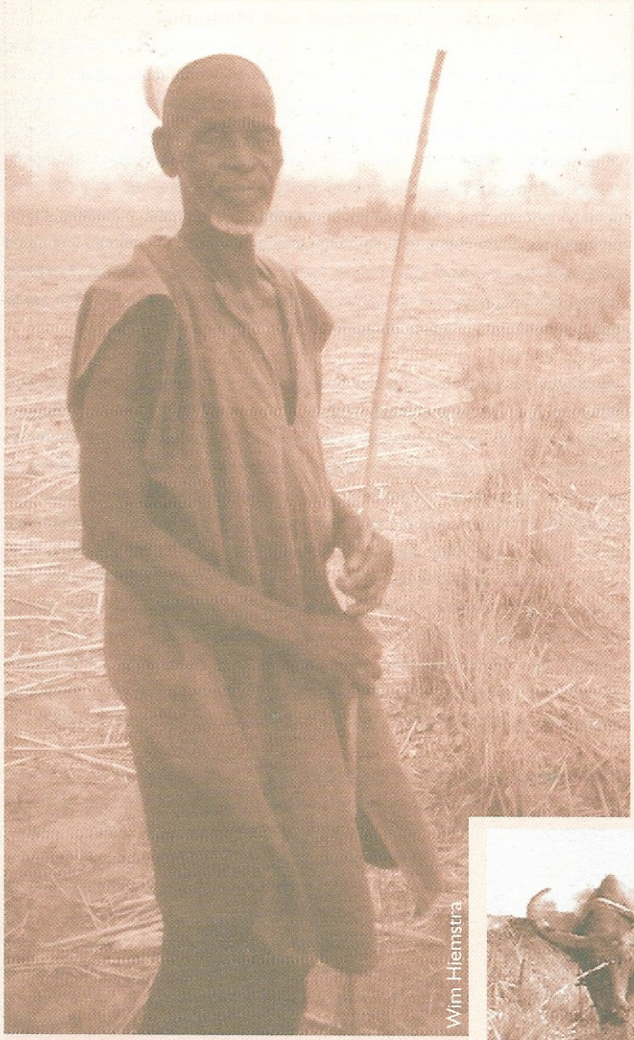
**Box 5.1 Key aspects of interactive participatory learning processes**

*Step-by-step learning:* focuses on cumulative participatory learning by all the stakeholders involved in the development process.
*Multiple perspectives:* assumes that individuals and groups make their own evaluations of situations that can lead to different actions. This implies that there are many ways of describing the real situation.
*Iterative group learning:* the complexity of the world can be revealed only through an iterative process of group inquiry and learning.
*Leading to sustained action:* the learning process leads to debate about change. The methodology is concerned with the transformation of existing activities to try to bring about changes which people in their respective situations consider as improvements (Pretty 1995).

## Facilitation of farmer-led development

Development workers, researchers and policy makers play an important role in strengthening farmer-led development and in the facilitation of concerted action. Development workers stimulate and facilitate the local development process and strengthen farmers' capacity to learn, adapt and innovate. Researchers support the local development process by taking part in studies to assess the local situation and they provide advice in setting up experiments. They can also assist in monitoring and evaluation, and carrying out scientific research into the problems identified by farmers. Policy makers, together with farmers, analyse policies to see how far they create favourable conditions for the development of LEISA. In this way a participatory process is established that strongly improves the effectiveness of development.
As knowledge relating to the development of sustainable agriculture is still limited, these participatory development processes are interactive 'learning' processes (Box 5.1). This not only involves learning about the practical aspects of sustainable agriculture but also about the implications of knowledge management, technology development, marketing and fair trade (Röling and Jiggens 1997).

A participatory learning and development process requires profound changes in the attitudes of those involved. Such processes build on farmers' knowl-



Wim Hiemstra

Indigenous knowledge supports self reliance

edge, skills and experiences and strengthen local decision-making. Researchers, policy makers, development workers and farmers can all be considered experts. Farmers know about their own reality and their land use systems. They can be skilled innovators who have developed ways of experimenting through trial-and-error. In order to co-operate with farmers, trust must be built up by respecting local values, understanding and speaking the farmers' language and by working together in a spirit of equality. In this process, outsiders often have to reorient their thinking on agro-ecology, 'agri-culture', the indigenous economy and knowledge, gender roles and relations, and methodologies for participatory learning and development.

The potential to facilitate and support participatory processes may differ widely from one situation to the next depending on the skills and resources available. In one situation it may only be possible to stimulate reflection on past and present experiences and relate these to future plans, in another experimentation at community level can be improved or a broad process of participatory development and concerted action facilitated. There is already considerable choice of methodologies for participatory land-use development including Participatory Learning and Action (PLA), Rapid Assessment of Agricultural Knowledge Systems (RAAKS), Participatory Planning (for example, Gestion des Terroir), Farmer-to-Farmer (FtF) extension, Participatory Assessment, Farmer Field Schools (FFS) and Participatory Technology Development (PTD). Each of these approaches deals with one or more aspects of participatory agricultural development: analysis, planning, technology development, institutional development, monitoring, evaluation or the sharing of information. Below, we will examine some methodologies for participatory assessment, planning, learning, experimentation and extension.

## Participatory Assessment and Planning

Assessment involves an analysis of the evolution of farming and seeks to explain movements away from or towards sustainability. It also seeks to identify the options for bridging the gap between present trends and future needs. Assessment consists of monitoring changes in conditions of production, objectives and needs, and evaluates the impact of experiments and adaptations. Sustainable agriculture includes not only the production system, but also involves processing, input, trade, transport, communication, consumers, and research and extension. Therefore, it may be necessary to include in the analysis the processing and recycling of organic waste, the production of synthetic fertilisers, pesticides as well as the social and environmental factors related to these activities.

Ideally, the development of sustainable agriculture requires a comprehensive, historical and dynamic analysis both at micro and macro levels. However, experience with comprehensive analysis in Farming Systems Research shows that lack of time and resources often means it is impossible to examine all aspects of agriculture. Depending on the objectives of the assessment, the availability of money, and the situation and skills of the actors, decisions have to be made about what should be included in a participatory assessment. In order to avoid assessments taking up too much of the farmers' time and resources, participatory methods are needed that focus on key issues. Participatory assessment should support farmers own analysis of factors that directly affect them and which they can influence. Assessment of the wider development context, and especially of those aspects farmers cannot change easily, can be left, in the first instance, to researchers and policy makers.

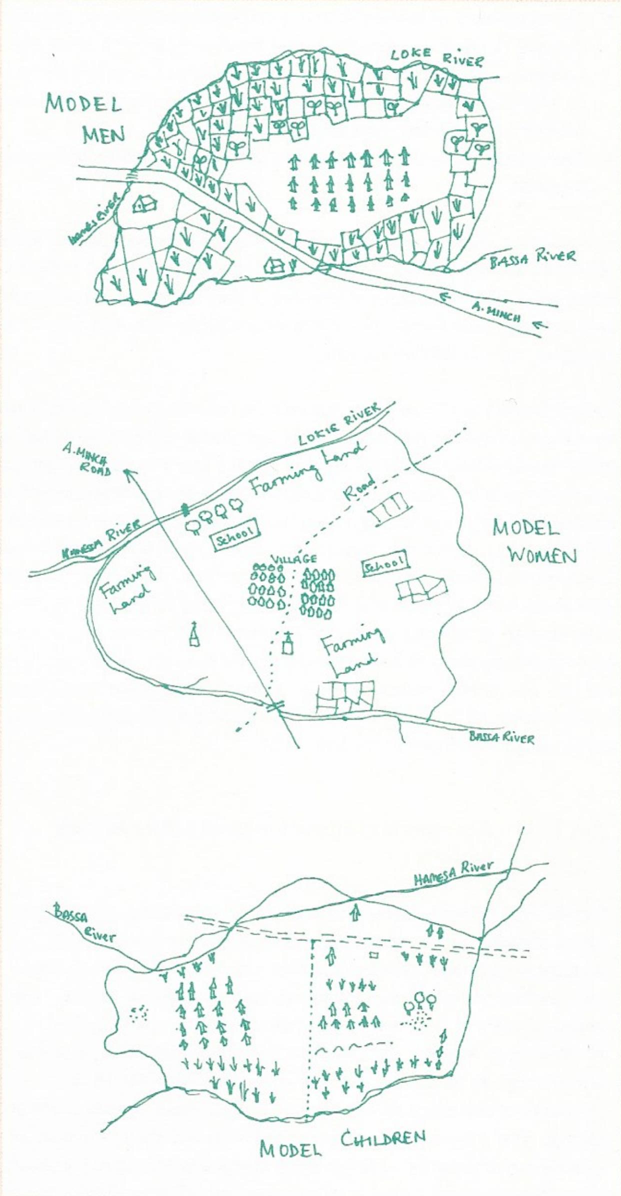
Conventional assessment in agriculture is generally restricted to economic analysis. As environmental and social costs are externalised, this type of assessment tends to encourage a lack of sustainability in agricultural development. A holistic reference base covering the economic as well as the ecological and social objectives of agriculture is needed. Criteria of sustainability' (Box 1.6) should be fixed by norms which can be monitored using a set of measurable indicators. A relatively homogeneous group of farmers may be able to formulate common objectives, criteria, norms and indicators for sustainable agriculture. However, as different categories of stakeholders often have conflicts of interest, expectation, experience and vision, it may not always be easy to come to an agreement on criteria and indicators.

The relative importance given to each criterion may vary from stakeholder to stakeholder and can change over time as awareness and insights into sustainable agriculture evolve. Policy makers, for example, may require scientific quantitative indicators before they are convinced, while farmers may prefer indicators related to natural phenomena with which they are more familiar. Thus, to make the planning and implementation of concerted action possible, participatory assessment is needed in which differences in visions become visible and negotiable. The challenge in assessment is to find ways to balance the different criteria of sustainability and the diverse interests of different categories of farmers with those of other land users and the state.

## Participatory tools for assessment and planning

There are many conventional and participatory assessment and planning methodologies, and new methodologies continue to be developed. Here we examine some examples.

Participatory Rural Appraisal (PRA) recently renamed Participatory Learning for Action (PLA), is a methodological approach that is used to enable farmers to analyse their own situation and to develop a common perspective on natural resource management and agriculture at village level. PRA is an assessment and learning process that empowers farmers to create the information base they need for participatory planning and action. Outsiders contribute facilitation skills and external information and opinions. Many different tools have been developed for use in PRA. There are four main classes: tools used in group and team dynamics; tools for sampling; methods for interviews and dialogue; and methods for visualisa-




Mapping land use in Ethiopia, perceptions differ.


Ato K.G. de Graft-Johnson

tion and preparing diagrams. Most countries have had some experience with PRA and local publications are available. IIED regularly reports on new developments in its PLA notes (Pretty et al 1995).

Rapid Appraisal for Agricultural Knowledge Systems (RAAKS) is a recently developed methodology for stakeholder analysis. It takes interdependent actors through a mutual learning process by opening various 'windows' on their interaction and knowledge. Analysis can focus on the actors, tasks, communication, linkages, co-ordination, knowledge networks and systems. It considers impact, knowledge management, actor potential and planning. RAAKS aims at improving stakeholder problem-solving capacity through improved communication and joint learning. Although action planning is part of the approach, its main strength is the analysis methodology (Engel and Salomon 1997).

