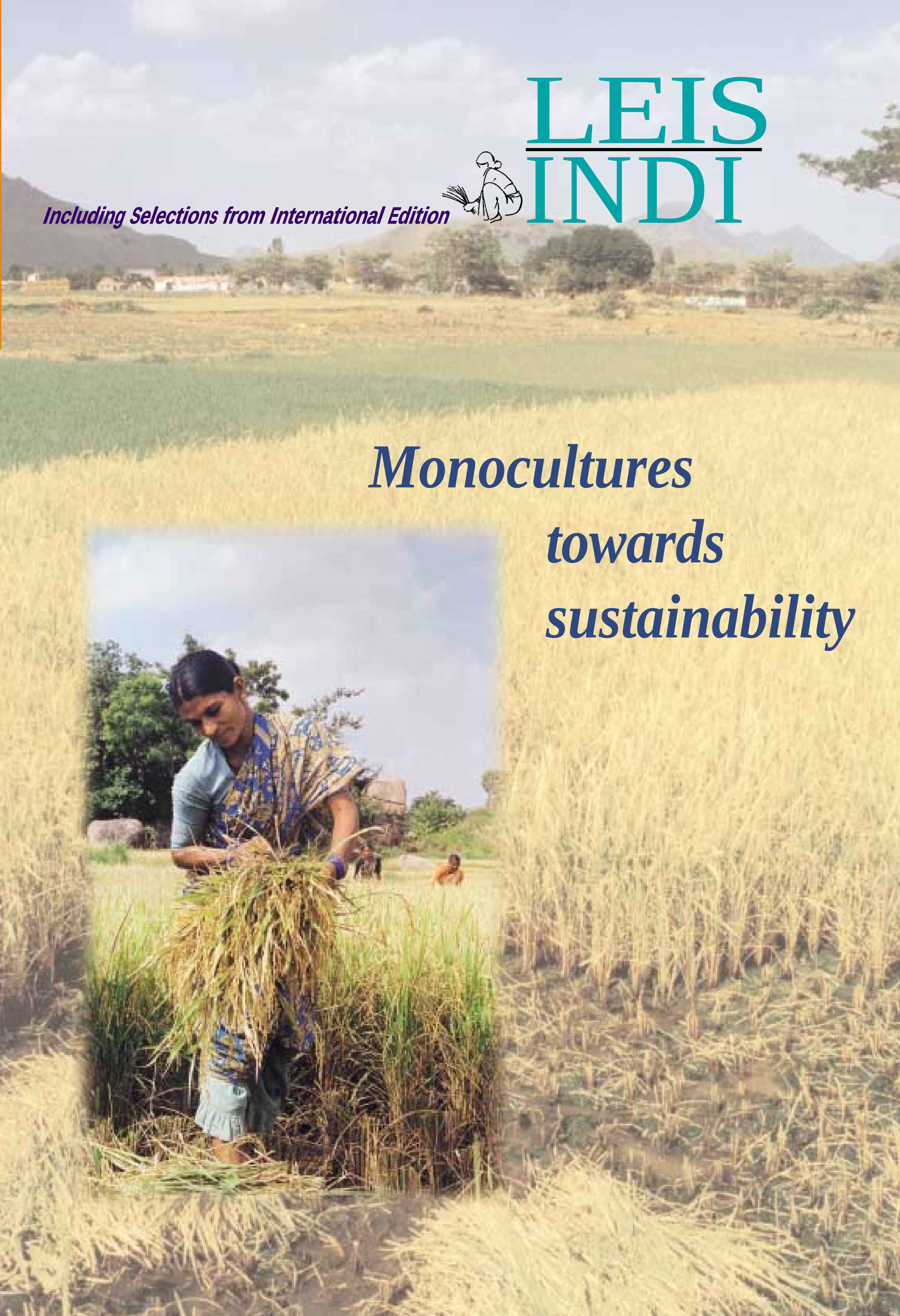
December 2000 volume 2 no. 4

LEIS INDI

Including Selections from International Edition

Monocultures towards sustainability



LEISA

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The editors have taken every care to ensure that the contents of this Newsletter are as accurate as possible. The authors have ultimate responsibility, however, for the content of individual articles.

The editors encourage readers to photocopy and circulate Newsletter articles.

Dear Readers

We would like to thank you for your encouraging response resulting in increasing readership, feedback and contributions. We are also looking forward to your increased support for the future themes.

The issue of LEISA India focuses on monocultures including annual commodity crops. It emphasises the experiences being gained with development of LEISA for typical Green Revolution systems. We assume that farmers with larger holdings, specializing in commodity crops too have at least as many ecological sustainability problems. That is the reason we have included few articles on large scale farming.

We have included articles highlighting eco-friendly technologies for Groundnut and Cotton, results of inter cropping experiments, and interesting traditional practices. From this issue onwards, we have merged contributions received in India with selections from international edition, thus, not maintaining seperate sections.

Hopefully, the articles and additional information would inspire more initiatives towards LEISA.

Corrigendum: In the last issue, September 2000, Volume 2 no.3, author’s name of the article ‘Cultivation of medicinal plants as mixed crops in Malenadu region: a study’ has been misspelt. The correct spelling is: Keshav H Korse. We deeply regret the error and the inconvenience caused.