Gender Analysis in Agriculture Gender Analysis seeks to analyse and monitor the roles of men and women and their needs in land use and agricultural development. It aims at empowering women to improve their position relative to men in ways that will benefit and transform society as a whole. The analytical tools involved focus on social relations and the division of resources within social units. They make it possible to distinguish between the different activities, aspirations, needs and interests of social groups and particularly between those of men and women. Gender analysis has been extended to generation analysis (Oxfam 1994; Feldstein and Poats 1989; Feldstein and Jiggens 1994).

Bio-resource analysis This approach is being developed by the International Centre for Living Aquatic Resources Management (ICLARM) and the International Institute for Rural Reconstruction (IIRR). Flow diagrams are drawn to map 'bio-resource flows'. These are used to identify options for improving the farming system including increasing species diversity, recycling, bio-mass production and improving economic efficiency, all indicators reflecting economic and ecological sustainability. Using an indicator diagram it is possible to see whether or not a system is becoming more sustainable. This is a particularly useful learning approach when brainstorming together about the types and directions of bio-resource flows. It is less useful when precise analysis is required (Bimbao, Lopez and Lightfoot 1995).

Assessment of progress towards sustainability In its concern for environmental conservation, IUCN uses a participatory approach to 'assess progress toward sustainability'. IUCN has developed methods for system, self- and project assessment. Its approach fosters 'questions for survival' such as:

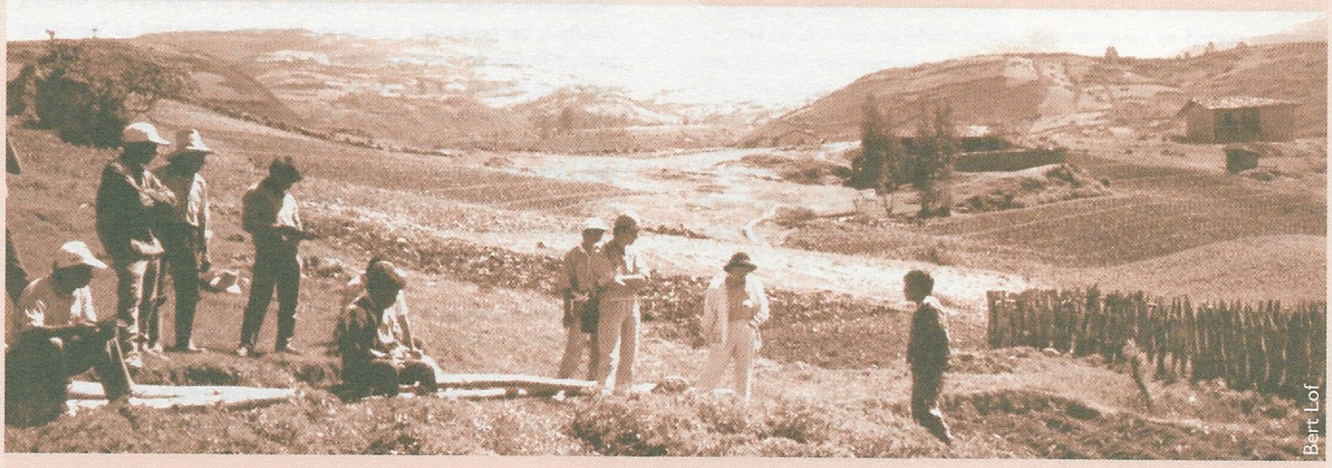
- What is the condition of the people and the ecosystem?
- What is the nature of the interactions between people and ecosystem?
- What motivates people to do what they do?
- What action should people take to improve their own situation and that of their ecosystem?
- How should these actions be taken?
- How do people know whether things are getting better or worse?

Programmes of action can be developed from the answers to these questions. IUCN has developed several tools for this including 'Participatory and Reflective Analytical Mapping' (PRAM), 'Assessing and Planning Rural Sustainability' and the 'Barometer for Sustainability'. To develop consensus on the priorities and actions among local communities and other key stakeholders, IUCN has developed a method known as 'Strategic negotiation for community action' (IUCN 1997).

Several networks that include FAO and the World Bank, are developing environmental monitoring systems. These approaches use indicators and employ a 'pressure-state-response' framework. This framework makes it possible to link pressures exerted on land quality by human activities and chart their effects on the state of the land. Changes over time, the response by society to these pressures, and the activities of land users and policy makers can also be linked together (Pieri et al 1995). Generally, these indicators monitor the more direct relationship between human action and the environment, such as the impact of forest clearance, the cultivation of steep slopes and over-stocking. The use of such techniques, however, may obscure the more complex interactions between economics, politics and

**Box 5.2** *The Campesino a Campesino movement, Nicaragua*

The Nicaraguan revolution and agrarian reform of the 1980s put *campesinos* at the centre of social change. This had a profoundly emancipating effect. For the first time they were able to organise freely on a large scale and formed the *Unión Nacional de Agricultores y Ganaderos* (UNAG). This led directly to the *Campesino a Campesino* movement. Between 1986 and 1989, UNAG, in a collaborative pilot project with a Mexican NGO (SEDEPAC), organised a series of training visits between Mexican and Nicaraguan *campesinos*. The objective was to train the Nicaraguan *campesinos* in those soil and water conservation techniques that the Mexican *campesinos* had found effective. During these visits, the Nicaraguans took part in experimentation and peer training that led to a threefold increase in basic grain production and produced a strong Nicaraguan team of *campesino* promoters. The majority of its *campesino* members were simply farmers who were ready to experiment and share with others. News of the successful project spread rapidly amongst *campesinos* throughout Nicaragua. Dissemination occurred spontaneously. Short practical courses, field visits between villages and small-scale experimentation formed the bases of the UNAG project. Training was extended to introduce agricultural technicians and advisors from other NGOs to *Campesino a Campesino* methodologies. Soon, through direct farmer-to-farmer contact and support from local NGOs, courses, activities and materials started to appear in many parts of the country (Holt-Gimenez and Cruz Mora 1993).




Farmer-to-farmer extension in Peru, enthusiasm and creativity culture, and land use and the environment. In these approaches, scientific as well as grassroot indicators are used (Hambly et al 1996).

Traeger (1997) gives an overview of approaches that are based on the use of indicators. Many of these methodologies are not very participatory. The Land Quality Indicators programme co-ordinates these initiatives. (see LQI programme on http://www.esd.worldbank.org).

Experience with these methodologies is still limited, although more work has been done with PRA and Gender Analysis. If the methodologies available could be presented in one overall framework, it would make it easier to select those most appropriate for the task in hand.

## Participatory learning, experimentation and extension

This category of methodologies centre on approaches concerned with strengthening the capacities of farmers to learn, experiment, adapt and innovate. Farmer-to-Farmer extension, the Farmer Field School approach, and Participatory Technology Development are among the most well-known approaches in this category. These approaches also include assessment and planning based on the methodologies referred to earlier.

*Farmer-to-farmer extension*

Since the early eighties, farmer-to-farmer extension has taken on the form of a movement in Central and Latin America. Small farmers began to analyse their situation and questioned the anti-ecological and anti-smallholder technologies of the Green Revolution model being promoted. Farmers started to value farmers' own knowledge and the process of learning from other farmers. In farmer-to-farmer extension, farmers are seen as active subjects in their own development. Their response to the factors that limit production is to use local resources in an ecological way and to try and change the traditional vertical relationship between extension workers and farmers. The objective of farmer to farmer extension is to strengthen farmers' innovative spirit and their ability to communicate knowledge with other farmers. In this process farmer promoters play an important role (Selener et al 1997).

*Farmer Field School approach*

The Farmer Field School approach developed from the Integrated Pest Management programmes supported by FAO in Southeast Asia in the nineties. At present Farmer Field Schools are also being organised in INM, bio-diversity and soil and water conservation. Farmers discover and learn for themselves the relationship between crops, pests, predators and soil and water (Box 5.3). The Field Schools are characterised by strong farmer-led and farmer-to-farmer extension. The aim is to empower farmers so they are able to select and adapt the technologies most appropriate to local agro-ecological and economic conditions. Emphasis is placed on the fact that farmers should then go on with the process of technology selection and adaptation themselves. Researchers and development workers need to become experts in facilitating participatory learning, selection and adaptation.

Farmer Field Schools encourage direct interaction between people and ecology. In field school IPM training, basic principles are discovered in the fields and linked to farmers' previous conceptions and experiences. In this way, farmers regain control over knowledge generation and dissemination, and technology development (Scarborough et al 1997).

*Participatory Technology Development*

PTD is essentially a process of purposeful and creative interaction between rural people and outside facilitators. Through this interaction, the partners try to increase their understanding of the main features and


Farmers' experimentation and joint evaluation: mutual learning in Shamuku, Zambia.

### Box 5.3 Farmer Field Schools: learning through discovery

The phrase Farmer Field School was first heard in Indonesia in 1990. Five years later IPM farmer field schools had been conducted in more than 15,000 villages in Indonesia and in thousands of communities in Vietnam, India, Bangladesh, the Philippines, China, Korea and Sri Lanka. As with ecology, the field school approach requires a radical shift in our attitudes towards, and perceptions of, farmers. We have become used to hearing farmers described as 'conservative', 'risk averse' and 'traditionally minded'. In the IPM field school approach, farmers are seen as a fundamental resource. People are viewed as intrinsically curious and creative, and as wanting to gain control over their lives through understanding the forces and patterns that affect them. For farmers, gaining an understanding of the ecology of their fields, and being able to manage the complex processes that occur there, is a form of empowerment that reduces insecurity and creates self-confidence.

Education is seen as a process that takes place in the learner not in the teacher/facilitator. Therefore, in a field school, it is the farmers who gather the data and discusses, analyses, presents and experiments. A farmer who masters a process can 'teach' that process to others, allowing them to discover it for themselves (Scarborough et al 1997).

dynamics of the local farming systems and define problems and opportunities. They also learn how to experiment with a selection of 'best-bet' options for improvement. These options are based on ideas and experiences derived from indigenous knowledge and formal science. This process of technology development does not only attempt to find solutions to current problems. It also tries to develop sustainable agricultural practices that conserve and enhance natural resources for future generations. Most important of all, PTD aims to strengthen the capacity of farmers and rural communities, enable them to analyse ongoing processes, and develop relevant, feasible and useful innovations.

Six main steps in PTD

- ***Getting started***: building relationships for co-operation; preliminary situation analysis; awareness mobilisation.
- ***Looking for things to try***: identifying priorities; identifying 'best-bet' options from indigenous knowledge and scientific sources; screening options.
- ***Designing experiments***: reviewing existing experimental practice; planning and designing experiments; designing, monitoring and evaluating protocols.
- ***Trying things out***: implementing experiments; monitoring and evaluation.
- ***Sharing the results***: communicating basic ideas and principles, results, and the PTD process; training in skills, proven technologies and use of experimental methods.
- ***Keeping up the process***: creating favourable conditions for continuing experimentation and agricultural development (see Veldhuizen et al 1997 (a) & (b); Reijntjes et al 1992.

*Box 5.4 Complementarity and contrast: PTD and conventional research*

Conventional research tends to have long-term goals, more generic applications and a tradition of methodological rigour. The complementary strengths of PTD help to fill gaps in conventional research by providing rapid results to site-specific conditions, and by providing farmers with better tools to sustain the process of adapting to change.

At the same time it is not so much the complementary nature but the differences which are emphasised when a PTD approach is introduced into conventional project and programme settings. PTD contrasts with top-down, 'transfer-of-technology' approaches in which the farmer is perceived as a passive receiver of technologies generated elsewhere.

The success of a PTD programmes is not measured by its outcome. Solving a particular problem is not the issue. New problems arise continually. A PTD programme can be judged as successful only if the farmers have benefited from their collaboration with outsiders and become better able to handle new concerns. The ILEIA Reader Farmers' research in practice: lessons from the field (Van Veldhuizen et al 1997(b) presents an collection of case studies of PTD experiences that demonstrate the effectiveness of this approach. PTD has just started to develop. Questions remain about its applicability in different socio-economic, institutional and policy contexts. These relate to assessing its impact, judging the trustworthiness of research findings; influencing policy and policy making; and the issue of institutionalising participatory approaches in large, governmental bureaucracies. Other issues include creating enabling external institutions, building social capital, and setting PTD in a wider, regional, economic context. As van Veldhuizen points out, there are still many challenges ahead. (Van Veldhuizen et al 1997(b). A PTD Circular provides a six-monthly update on publications and events relating to PTD. It can be obtained on request from ETC Netherlands, PO Box 64, NL 3830 AB Leusden, The Netherlands.


Participatory Technology Development: the ILEIA Research Programme in Peru.

This process of technology development is closely linked with social change and encourages local innovation, self confidence, and self respect through self-organised planning, implementation and the evaluation of systematic experiments. The process also fosters a cultural awareness as planning and assessment obliges participants to take account of their own situation and the responsibilities and needs of others in the community.

***Integrating approaches in support of sustainable development***

There are considerable overlaps and complementarity between these approaches to participatory learning, planning and action and also important complementarities. Each has its strengths and, if combined, they could be of considerable significance in the development of sustainable agriculture. PRA and RAAKS are important appraisal methodologies and can be used in PTD and FFS. Experimentation in the Farmer Field School approach is still strongly focused on learning (Loevinsohn and Meijerink 1998), and the PTD approach could complement the FFS approach by introducing or strengthening those elements of farmer experimentation that relate to technology adaptation. This would enable farmers to continue the process of technology selection and adaptation. New assessment tools could also strengthen the capacity of FFS farmers to analyse their situation and monitor change towards sustainability. In this way the ecological learning approach of FFS would become more appropriate for changing farming conditions and a continuous development towards sustainable agriculture - LEISA. Initial experiences of integrating PTD in FFS are presented by Van de Fliert in Part Three of this book. Although, further development and institutionalisation of participatory approaches is still necessary, their potential in relation to the development of sustainable agriculture and further strengthening farmer accountability is now widely accepted.

# 6. Building bridges to LEISA

### Taking stock

Seven years after the UNCED conference in Rio progress has been made in putting sustainable agriculture and LEISA on the agenda. Much has been done and achieved in the past 15 years by those who are convinced that LEISA must be advocated and implemented if sustainability is to be achieved in agriculture. Increasingly, national and international agricultural development, research and policy institutions favour LEISA approaches, participatory development and providing stronger support to poor farmers.

However, much more needs to be done. The regeneration and transition of agriculture towards LEISA, world wide, has only just started. Poverty, population growth and increasing food insecurity - especially at the local-level-demand that urgent and immediate action be taken. Such short-term responses can endanger agricultural sustainability in the long run. The need to regenerate HEIA and LEIA and make a transition to sustainable, more intensive agriculture throughout the world is clear. LEISA calls for an agriculture that is economically competitive, ecologically sound and respects social and cultural values. ILEIA and many others are of the opinion that such a LEISA can contribute to finding the right solutions for locally specific situations.

As discussed earlier in this volume, there are three major reasons why LEISA should be furthered. By emphasising synergy and complementary in use of resources and knowledge, LEISA

- provides a response to unsustainable LEIA and HEIA production systems,
- promotes technologies that aim to intensify agricultural production, and
- emphasises the importance of empowering farmers and their communities in finding local solutions through participatory methodologies.

Empowerment and farmer-led development are essential. In a recent ILEIA video, **Building bridges: LEISA in practice**, the manager of Sandema Agricultural Station, in Northern Ghana, Moses Appiah, reflected " Though LEISA and the PTD process farmers gain a lot of self-confidence and self respect. They become more motivated to work by themselves, to identify their own problems and solutions and to transfer this into practical terms. I think this is a sustainable base for development" (ILEIA 1998).

This issue is becoming more urgent as strong processes to globalise economic markets and world views create new opportunities but entail negative effects as far as the ecological and social sustainability of small farmer livelihoods are concerned. The recent emergence of biotechnology and genetic engineering in an attempt to increase productivity and yields is a new dimension in this globalisation processes.

When macro-economic and cultural processes put pressure on the livelihood systems of small farmers poverty, ecological degradation and social disintegration occur. If the causes and effects of these processes are not well understood and their ecological and social implications are not taken into account, the sustainability of local agricultural systems becomes intensely vulnerable. Because agricultural development is influenced by macro processes and is situation specific and people based, action needs to be taken at both micro and macro levels.

Local solutions have to be found by local people using their own knowledge, resources, institutions and responsibilities. These efforts must be complemented and supported by others. LEISA provides an approach that focuses on the local context and with the help of participatory methodologies tries to make the best use of local and external resources and of indigenous and scientific knowledge. Empowerment and accountability are important preconditions for farmer-led agricultural development and LEISA (Laban 1995). Farmers are not passive victims of changing conditions but adapt and innovate to improve their situation. Documented case studies in which thousands of farmers have been involved, show that LEISA is not an unrealistic dream. LEISA clearly has the potential, within ecological and economic limits, to guarantee local food security for a growing population, to improve the economic situation of small farmers, to maintain or increase genetic diversity, to limit deforestation and soil erosion and to preserve the natural resource base. These case studies provide important contributions and insights to the development of sustainable agriculture. Practical experience shows that participatory development processes to strengthen farmers abilities to experiment and innovate are crucial in the development of sustainable agriculture. Combinations of PRA, FFS, PTD and other methodologies mentioned in early chapters are powerful and have great potential. Such development towards LEISA, however, needs to be sensitive to the differences in prevailing conditions and opportunities and the types of farmers involved. Situations which demand priority and a specific LEISA approach include subsistence-oriented agriculture, small farmer market-oriented agriculture, organic agriculture, and urban agriculture.

Empowerment, farmer-led development and innovation of farming at farmer and community level is not enough. Concerted actions at higher levels are important if conducive policies for the development of LEISA are to be made and farmers are to be protected against unfair (inter)-national trade, rapidly changing production conditions that may be difficult to manage, and the effects of high-tech research and regulations that focus on and privilege some forms of agriculture. In spite of efforts and progress made, the agendas of many research and policy institutions are not yet geared to encouraging the conditions that make LEISA really work. Moreover, government spending in both development and research is on the decrease and there are strong tendencies amongst trans-national corporations to take the lead and impose domains of research which do not necessarily contribute to the development of sustainable agriculture and are often not in the interest of small, market- and subsistence-oriented farmers in the South. These corporations are investing huge amounts of research funds in the development of fossil energy-based technologies and genetic engineering. Patent rights on genetically modified crop varieties are increasingly controlled by a very small number of trans-national corporations at the expense of farmer rights, local landraces and indigenous varieties used by a majority of small farmers. It is essential that financial support be given to research capable of generating knowledge that can contribute to the preservation of our diverse natural resource base and the well being of the majority of the world's population.

In the long term, agriculture, the economic system in general, and human society as a whole can only be sustainable if it remains in balance with nature and if social equity is respected. This is nothing new. The unity of the spiritual, natural and social world is part of most traditional and ancient world views and philosophies. Actual trans-national economic and political interests, however, do not converge with the world views that have sustained life over the centuries. To counter these tendencies requires the concerted efforts of growing numbers of different types of people who are prepared to embrace the principles and necessities that underpin the concepts, approaches and political message of sustainable development in general and of LEISA in particular. ILEIA can contribute to this effort.

### Looking ahead

Much needs to be done. Mainstream research and development organisations and policy makers need to be convinced of the relevance of LEISA. There is an important need for interaction, communication, linking, and networking between all kind of partners in LEISA including farmers, consumers, NGOs, government agencies, research and training institutes and the private sector.

International and regional initiatives need to be taken that can function as bridges between these different partners in development of LEISA - sustainable agriculture in the North, South, East and West. Such initiatives, in direct collaboration with national partners and with the full acknowledgement of each others roles, could have an important function in the implementation of concerted actions in the development, documentation, evaluation and exchange of experiences, publication of information, training and research, advocacy, policy discussion and networking. There are already many national and international organisations involved in such activities but by improved co-ordination and collaboration more could be achieved. ILEIA sees a need for the following:

- raising funding for development and research in LEISA;


- providing the skills and the insight to farmers, development practitioners and policy makers to use LEISA approaches and participatory methodologies;
- documenting and analysing LEISA cases in which large numbers of farmers are actively involved;
- building bridges between all kind of different actors (farmers and scientists, development workers and researchers, NGOs and Government agencies, producers and consumers) in the South and the North to spread LEISA and to internalise LEISA and participatory action approaches in their development and research agendas;
- providing the evidence for advocacy in order to influence policies and create an environment conducive to LEISA by deriving lessons and approaches from documented experience;
- raising awareness among urban and western consumers about the adverse linkages that exist between non-ecological, non-sustainable ways of agricultural production on one hand and the overall livelihood systems of a majority of farmers in the Third World and safe and healthy food on the other. This needs to be done by simple but adequate messages, mobilising their involvement and support to develop LEISA;
- electronic and hard copy publication of the many experiences, stories, actions and innovations that demonstrate the relevance of LEISA in contributing to the achievement of sustainable agriculture and livelihood systems.

In these efforts increased attention should be given to finding adequate responses to the question of how we can:

- match the ecological with the economic and the economic with the socio-cultural so that, in future, agriculture meets its sustainability criteria;
- intensify agricultural production without compromising our natural resource basis;
- ensure that half of the world's farming population is able to continue to derive a living within their own socio-cultural environment without being marginalised by a macro-economic world vision and way-of-life that is loosing essential elements of humanity, and
- match a higher degree of farmer-led development with actual globalisation processes.

Two important issues remain.

- What type of policy environment is most conducive to enhancing LEISA and farmer-led development?
- What impact does economic liberalisation and genetic engineering have on the sustainability of agriculture and the livelihood of millions of small farmers?

### ILEIAs contribution

ILEIA intends to go on contributing in an active and collaborative way to the efforts of those working to develop LEISA. **Building bridges between partners in LEISA** (ILEIA 1998) is the motto of the new ILEIA that many wish to see continuing as an Independent Knowledge and Information Centre on LEISA. Through a global programme, and support to publication and networking activities in different regions (Latin America, Francophone Africa, Arabic Middle-East and Maghreb, South Asia and later Anglophone Africa, and Southeast Asia) ILEIA hopes to help build new stepping stones towards sustainable agriculture.

ILEIA wishes to contribute to the further development and enhancement of LEISA by continuing to produce the ILEIA Newsletter and other publications in both hard copy and on the Internet. We also hope to be able to

respond to the growing demand for other languages. If funding permits we would like to make a start with French and Arabic, but other languages such as Hindi, Chinese, and Portuguese are also real possibilities. Further documentation, publication, inputs to news agencies and broadening access to electronic information on LEISA are also seen as essential activities. Creating and sharing of knowledge and information must continue to be one of ILEIA's main tasks.

Mainstreaming LEISA, or internalising LEISA in the research and development agendas of those organisations and institutions that focus on land use and natural resource management is also a matter of urgency. Contributing to the debate on the conceptual and policy dimensions of LEISA in order to enhance LEISA at the farm level can be achieved by providing information on documented experiences with LEISA in their specific, socio-economic contexts.

ILEIA proposes to play a bridge building and catalysing role by supporting initiatives in the domain of LEISA being carried out by partners throughout the world. Facilitation and short-term grants could be used to enable partners to initiate activities related to training, case study documentation, research, policy and networking. For this, intensive collaboration with national, regional and international partners will be sought. Making these initiatives possible would, in ILEIA opinion, help to anchor LEISA in local and regional institutions. ILEIA is convinced that such support together with specific language editions of the Newsletter would be most effective when given a regional focus. At the moment ILEIA is engaged in discussions with funding partners to support this challenging programme.

# High potential hillsides Soil conservation and recuperation in Meso-America

Roland Bunch

In-row tillage, is becoming more widely used.

## Introduction

A major movement of soil improvement has sprung into life on the hillsides of Meso-America during the last 30 years. Basically, this movement has come to life because of a convergence of three factors:

- an increasing realisation among villager farmers that population pressures are forcing them to intensify their land use - that traditional slash and burn systems must be intensified or changed.
- a growing effort among development organisations, mostly NGOs, to develop and spread soil conservation and soil recuperation (SC and SR) techniques, using primarily farmer-led, or farmer protagonist, methods of research and extension.
- the existence of widespread traditional systems of intercropping different species of beans with maize.

The following article describes the SC and SR techniques that have made this movement possible in Meso-America (the area from Central Mexico through Nicaragua). It includes descriptions of the practices, how they have changed over time, analyses of their economic costs and benefits, and data on their sustained adoption or abandonment by small farmers.

## Soil Conservation

SC refers here to techniques used to reduce water run-off and erosion on hillsides, whereas SR refers to those that increase medium- to long-term soil fertility, usually through the application of organic matter. The major SC practices used in Meso-America are contour hedgerows ("live barriers"), contour rock barriers, contour or drainage ditches, and in-row tillage (known also as "minimum tillage").

### *Contour hedgerows*

Contour hedgerows consist of vegetation that is planted along contours spaced 1.5 to 3 vertical metres down a hillside. The hedgerow serves to interrupt run-off, thereby trapping soil and gradually forming a bench terrace.

Hedgerows were first popularised among small farmers in Meso-America in the late 1960s when the NGO World Neighbors learned of the technology from Marcos Orozco and began spreading it around Central Guatemala. At that time, hedgerows invariably consisted of Napier grass (*Pennisetum purpureum*), and were planted every 1.5 metres of vertical distance down the hillside. From Guatemala, the World Neighbors introduced the hedgerows to Mexico and Honduras, and to the *Campesino a Campesino* programme in Nicaragua.

As they have done with most of the SC technologies, farmers have modified the hedgerows almost beyond recognition. A study five years after programme termination in Honduras shows that farmers with grazing animals have maintained some or all of their hedgerows in Napier grass or king grass, but most of those without animals have changed to multi-purpose species, such as pineapples, lemon grass, medicinal plants, and fruit trees, the latter sometimes associated with grasses. Sugarcane has become the most popular new hedgerow species.

The distance between hedgerows also varies from 1.5 to 3.5 vertical metres, depending on soil type, rainfall and the existence of other SC practices such as cover crops, in-row tillage and/or micro-terraces between the hedgerows (Lopez et al 1995).

The economics of hedgerows vary widely depending on the slope, the species used and the value of the crops between them (Ellis-Jones et al 1995). Thus, the labour costs of establishing grass hedgerows in Honduras range from about US$11 per hectare for a 15 percent slope to US$37 per hectare for a 50 percent slope (Almendares et al 1995; Mejia 1993) making them one of the cheapest technologies available. Farmers usually do not reap the benefits of increased soil fertility the first few years, but the food or fodder produced by the hedgerows often pay back the costs within a year or two. Long-term benefits, such as increased land values, reduced risk, and higher productivity make the practice very attractive. In fact, the most important long-term benefit is that it makes possible all the other SC and SR measures, because they will no longer be destroyed or washed down the hillside.

Hedgerow adoption rates show how much farmers appreciate these benefits. A rough estimate would put present sustained adoption at between 50,000 and 75,000 farmers. A study done five to fifteen years after programme termination shows adoption varied from 90 to 135 percent of original adopters five years after the program ended. Fifteen years after termination, adoption rates had doubled (Bunch and Lopez 1995). It should be noted, however, that in areas where projects used artificial incentives to motivate "adoption," the technology was still being maintained by only 5 to 10 percent of the farmers just two years after termination (Lopez 1992).

### *Contour rock walls*

Rock walls replace hedgerows where rocks are so common as to disturb farming operations. The walls are built on a contour every 1.5 to 3.0 vertical meter down a hillside. Costs, however, are high, from US$125.00 of labour per hectare for a 15 percent slope up to US$410.00 on a 50 percent slope), and the wall itself provides few additional benefits (Almendares 1995; Mejia 1993). Many NGOs have now moved to just pushing the rocks out of the row in in-row tillage, or forming small piles of rocks about every third row, thus reducing labour costs considerably. Cost also becomes difficult to assess because the work is combined with other operations and is often done gradually over several years.

### *Contour or drainage ditches*

This technology consists of a ditch just beneath the hedgerow, either on a contour or at a 1 or 2 percent slope. The purpose is to stop run-off and either hold the water or, if on a slope, drain the water out of the field. Nevertheless, even though we previously promoted such ditches widely, with positive long-term results, we now see them as requiring too much labour. Drainage ditches are still recommended at times, but only when poor drainage obviously limits productivity.

### *In-row tillage*

In-row tillage consists of tilling the soil only in the crop row, leaving the soil between the rows untilled. This often adds productivity just by itself to no-till traditional systems. Over a period of three or four years, it also forms a microterrace, that reduces erosion and concentrates water in the root zone. The practice also allows organic matter to be incorporated into the soil, concentrating it in the root zone of crops, and allowing its residual effect to be used by crops year after year, since the row remains in the same place. Because of these and many other advantages, in-row tillage, along with contour hedgerows, is one of the two most widely used SC. practices in Meso-America today.

In-row tillage, a variation of the "strip tillage" used in the United States, was first practised in Meso-America by Elias Sanchez on his demonstration farm in Honduras in the early 1980s, and then was popularised by World Neighbors and other NGOs. The most common change farmers have made in this practice is that of varying the width of the tilled strip. Usually for basic grains planted in rows about 1 meter apart (for example maize, cassava, and potatoes), farmers till an area about 35 centimetres in width, whereas for beans they till a strip 50 to 60 centimetres wide to allow for a double row. For vegetables they may widen the cultivated row to 80 cms. In a few villages, where farmers produce high-value vegetables, they actually build micro-terraces right from the start, investing additional labour in order to have the micro-terraces formed immediately.

The cost of in-row tillage varies tremendously depending on soil type, slope, the presence of rocks, the width of the row, and whether it is done by hand or by animal traction. In-row tillage done by hand will cost an average of about US$130 per hectare to establish, US$65 per hectare to redo the second year, and US$45 hectare per year thereafter. However, using a mule (which is generally possible only on slopes of less than 45 percent), it will cost about US$30 per hectare to establish and $20 hectare per year to maintain. Benefits will also depend on the soil type, the amount of organic matter. incorporated, and the crops grown. The greatest advantage may well be that after four or five years, farmers using in-row tillage and incorporating large amounts of organic matter may well be able to move to high-productivity zero tillage with surface applications of organic matter, thereby reducing costs further while maintaining yields.

A study in Honduras indicates that hand-built in-row tillage was sustained only where farmers could use it for irrigated vegetables (Arellanes 1994). However, the experience of other programmes indicates that in-row tillage done by animal traction is being adopted spontaneously by maize farmers with no irrigation, and that farmers using animal traction to make in-row tillage dedicate larger areas of land to this practice. Thus, even though this innovation is too recent for post-programme studies, experience would indicate that hand-built in-row tillage is profitable and sustainable only for higher-value crops, whereas in-row tillage done with animals is widely competitive even for basic grains.

Of course, along with contour barriers and in-row tillage, farmers have also adopted strip farming and planting in contour rows, and have quit burning. These practices require virtually no additional costs, while their advantages are also relatively small, though enough to make them widely and sustainably adopted.

## Soil recuperation

### *Green manure/cover crops*

The addition of major quantities of organic matter to the soil has proven to be the most important and easiest way for small farmers to maintain or boost the natural productivity of their soils, even those soils so depleted they have been abandoned. This practice of reviving deteriorated soils through heavy organic matter applications (the benefits to productivity of which are highly underestimated by most agronomists) is now called "soil recuperation". Although many sources of organic matter may be used, including animal manure, coffee pulp, sugarcane pulp and compost, the least expensive and most widely used in Central America is green manure or cover crops.

In Latin America, green manure or cover crops are utilised in such a way that they do not use land that has an opportunity cost; do not require any out-of-pocket expenses; do not require major amounts of additional labour, and finally, provide benefits other than merely improving the soil (Bunch 1995). Thus they can be grown during the dry season or in periods of frost, under fruit trees, on fallowed land or intercropped with traditional crops, such that the land they occupy cannot otherwise be used. In Meso-America, intercropping them with maize or growing them under fruit or coffee trees has been the most popular approach, although farmers are experimenting many other uses (Anon 1997). Green manure or cover crops should thus be developed to produce high-protein human food, to produce feed or fodder for animals, or for weed, disease or pest control, in addition to soil improvement (Bunch 1997).

While many green manure or cover crops in Meso-America are traditional, the velvet bean has been introduced over the last 60 years, and has spread spontaneously among tens of thousands of farmers in Mexico, Guatemala, and Honduras. Systematic extension of green manure and cover crops began, so far as we know, with two independent efforts: the work of Drs. Steve Gliessman and Roberto Garcia in Tabasco State, Mexico, and that of this author, working with World Neighbors in Guatemala, both in the mid-1970s.

The systems used in Meso-America vary tremendously. Traditional systems include the intercropping of maize with scarlet runner bean (*Phaseolus vulgaris*), cowpeas (*Vigna unguiculata*), the lablab bean (*Dolichos lablab*) and rice bean (*Vigna umbellata*). Introduced systems include intercropping maize, sorghum, and/or cassava with velvet bean (*Mucuna sp.*), jackbean (*Canavalia ensiformis*), sweet clover (*Melilotus albus*) and a variety of vignas, as well as planting any of these or some perennial legume under perennial crops (Anon 1997).

Most of these systems were developed and adapted almost totally by villagers. Even in the case of introduced systems, programmes brought seed into the area, but villagers adapted the planting dates, seeding rates, crop associations and management regimes to their own specific needs. During this process, farmers have tended to move toward added diversity, reduced labour requirements, and a maximisation of uses for the green manure or cover crop species (for example, additional ways of cooking them or feeding them to animals).

The few scientific studies done so far on the benefits of these practices have yielded varying results. A study of the economics of a maize-velvet bean system in Honduras showed that the cost per ton of maize produced was 30 percent less than in a nearby high-input maize system (Flores 1992). A second study of a different maize-velvet bean system also showed it to be economically advantageous (Ellis-Jones et al 1995) while a third study showed negative benefits (SILSOE 1998). This apparent discrepancy is probably due to the third system's incorporation of the green manure cover crop in a warm, lowland climate some five months before subsequent planting. Most of the organic matter and nitrogen were most likely burned out. None of these studies took into account any uses of the green manure or cover crops other than for increased soil fertility, and all assumed subsequent maize production (a relatively low-value crop).

Precise figures on levels of present use and adoption or abandonment are scarce, partly because the traditional systems remained largely invisible to professionals until the late 1980s, and most of the green manure or cover crop extension efforts began at that time or even later. Nevertheless, guesstimates can be made about general trends. Probably something well over 200,000 farmers use green manure or cover crops in Meso-America today. The most common systems would be the scarlet runner bean-maize systems that exist from Central Mexico south into Nicaragua (140,000+ farmers), the velvet bean-maize systems in patches from Veracruz State in Mexico through the

Green manure really makes a difference.

Polochic Valley in Guatemala to the north shore of Honduras (40,000+), and the vigna systems that exist in patches along the Pacific coast from Oaxaca State in Mexico to Western Nicaragua (10,000+). Introduced systems have probably been adopted sustainably by only some 5,000 to 7,000 farmers.

Whether these systems are presently spreading or contracting is debatable in many cases. The most heavily studied system, the velvet bean-maize system in Northern Honduras, seems to be contracting rapidly in the areas it has been used the longest, because of encroaching cattle farmers, recently changed tenure laws, and nearby alternative sources of employment (the area planted in maize is dropping about as fast as is that in velvet bean) (Neil undated). On the other hand, very similar systems are spreading spontaneously to new areas of colonisation in Honduras, as well as into Belize, the Guatemalan Peten, and Chiapas and Tabasco States in Mexico.

Several of the other traditional systems are probably being gradually abandoned, such as the scarlet runner bean in Mexico and Honduras, and the vignas in El Salvador, while the introduced systems, really just getting started, have a mixed record so far, though evidence of spontaneous adoption exists in cases where green manure and cover crops have multiple uses. As farmers are taught additional uses for many of these beans, adoption trends will likely improve. Also, if petroleum prices increase substantially (quite likely sometime within the next 10 to 15 years, as world petroleum production peaks), green manure and cover crops will be able to compete even better with chemical fertilisers (MacKenzie 1996).

***Coffee pulp, sugarcane pulp, and other sources of organic matter***

The use of these often locally available resources (not generally practised traditionally), has become very popular. Especially where vegetables or fruit are grown, they often provide strikingly favourable cost-benefit ratios.

## Can they compete with high-external-input techniques

Tens of thousands of farmers using low-input SC or SR techniques maintain or increase their yields each year, rather than suffering decreasing yields, as before. Costs are often lower than for high-input agriculture, with similar yields. At the same time, these same farmers no longer have to leave their land fallow or burn forests in search of new land. Farmers who previously had to migrate in search of new land every two to four years have now used the same land for 15 to 25 years.

A study of 12 villages in Guatemala and Honduras using many of these technologies shows that average maize yields have increased from 0.5 tons per hectare to 3.4 tons per hectare over 22 years, temporary outmigration has almost been eliminated, permanent outmigraton to city slums has been reversed, wage levels have increased, land values have shot up, educational levels have improved, and village organisation has advanced. Farmers in the four Guatemalan villages in this study are now producing an average of 4.4 tons per hectare of maize, while farmers in neighbouring villages using approximately three times more chemical fertiliser per hectare but no SC or SR techniques are harvesting only about 1.4 ton per hectare (Bunch and Lopez 1995).

Closer, more scientific comparisons between specific high- and low-input systems would be desirable, but may well be difficult to carry out. Robert Chambers has described villager farmers as having "complex, diverse" farming systems (Chambers 1994). In Meso-America, farmers using SC or SR not only have complex and diverse systems, but rapidly changing ones, too. They know that only through rapid change can a farming system remain profitable over time.

Furthermore, the benefits of any SC or SR technology depend very much on the rest of the farming system. The benefits from hedgerows and in-row tillage depend heavily on the value of the crop planted between or in them. The major benefit of in-row tillage comes from being able to incorporate organic matter from green manure or cover crops and eventually being able to forego tillage altogether. The green manure or cover crop species, and the costs and benefits of that species, will vary from one crop or crop rotation to the next, and the value of the improved soil will depend on what crop follows the green manure or cover crops and when, as well as the cost of alternative sources of organic matter for the system.

It is virtually impossible to compare complex, diverse, rapidly changing low-input systems with high-technology systems that are also complex and rapidly changing, even if somewhat less diverse. Even when achieved, such a comparison may be largely irrelevant because it would only apply to those few farmers using a similar system, and even they will likely modify their systems within a few years. Furthermore, frequently there are no high-input systems with which these low-input systems can be compared. The velvet bean-maize study mentioned earlier, for instance, had to compare a velvet bean-maize system on a 35 percent hillside with a high-input maize system on flat land, because the high-input system will not function on a hillside (Flores 1992).

Another study analysed ten different "improved systems" of production in southern Honduras, each combining several of the above SC and SR technologies, plus a few others. All ten systems were more profitable than the traditional system. Nevertheless, they varied from being just slightly more profitable (a system using only hedgerows and contour ditches) to one in which added income was over six times that of the added costs (a system including hedgerows, in-row tillage, green manure or cover crops and some chemical fertiliser) (Almendares 1995). But no unirrigated high-input systems existed that could be compared with these systems, probably because the risk of losing one's considerable investment to drought is too high. Furthermore, local irrigated systems do not produce maize, beans and millet, the low-value subsistence crops that dominate the traditional systems. And the irrigated systems only function on flat land. Thus comparison would be largely useless.

Therefore, this author would see widespread adoption or abandonment of technologies as a more useful measure of economic feasibility than scientific studies. Given the now well-substantiated fact that villager farmers largely behave in economically rational ways, the spontaneous, non-subsidised adoption or abandonment of a given technology over large areas of a nation should logically indicate a technology's ability to compete economically. Thus, the fact that many low-input technologies are being sustained or are spreading in Meso-America, even years after outside intervention, would seem to be the best proof we will probably ever have that certain low-input SC or SR technologies are economically viable under these farmers' complex and diverse conditions. Using this measure, technologies such as multi-purpose contour hedgerows, animal-traction in-row tillage, and a good number of multi-purpose green manure and cover crops have definitely proven themselves competitive with competing high-input technologies.

Even though we now have good evidence of the economic feasibility of these technologies, if they are to continue to compete we must continue to improve them, both in quality and quantity. We must find more ways, and more efficient ways, to use green manure and cover crops as food and fodder. We must do a good deal more research on integrated pest management (IPM), especially for small-scale commercial vegetable growers. And we must research ways that allow individual small-scale farmers to harvest rainwater, to better use their improved soils and to make both SC and SR and low-input agriculture in general, more attractive in semi-arid areas.

## Recommendations for other areas

- Multi-purpose contour hedgerows and animal-traction in-row tillage have been well validated for use by hillside farmers, and should be widely taught to hillside farmers in much of the tropics.
- Green manure and cover crop technologies should also be widely adaptable for use in the tropics. In this case, the one major exception would be intensive, high-value systems such as irrigated vegetables, where purchased organ matter and compost, for example, become competitive because of the high opportunity cost of any land dedicated to green manures and cover crops.
- Artificial incentives, including subsidies, give-aways, and food-for-work, should not be used for promoting SC and SR technologies. Programmes should choose and/or design technologies such that full payback in increased productivity comes within the first year, thereby making artificial incentives unnecessary.
- More research is urgently needed on micro-scale water harvesting and IPM.
- All further research for villager farmers should take full advantage of participatory technology development (see Veldhuizen et al 1997).
- Extension of these technologies should use farmer-led or farmer protagonist methodologies. (See, for instance, Bunch, 1982, and FAO)

# Traditional mulching practices in Burkina Faso

**Fidèle G. Hien**

## Introduction

In Burkino Faso, extension programmes implemented before the late 1990s for the country as a whole and the central plateau in particular, have demonstrated that investments intended for the intensification of agro-pastrol production systems have not been effective in meeting actual needs. However, indigenous technologies and practices of water and soil management have developed which, when combined with the measures proposed by the extension services, have sometimes given rise to surprising results that have attracted the interests of both researchers and extensionists. In the Centre Nord of Burkino Faso, traditional mulching is one of these practices. There has been a remarkable growth in the use of traditional mulching since 1974-1985 when there was severe drought. First used as a traditional technique for conserving water at field and plot level, mulching has been improved progressively by integration with other anti-erosion and soil management techniques. Today, it is recognised as an effective way of managing water and soil fertility in the region.

Traditional mulching has been the object of recent quantitative and qualitative research efforts. These have made it possible to better evaluate the conditions under which mulching has been developed as well as its impact in agro-ecological and socio-economic terms. This case study provides a summary of the most significant results of these research efforts. They not only clarify the motivations of farmers in this part of Burkina Faso, but also rekindle the discussion on sustainability and the development conditions of a practice that has shown its ability to go beyond the basic objective of subsistence.

## Agriculture in Centre Nord

Centre Nord, the context in which mulching has developed, is part of the Mossi Plateau. Mulching is now being practiced in most of its provinces but especially in Sanmatenga, Namentenga, Bam and Passoré. Between 1985 and 1996 the population has increased by 35 percent. At the moment, the average population density is 52 inhabitants per square kilometer in Sanmatenga, for example. Centre Nord lies at an altitude of 300 metres and is almost flat. Rainfall is between 500 and 800 millimetres. Most soils are ferruginous, crusted and shallow (47 percent). The deep and heavy soils (16 percent) have the best agricultural potential. On average, only 43.5 percent of the land can be cultivated. In 1990, 24 percent of the tillable land was strongly degraded (BUNASOLS-MAE 1990). The natural vegetation is seriously degraded due to over-grazing and over-exploitation because of fuel wood collection.

The Mossi Plateau is considered to be a region were the exploitation level of the land is far above its carrying capacity and where the production system has entered a downwards spiral of degradation (Kessler and Boni 1991; Zoungrana and Zoungrana 1992; Hoek vd et al 1993; Hien 1995). Fallow periods have become very short and nutrients are being depleted. There are negative balances for organic matter (-1.37 tons per hectare per year) and nutrients: Nitrogen (-15 to -20 kilograms per hectare per year) and Phosphate (- 2 kilograms per hectare per year).

In Centre Nord two production systems are found: the Mossi agro-pastoral system and the Peulh pastoral system. Due to degradation, the two systems compete increasingly for fertile lands in the valleys. According to Barning and Dambré (1994), the farmers' socio-economic situation is rather weak: 43 percent of the farmers produce for subsistence, they are poor and without the means to invest in agriculture. Only 19 percent of the farmers can be considered as resource rich and able to invest in crop or livestock production. On average, the grain production balance is negative (-49 kilogram per person per year) just as the income balance (-3000 F.CFA per year). Investment in livestock production gives the best result and is less risk-prone.

## Mulching: origin and development

According to the farmers of Tagalla, Sanmatenga province, mulching is an old technique used to improve soil conditions. Today, it has spread over large parts of the central plateau. Its reappearance was particularly striking after 1974 and more so after 1984, times of severe drought in the Sahel.

Mulching consists of spreading the plots to be cultivated with 6000 kilogram per hectare of straw from *Loudetia togoensis*, an annual herb typical of the superficial soils of the Sudano-Sahel region (Lafay andt Ranson 1995) at the end of the dry season. After it has flowered, the straw of *Loudetia togoensis* can be collected freely from fallow land. It is not a very appetising plant and provides poor forage. This straw, together with household refuse, chaff and dung are the inputs traditionally used by the farmers of the Centre Nord. Dung is the most preferred source of organic matter. Chemical inputs are generally too expensive to be used for cereals, the subsistence crop. Mulching seems to be the simplest solution and the one most within the reach of the farmers of the region who want to improve their soils (Slingerland and Masdewel 1996). Sowing takes place one or two days after the first major rains and there is no tillage before planting. There are three successive weedings in order to incorporate and ensure that the straw is well decomposed before the end of the growing season.

The decision-making criteria used by farmers as to whether mulch should be applied take three factors into consideration: soil type, the type of crop, and the field type. Lafay and Ranson (1995) point out that mulching takes place primarily on so-called "hot" soils. During the 1994 season in the village of Tagalla, mulch was applied in a 100 percent of cases to rehabilitate the denuded and crusted soils known as Zippellé in the traditional classification of land (Schutjes 1991). On shallow and gravel soils, the Zegedega soils, mulch was applied to 44 percent of farmland. Clay-loam or sandy-clay soils found on slopes, and known as Bolé, were mulched in 37 percent of cases. The so-called "cold" soils - sandy soils or Bissiga and heavy soils of the lower areas known as Baongo - are generally less involved and formed respectively 28 percent and 8 percent of the mulched fields in 1994. On these soils the straw is generally burned two days after sowing in order to prevent weeds. For the farmer, mulching aims above all to preserve the humidity of the soil for the benefit of the seeds and this is more important than the fertilising effect of mulch on the soil. This explains why the straw is burnt two days after sowing on the so-called "cold" soils where water storage capacity is the highest (Lafay and Ranson, 1994, Hien et al 1997).

Sorghum is the crop most often associated with mulching whereas millet is considered to be better adapted to drought conditions. Maize is much more demanding of water and nutrients and, as far as this region is concerned, has become a marginal crop only planted in fields that receive more dung and household refuse.

Fields nearest to the house (*champs de case*) receive priority as far as household refuse (38 percent of production in Tagalla in 1994) and cow dung with or without mixed straw (31 percent) is concerned. The fields situated in the proximity of the village (*champs de village*) are the most mulched (50 percent of the household of Tagalla in 1994), followed by the fields nearest to the house. When cow dung is in short supply to fertilise these fields, straw and other inputs are used to complement it. The fields in the bush (*champs de brousse*) that are farthest away from the house receive the least input. In 1994, 53 percent of bush fields in Tagalla received no inputs at all.

Lafay and Ranson (op cit.) have observed that, in Tagalla, the popularity of stone lines as an anti- erosion measure have been accompanied by an increase in mulching. Barning and Dambré (1994) noted that in the province of Sanmatenga in general the practice of mulching decreases when the level of animal traction used by farmers increases. Ploughing before planting is never accompanied by mulching.

## Expansion: reasons and limitations

The analysis of the ecological and socio-economic conditions of agriculture in the Centre Nord reveals why the practice of mulching has spread. Faced with a pressing shortage of land and a growing population, even the poorest pieces of land have had to be brought into cultivation. This has meant that farmers have had to intensify their efforts. Mulching in this region, as well as the practice of Zaï in the northwest of Burkina, are expressions of this imperative.

According to Lafay and Ranson (op cit.), farmers in the central northern region attribute the increase in mulching to two essential factors. First, they have less fertile land to feed more people and second rainfall has decreased over the past 30 years. Rainfall has become more erratic and when it does fall it is often violent and stormy. In the province of Sanmatenga, annual rainfall decreased between 1960-1978 and 1979-1988, varying from 41 millimetres in the south of the province to 210 millimetres in the north (Hoek vd et al 1993). At the same time maximum intensity during a 30 minute interval can reach 108 millimetres per hour (Hien 1995). The number of days of rain has decreased and as a result the season is shorter.

Lafay and Ranson reported that from 1984, some agriculture extensionists began to advise mulching in the technical package presented to farmers. For this reason many farmers began mulching when they saw that their neighbours who practised this method were getting better results. These types of examples have played a very important role ensuring the spread of mulching.

There are two limitations to the development of mulching. First, the lack of straw and second the lack of means and time available to farmers. The straw of *Loudetia togoensis* is mainly harvested on more gravelly, shallow soils (Zagedega) that are generally considered impossible to cultivate. These non-cultivatable soils represent about 56.5 percent of the total area of Sanmatenga province, varying from 80 percent in the districts of the north to 26 percent in those in the extreme south (Hoek vd et al 1993). Moreover, much of this non-cultivatable land is extremely degraded. Like elsewhere in the Sahel, primary production on these soils is closely linked to rainfall patterns (Penning de Vries and Djitèye 1982; Breman and de Ridder 1991). At flowering the straw production varies from between 2500 and 4500 kilograms of dry material per hectare according to the season and the quality of the soils. An average of 6000 kilograms of straw has to be spread at the end of the dry season. The loss of biomass during this period is estimated to be about 25 percent of the plant at flowering stage. This means that the straw of two to four hectares of bush - according to the season - has to be harvested in order to meet the mulching needs of a one hectare field. This is why the bush has not been burnt for the last 10 years.

Transporting the straw is the second constraint facing the farmer. The straw is generally transported by foot from the bush to the fields and is mainly carried by men. The quantities transported vary from 10 to 15 kilograms per person and per trip (Lafay and Ranson op cit.). Depending on the distance from where the straw is gathered, to the field, and the number of active persons in the household and their carrying capacity, the farmer will need between 80 and 200 working hours to collect the amount of straw necessary to mulch one hectare of land. Thus, mulching takes the farmer about a month's work before sowing begins. This is why bicycles can often be profitably used. However, the most practical means of transport is an animal-drawn cart but it is expensive. Since the devaluation of the local currency in 1994, transport costs are about F.CFA 200,000. This figure must be compared to F.CFA 55,000, the estimated annual average household income (Barning and Dambré 1994).

## Ecological impact of mulching

For the farmers of the Centre Nord, mulching increases the production of sorghum. The work of Lafay and Ranson (1994) and Slingerland and Masdewel (1996) sheds some light on the socio-economic aspects of the technique. Research conducted after 1996 has focused on the ecological performance of mulching practices (Hien et al 1997 and 1998). Experiments carried out at farm level in Tagalla village have made it possible to compare the effects of four treatments that combined mulching, stable dung and natural phosphate on the hydrodynamic parameters of the soil, the sorghum production, and nutrient flows and balances. The goal of these experiments was to come to a better understanding of the processes that determine increases in sorghum production and to make it possible to evaluate the sustainability of the system in terms of nutrients. During the cropping season of 1996 with 623 millimetres of rainfall - nearly a normal pattern - three treatments with six repetitions were compared using non-mulched plots as a control:

- simple mulching (6000 kilograms DM $ha^{-1}$) with the dry leaves of *Loudetia togoensis*: refered to here as Pa
- mulching (6000 kilograms DM $ha^{-1}$) + 2000 kilograms. ha-1 of dung or PF
- mulching (6000 kilograms DM $ha^{-1}$) + 200 kilograms. $ha^{-1}$ of "Burkina Phosphate" (natural phosphate ) or PP

After the straw had been spread following normal local farming practice, evaporation was measured over a period of ten days from the time that a local variety of white sorghum was sown. Measuring rainfall and run-off made it possible to calculate the infiltration levels and the run-off thresholds (Hien 1995; Hien et al 1997). At the same time, the germination and seedling settlement of the plants were monitored and the yield levels of grain and straw were measured at harvest time. The total reserves of nitrogen (N), phosphorous (P) and potassium (K) in the first 0–30 centimetres of soil have also been assessed. The absorption of N, P, and K by the plants during the growing season was monitored every two weeks from the fortieth day after planting up to the flowering stage. Thus, it was possible to measure the changes of N (Nb), P (Pb) and K (Kb) in the sorghum biomass above the ground. At the same, the straw and dung have been analysed and finally, on the basis of data related to nutrient flows in the agricultural systems of Burkina's central plateau (Piéri 1989; Lompo 1993) and of the Sahel in general (Penning de Vries and Djitèye 1982), an evaluation of the N and P balances was made. The results of this work can be summarised as follows:

- ***Mulching significantly improves the hydrodynamic conditions of the soil***

As far as water flows are concerned, mulching secured 64 percent reduction in water losses and, in comparison to the control plots, infiltration into the soils has improved 4 to 7 times. Evaporation was reduced by 30 percent on mulched plots.

- ***Mulching improves crop development conditions and crop yields.***

Statistical analysis of the results shows that mulching significantly improves the period of germination. It reduces primary mortality (after germination) of sorghum and positively influences the production of grains and straw. For straw production, the difference was highly significant ($p<1$ percent) between the control T (480 kilogram DM $ha^{-1}$) and the treatments with straw: Pa (2265 kilogram DM $ha^{-1}$), PF (2729 kilogram DM $ha^{-1}$) and on the hand was also significant ($p<5$ percent) between the control T and the treatment PP (1836 kilogram DM $ha^{-1}$). The treatments with straw when compared to each other did not show any significant difference. As far as the grain yield is concerned, the analysis also showed that the treatment control T (140 kilogram $ha^{-1}$ on average) revealed a highly significant difference when compared to the treatment Pa (774 kilogram $ha^{-1}$), PF (1064 kilogram $ha^{-1}$) and PP (687 kilogram $ha^{-1}$). The treatments PF and PP showed a difference at the 5.7 percent level while there was no significant difference between PF and Pa.

- ***From the point of view of mineral balance mulching has some risks***

The N and P balances have been calculated on the basis of the principal that, within the local agricultural system, all the crop residues at harvest are export-ed. This implies that the calculated immobility corresponds to the mineral exports. The balances of N and P at the end of the 1996 rainy season are given in the following table:

| | | Treatments | | | |
|---|---|---|---|---|---|
| | | T | Pa | PF | PP |
| Inputs | N | 4.00 | 17.80 | 51.00 | 17.80 |
| | P | 1.50 | 1.62 | 9.62 | 24.00 |
| Losses | N | 9.40 | 25.20 | 32.30 | 21.70 |
| | P | 0.78 | 2.45 | 3.50 | 2.17 |
| Balance | N | -5.40 | -7.40 | +18.70 | -3.90 |
| | P | +0.72 | -0.83 | +6.12 | +21.83 |

Despite the fact that important quantities of straw are involved, the mineral input linked to mulching with *Loudetia togoensis* hay is extremely weak. This is because of the bad quality of the straw at the end of the dry season. The level of N in the straw at that time is less than 0.23 percent. On the other hand, the organic input associated with this practice is very important (5600 kilogram $ha^{-1}$ of organic matter). Simple mulching (Pa) revealed a relative phosphorous shortage in the soils. The input of dung or "Burkina Phosphate" has made it possible to mitigate this shortage which resulted into a better P/N balance (Van Duivenbooden 1996): the P/N ratio at flowering stage was 0.1. Indeed, the input of dung has considerably improved the availability of nitrogen. Equally, the input of 200 kilogram $ha^{-1}$ of "Burkina Phosphate" stimulated the absorption of P. The greater availability of this element has improved the uptake of N with the result that the N balance has become negative.

In general, the calculated P balance confirms the observation (Lompo 1993) that the P input, whatever its source, improves the P balance. This is especially the case when the P source is less soluble (as with " Burkina Phosphate" in our case). These data also confirm the conclusion that mulching, applied alone, primarily aims to improve the bio-physical condition of the so-called 'hot' soils in order to improve germination and seed establishment (Lafay and Ranson 1995; Slingerland and Masdewel 1996; Hien et al 1997).

As far as the mineral balance is concerned, two treatments would, in the long term, imply a risk of soil mining. Simple mulching (Pa) that only improves the availability of water would mine the soils of N and P, and the treatment straw and natural phosphate (PP) might mine nitrogen reserves more rapidly because of an increased input of phosphorous. The combination of mulching and dung (PF) show the best sustainability characteristics at plot level.

The weak yield levels observed in the control plots, as well as the higher levels of nitrogen and phosphorus in the sorghum biomass at the flowering stage indicate quite clearly that, without mulching, production is primarily limited by water. Thus, it is logical that the simultaneous improvement of soil water conditions and N and P availability (treatment PF) has given the best results.

## The socio-economic advantages and limitations of mulching

Mulching appears to be a common practice amongst Mossi farmers (Barning and Dambré, 1994; Lafay and Ranson, 1995), because there is little dung available within their households. Peuhl herders who have access to cattle and dung, only mulch very rarely. In order to get an adequate supply of cow dung, Mossi farmers sometimes enter into "cow dung contracts " with the Peuhls. The Peuhl are paid in kind or in natura and they leave their cattle overnight on Mossi fields for part of the dry season.

Amongst the Mossi, mulching is also the only way women can improve the yields they get from their fields. Women's fields are generally situated on less fertile soils. Lafay and Ranson have observed that women's fields are more frequently mulched than those of the men. Women do not own land themselves and often they have to change fields because their husbands have new cultivation plans. In addition, apart from a few rare exceptions where women possess cattle themselves, the dung comes from the family stable and is primarily intended for the family field.

Compared to the average yield levels in the region which are about 450 kilogram $ha^{-1}$ on top soils (DEP-MAE, 1988 and 1989 cited by Hoek vd et al 1993), mulching alone would, in a normal rainfall year, allow an increase in sorghum yield of about 50 to 75 percent on this type of soil. When this is also combined with dung (2000 kilogram $ha^{-1}$) the yield levels realised in Tagalla are at least two times better than the regional average. As far as the financial balance of the households is concerned, evaluation shows that even with a doubling of yield levels, the time dedicated to the transport of straw (about 180 hours of work per hectare) does not constitute an improvement in financial terms. Only the transport of straw by animal-drawn carts would result in a ten-fold reduction in the number of hours worked. This would contribute to an improvement or maybe even bring the financial balance of the households into equilibrium.

## Conclusion and discussion

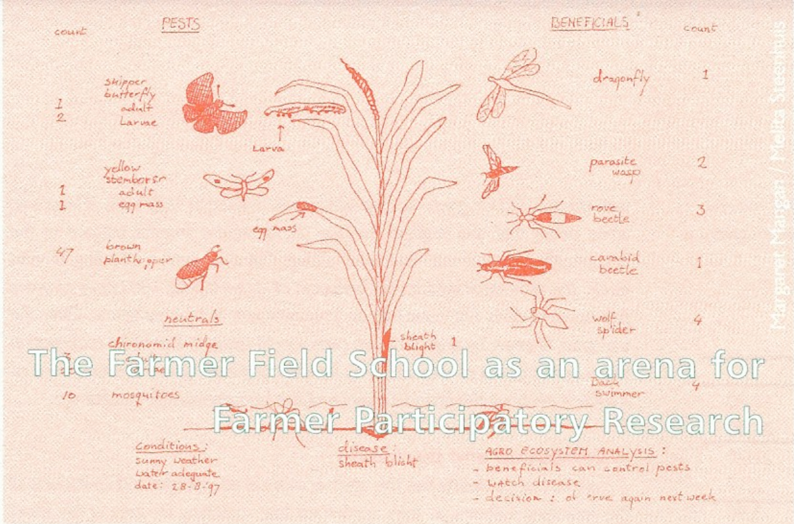
Farmers quite clearly see the agro-ecological advantages and limitations of the mulching systems as they confirmed that mulching by itself is the most effective when rainfall is inadequate (Hien et al 1998). In conditions of drought dung when used alone would cause growing difficulties because of water stress and would result in lower biomass and grain production. By contrast, when there is good or normal rainfall, mulching alone would result in an important growth of the biomass but grain yield levels are lower. In other words as Barning and Dambré (1994) and Lafay and Ranson (1995) have shown, farmers prefer dung to simple mulching in normal rainfall conditions. They know that the straw does not add significantly to soil nutrients but does improve humidity. Mulching appears to be the only solution when it comes to improving sorghum yields in situations where dung is not available in sufficient quantity and where chemical fertilisers are too expensive.

The work of Hien et al (1997 and 1998) show that for farm households it is at least possible to achieve a positive mineral balance by combining mulching and dung application. The N and P balances obtained by combining 6000 kilogram $ha^{-1}$ of straw and 2000 kilogram $ha^{-1}$ of dung show that it is possible, at least at a certain level, to achieve sustainable agriculture based on low levels of external inputs. Dung in this context is the most limiting input. Simulation shows that, by combining it with mulching, it becomes possible to reduce the input of dung by half to 1000 kilogram $ha^{-1}$ without compromising the N and P balances and still increase the content of organic matter in the soil.

At the village level, however, improving the sustainability of the system necessarily involves a combination of various measures that would allow an increase in the availability of both straw and dung. Hoek vd et al (1993) has shown that the need for organic matter or compost to maintain the fertility of cultivated soils in Sanmatenga is 2.7 tons per hectare per year. Even if there were a complete, 100 percent, stablisation of cattle and other livestock in the province, this would only provide enough dung for 25 percent of the land being cultivated. At the same time Hoek vd et al (1993) have observed that, in financial terms, the expenditure required for composting would largely exceed the income it produced. By reducing dung input by half in a system that combines mulching and dung, the availability of dung could be increased. However, it is likely that the absence of investments aiming at the conservation and rehabilitation of sylvo-pastoral lands will contribute to a decrease of fallow land, as compared to total cultivated land needed to maintain the organic and mineral equilibrium of the production system. This lack of investment favours the accelerated degradation of sylvo-pastoral land (Hien 1995) and reduces the level of straw production. Finally, the stabling of cattle and other livestock - a pratice that has been pursued for the last ten years in a number of villages in Sanmatenga - assumes that the production of dung at household level can be doubled and that, at the same time, the regeneration of non-cultivated land is helped by reducing animal pressure on it. There are not many choices available in situations like those found in the Centre Nord.

*Translated from the French by Bert Lof and Carmen Rodriguez.*

With and without mulching, the difference is clear.




# The Farmer Field School as an arena for Farmer Participatory Research

**Elske van de Fliert, Wiyanto and Ann R. Braun**

Inspired by ILEIA publications on Participatory Technology Development (PTD), the International Potato Center (CIP) and its partners in Indonesia, Mitra Tani, Yogyakarta; Duta Wacana Christian University (UKDW), Yogyakarta; and Research Institute for Legumes and Tuber Crops (RILET), Malang initiated a participatory project in November 1994. The objective of the programme is to develop Integrated Crop Management (ICM) approaches for sweetpotato cultivation, including an adapted Farmer Field School (FFS) model for sweetpotato ICM, in major production areas in Indonesia. This paper provides an example of how Farmer Participatory Research (FPR) can support Farmer Field School (FFS) development, and how FFS can provide an arena for participatory evaluation of technology . An analysis of opportunities and constraints to farmer participation in technology development and FFS as an extension model, are elaborated.

## The project

Since CIP has a research and development mandate, the project is limited to the development of technology and extension approaches, and anticipates large-scale extension and implementation by developing self-supporting ICM Programmes that are linked to on-going extension mechanisms. The first phase of the project (1994-97) focused on technology and extension development, and phasing over to the Indonesian National IPM Programme and NGO Programmes. The second phase (1998-99) is devoted to participatory monitoring and evaluation and further institutionalisation of ICM training and implementation. Sweetpotato cultivation systems have received little attention in Indonesia's agricultural development programmes, and little investment in research has occurred, leaving a gap in field testing under farm conditions. No training on sweetpotato has ever been given to extension officers by national programmes. Consequently, the project was designed to identify and tackle gaps in both technology development and extension approaches. The FFS model, successfully implemented since 1989 for rice IPM in Asia (Kenmore, 1991; Van de Fliert, 1993), was chosen as the starting point for extension development for sweetpotato ICM.

## A participatory approach

The participatory approach applied for project implementation favoured the achievement of specific outputs envisioned by the project, including identification of farmers' cultivation and training needs; development of ICM technology appropriate for cultivation conditions in Java; development of an FFS model for ICM; cadres of trainers trained on ICM FFS; and development and inititation of self-supported ICM programmes. The participatory nature of the project in both technology and extension development is demonstrated by (Van de Fliert et al., 1998): · intensive participation of eight farmer researchers (farmers from the four project sites) at all stages of the project; · involvement of the farming community (men and women farmers, traders, consumers) at the stage of problem identification and analysis; and · participation of farmers in testing and evaluating the ICM FFS curriculum.

Participatory research approaches enhance effectiveness and efficiency of more conventional research activities. In addition, they accelerate technology dissemination through early integration of farmers in the process of testing and adapting technologies and in the development of extension methods. Farmer involvement in technology development also reveals which experimental and analytic skills need to be strengthened, and serves as an important source of input for further training curriculum development.

## Farmer experimentation

During the technology development phase of the project, the team of eight farmer researchers and collaborators from Mitra Tani, CIP, UKDW and RILET, met twice per year at Evaluation and Planning Workshops. Project sites were visited every month by Mitra Tani collaborators. These workshops and visits were crucial to the on-going process of setting the research agenda to reflect farmers' needs, and incorporating the farmer researchers' work into the technology and curriculum development efforts (Braun and Van de Fliert, 1997). During the workshops, problems identified in the field were analysed; possible solutions were developed from farmer practice, research experiences, and from the literature were shared. New research topics for the coming season were identified by the farmer researchers; and experiments were designed together. Over a period of five seasons, the eight farmer researchers conducted fifty-seven trials on twelve different research topics. The majority of these topics dealt with fertilisation. This was in respons to farmers' priorities and reflecting the information gap on this issue. As a result, inefficient fertilisation practices were modified from those developed by farmers from their experience as rice cultivators.

Additional experiments were done in pilot ICM FFSs. Some of these experiments were designed as learning exercises. An example is a leaf defoliation experiment aiming at changing farmers' perception towards leaf-eating pests by allowing them to observe the negligible effect of defoliation on root yield. A second type of experiment used served a demonstration purpose. In a demonstration experiment an IPM or ICM practice applied on one half of the field is compared with farmer practice on the other half. Other experiments addressed topics prioritised by the farmers and served a technology evaluation and adjustment purpose. Examples are variety trials evaluating a range of sweetpotato varieties new to the FFS location, and fertiliser application rates.

The FFS curriculum includes several exercises in which farmers learn basic guidelines for experimental design and are given the opportunity to practice on the FFS field in order to enhance their skills. The results of all these experiments conducted during the ICM technology and FFS curriculum development stages, contributed greatly to the guidelines compiled for sweetpotato ICM. It is stressed here that the ICM guidelines are not meant as fixed recommendations. They are flexible guidelines that provide a starting point for further testing and adaptation under the specific conditions of each location. They emphasise creation and conservation of a healthy ecosystem by promoting soil, seed and crop health.

## Training of trainers and FFS

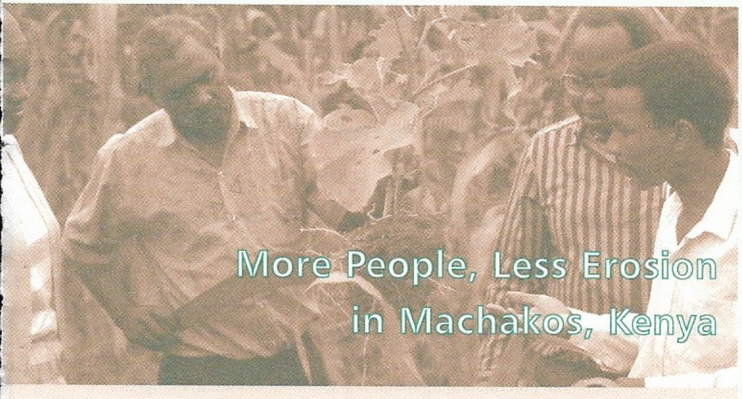
After the sweetpotato ICM technology and concomitant FFS model were ready for implementation, the project trained forty trainers from the National IPM Programme (NIPMP) in June 1997, and forty-two trainers from local NGOs in April 1998. Both groups included staff as well as farmer trainers. The NIPMP trainees originated from six irrigated, major sweetpotato-growing areas from four provinces in Java, whereas the NGO trainees represented thirty organisations working in the dryland areas of thirteen provinces all over the country. As a follow-up to the training of trainers, the NIPMP conducted six sweetpotato ICM FFSs during the subsequent season, and more NIPMP and NGO FFSs are planned for the coming seasons. In addition to sweetpotato ICM FFSs, many of the NGO follow-on programmes planned included further testing and experimentation of the ICM approach on sweetpotato and other crops, some ICM FFSs in crops other than sweetpotato, and second generation training-of-trainers for the organisations' staff. Generally, FFS participants find the ICM FFS approach beneficial, since it provides them with knowledge and skills that allow them to obtain higher yields with lower expenditures. This congruence with farmers' needs can be fully attributed to the intensive involvement of farmers in the ICM and FFS development process.

### Farmer experimentation supporting FFS development

The Farmer Field School model is not a magic formula that guarantees the same level of success for other crops, conditions and regions that it did for rice IPM in many Asian countries. The experiential learning principles of the FFS approach are among the elements required for success. These need to be packaged as a learning opportunity tailored for the characteristics of the farmer audience, including socio-cultural aspects and farmers' specific perceptions of the agroecological under concerned. To fulfill farmers' expectations, the FFS should have a solid technical content that enables them to find answers to their questions. These answers can emerge from the self-discovery process promoted in the field school, or from exposure to problem-solving methods and new information. To make sure that the technical content provides suitable and applicable guidelines, farmers' involvement in technology development is of utmost importance.

### Farmer experimentation for further technology adjustment

Because the FFS is a season-long, field-based and experiential-learning activity, it can provide an arena for farmers to acquire or enhance experimental skills. It also offers the opportunity to directly test and adjust ICM guidelines that may be considered dubious by farmers. The ICM guidelines learned in a field school can never provide answers to all the specific problems encountered by farmers across a range of agroecological conditions, hence developing farmer capacity for further adjustment and development is essential. Experimentation in a field school often results in the spontaneous implementation of further studies by farmer groups. Therefore, farmer experimentation is of utmost importance if the ICM approach promoted is to spread from farmer to farmer, and from sweetpotato to other crops, enhancing collective action, which can contribute to better adapted and more sustainable farming systems.



# More People, Less Erosion in Machakos, Kenya

Exchanging ideas: the essence of agricultural evolution.

In 1930, the population of the Machakos District in Kenya, the Akamba people, was about 250,000. Extensive livestock raising was combined with shifting culti-vation on small hand-cultivated plots of maize and other food crops. Frequent and unpredictable drou-ghts decimated food production and damaged the heavily grazed rangelands. Much natural woodland had been removed and replaced by sparse shrub- and grassland. Farm yields were low and thought to be declining, soil nutrients were depleted, the topsoil was being eroded away and livestock numbers were considered to be far in excess of carrying capacity. The official view was that the farming system was unsustainable, if not in terminal decline.

In 1990, the population of Machakos District had increased by a factor of six to nearly 1,500,000. Although the district had roughly doubled in size, with the accession of previously uninhabited crown lands, population densities increased from under 80 per km$^2$ in the wettest areas in 1932 to nearly 400 per km$^2$ in 1989, and from about 50 per km$^2$ in the drier areas to nearly 150 per km$^2$.

Agricultural output (food and cash crops, horticulture and livestock) increased from less than 0.4 tons per capita in 1932 to nearly 1.2 tons per capita in 1989, and from 10 to 110 tons per km$^2$. Cash crops have only very occasionally occupied as much as 15 percent of cropped area as there is need to keep most land under food crops to avoid purchases at high prices in bad seasons. Nevertheless, because of their high unit values cash crops are vitally important as income generators. District food sufficiency improved substantially, some households buying, others selling. Living standards also improved through higher cash income. A growing part of cash income comes from off-farm activities. In 1981-2, only 50 percent of rural income in Machakos was from farming. But off-farm income was more locally generated than in the 1950s, when most men who needed work had to go outside the district, remitting part of their earnings home.

Soil and water conservation structures were extended, during 1960-90, to almost 100 percent of the district's arable land, excepting only the flattest and least densely populated areas. By 1990, rangelands was also coming under increasingly careful management. Planting and protecting trees on small holdings became universal practice. Measured tree densities were found to be highest on the smallest holdings. The farming system was more, not less sustainable than thirty years before.

The Akamba follow a normal investment strategy of investing first in the things that they perceive to give the highest reward, and later in those things that give a smaller reward. They saw that investment in education gave a high return, enabling the young to get good jobs. Young people were then expected to use part of their earnings to help their parents, and to make investments in family enterprises. The second investment was often in a non-farm enterprise, such as a shop or a transport vehicle. The third investment has generally been in the improvement of arable land and the enclosure of grazing. The fourth, which is more recent, involves other measures to improve grazing lands, which yield less than arable land. As the population increased, more grazing land has been converted to bush and more intensive methods of feeding livestock using crop residues and fodder crops, have been undertaken.

Some of the required new technologies and knowledge of new markets have come through official research and extension in particular a drought-resistant maize variety (which farmers now use, often in combination with their own varieties), methods of combating coffee-berry disease, coffee co-operatives and marketing structures, livestock health measures and some trees and fodder grasses. Other innovations have come through farmers' own experimentations and observations made during their travels outside of Machakos. Service abroad in the Second World War seems to have been a particular fruitful source of new ideas, but ideas were also acquired during journeys within Kenya in pursuit of work or trade. Some innovations have been introduced by traders, particularly from two canning factories and those trading in vegetables for export. Other ideas have come from educated relatives and from NGOs, often church-connected.

Machakos has certain advantages, including its proximity to Nairobi and Mombasa. Kenya as a whole has many advantages which have offset the fact that Machakos also has some major disadvantages, including low and variable rainfall and low average soil fertility.

**Adapted from Tiffen, M. Mortimore, M. and Gichuki, F. More people less erosion: environmental recovery in Kenya. Chichester, UK: John Wiley & Sons**

## List of Abbreviations and acronyms

| | |
|---|---|
| ACDEP | *Association of Church Development Programmes* |
| AME | *Agriculture, Man and Ecology* |
| AS-PTA | *Assessoria e Servicos a Projetos em Agricultura Alternativa* |
| CATIE | *Centro Agronómico Tropical de Investigación y Enseñanza* |
| CIP | *The International Potato Center* |
| CLADES | *Consorcio Latino Americano de Agroecologia y Desarrollo* |
| ENDA | *Environnement et Développement du Tiers-Monde* |
| FAO | *Food and Agriculture Organization of the United Nations* |
| FFS | *Farmer Field School* |
| GATE | *German Appropriate Technology Exchange* |
| GATT | *General Agreement on Tariffs and Trade* |
| GEYER | *Groupe d'Etudes et de Service pour l'Autopromotion Paysanne* |
| GMOs | *Genetically Modified Organisms* |
| GTZ | *German Agency for Technical Cooperation* |
| HEIA | *high-external-input-agriculture* |
| ICLARM | *International Centre for Living Aquatic Resources Management* |
| ICM | *Integrated Crop Management* |
| ICRAF | *International Council for Reseaech in Agroforestry* |
| IFOAM | *The International Federation of Organic Agricultural Movements* |
| IFPRI | *International Food Policy Research Institute* |
| IIED | *International Institute for Environment and Development* |
| IIRR | *International Institute for Rural Reconstruction* |
| INM | *Integrated Nutrient Management* |
| IPM | *Integrated Pest Management* |
| IPRs | *Intellectual Property Rights* |

| | |
|---|---|
| IUCN | *International Union for Conservation of Nature and Natural Resources* |
| LEIA | *low-external-input-agriculture* |
| LEISA | *low-external-input and sustainable agriculture* |
| NAFTA | *North American Free Trade Agreement* |
| NGO | *Non-Governmental Organisation* |
| NIPMP | *National Integrated Pest Management Programme* |
| ODI | *Overseas Development Institute* |
| PLA | *Participatory Learning for Action* |
| PRA | *Participatory Rural Appraisal* |
| PRAM | *Participatory and Reflective Analytical Mapping* |
| PTD | *Participatory Technology Development* |
| RAAKS | *Rapid Assessment of Agricultural Knowledge Systems* |
| REDAB | *Réseaus de Développement d' Agriculture Durable* |
| RILET | *Research Institute for Legumes and Tuber Crops* |
| SC | *Soil Conservation* |
| SR | *Soil Recuperation* |
| TOOL | *Transfer of Technology for Development* |
| TOT | *Transfer of Technology* |
| TRIPs | *Trade Related Aspects of Intellectual Property Rights* |
| UKDW | *Duta Wacana Christian University* |
| UNAG | *Union Nacional de Agricultores y Ganaderos* |
| UNCED | *United Nations Conference on Environment and Development* |

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# Leisa in perspective
## 15 years ILEIA

Written for the Jubilee of the ILEIA project (1984-1999), this publication sets subsistence as well as market-orientated agriculture in the perspective of ecological sustainability. It discusses the problems of intensifying agricultural production to meet the world's growing demand for food and other agricultural raw materials. In surveying the macro-processes that support the rapid integration of all types of farming systems into the international market, it focuses on the pressures experienced by small farm households that are unable or unwilling to enter market-orientated agriculture or who cannot maintain their position in an increasingly competitive global market.

The book raises the question of whether an ecologically sustainable intensification of agriculture is possible and examines LEISA approaches found in subsistence and market agriculture. Using case studies, the authors explore how LEISA can contribute to solving the agro-technical problems faced by small farmers and indicate how, in its social and cultural dimensions, LEISA has the capacity to preserve the continued independence and vitality of rural communities.

The authors show how LEISA draws on the stores of knowledge that small farmers have accumulated over centuries of agriculture and which have largely been ignored by modern technological research and development. They argue that farmers, researchers and development agencies need to use participatory methods in working together to develop LEISA further and to test its resilience in practice.

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