The Editorial team

Sustaining the Green Revolution by resource conserving technologies

Peter R. Hobbs, Raj Gupta, J.K.Ladha and Larry Harrington

The Rice Wheat Consortium in South East Asia has joined hands with farmers in developing resource conserving technologies to improve production and ecologise the rice-wheat system in the Indo Gangetic Plains. Farmers are experimenting with new technologies like zero tillage, direct seeding, bed planting, Integrated Pest Management and Situation Specific Nutrient Management. Although the use of some of these technologies is spreading fast, much still has to be done to make the Green Revolution sustainable.

ame promotes sustainable livelihoods through combining indigenous knowledge and innovative technologies for Low-External-Input natural resource management. ame is an innovative training programme and resource centre enhancing synergies between institutions and individuals involved in sustainable agriculture.

ILEIA is the Centre for Research and Information on Low-External-Input and Sustainable Agriculture. It seeks to exchange information on LEISA by publishing a quarterly newsletter, bibliographies, and books. ILEIADOC, the data base of ILEIA’s documentation centre, is available on diskette and on ILEIA’s Homepage: ***www.ileia.org.*** Back issues of the ILEIA Newsletter are also available on ILEIA’s website.

LEISA is about Low-External-Input and Sustainable Agriculture. It is about the technical and social options open to farmers who seek to improve productivity and income in an ecologically sound way. LEISA is about the optimal use of local resources and natural processes and, if necessary, the safe and efficient use of external inputs. It is about the empowerment of male and female farmers and the communities who seek to build their future on the bases of their own knowledge, skills, values, culture and institutions. LEISA is also about participatory methodologies to strengthen the capacity of farmers and other actors, to improve agriculture and adapt it to changing needs and conditions. LEISA seeks to combine indigenous and scientific knowledge and to influence policy formulation to create a conducive environment for its further development. LEISA is a concept, an approach and a political message.

Groundnut and Cotton Cultivation: technologies worth trying

S Balaji Rao, S S Kandagal, H Lanting

ame has been supporting Participatory Technology Development (PTD) primilarly in three states of South India in collaboration with various stakeholders. During the past five years, beginning with a single crop as an entry point and gradually moving towards IFS, focus is on improving and stabilizing LEISA technologies for specific crops (goundnut, cotton, paddy, ragi, green gram, red gram, bajra, jowar and vegetables). Highlighted are the technologies worth trying for Groundnut and Cotton.

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Mahaweli settlers in Sri Lanka diversify their farms using Farm Planning

Alice de Jonge

In the huge irrigated agricultural settlements of the Mahaweli in Sri Lanka, farmers are up against the ever-decreasing profitability of rice monocropping. Farm Planning for Sustainable Farming, introduced as a tool for better management of resources and sustainable farm development, has helped farm families to diversify their farming system and thereby increase their family income.

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Studies on *desi* cotton based intercropping under dryland conditions

R Naganagouda and others

Intercropping of cotton with short duration legumes, cereals and oilseeds was found more remunerative than growing solely cotton. Highlights results of the studies.

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Themes for 2001

Monocultures towards sustainability

Editorial

Monocultures of the main annual food crops urgently need to be made more productive and sustainable.

The global trends in agriculture – introduction of Green Revolution technology and market orientation, mechanisation, intensification, specialisation, hybridisation, biotechnology and liberalisation and globalisation of agricultural trade - all are favouring the expansion of 'high-input monocultures'. This threatens ecologically sustainable of agriculture and hence long-term food security. In this issue, we look at the negative impact of monocultures, especially of annual food crops, and the alternatives that are being developed.

Expanding monocultures

Whenever farmers focus on market production and adopt the agrochemical model, high-input monocultures become predominant. Not only the number of different crops and animals but also the genetic diversity tends to decrease. The increased use of agrochemicals seriously affects the natural biodiversity in and above the soil, on the farm and in the wider environment. Expanding scale and levelling of land leads to the loss of natural micro-environments and to a further decrease in diversity. In extreme cases this leads to large-scale farming with near endless high-input monocultures, year-to-year production of single crops on the same land, as in many Western and in some Southern countries like India (rice and wheat, p.8; groundnuts and cotton, p.19-20; The Philippines (sugarcane, p.23) and Bangladesh (rice, p.15).

Technological, economic and political forces are driving agriculture towards monocultures. Such systems are rewarded by economies of scale and contribute significantly to the ability of national agricultures to compete on international markets. The case on sugarcane monoculture in The Philippines (p.23) provides a good example of how monoculture reduces biological and economic diversity, degrades natural resources and affects small farmers.

Serious consequences

Although this type of agricultural development made it possible to increase production in excess of global population growth, there is increasing evidence that if continued its negative impact on food security, rural poverty, and the conservation of natural resources will outweigh the benefits. For example (Torres et al, 2000; Altieri, 2000):

- Evidence from a number of experimental and field sites indicate declining growth of yields for the main 'Green Revolution' cereals under intensive cropping on some of the better lands, e.g. the Indo-Gangetic plains (p.8). In some places, yields are actually in decline.
- Most large-scale agricultural systems exhibit a poorly structured assemblage of farm components, with almost no linkages or complementary relationships between crop enterprises and among soils, crops, and animals. Cycles of nutrients, energy, water and wastes have become more open which makes it increasingly difficult to recycle nutrients. Hence, these systems are very inefficient in the use of their resources.
- Higher primary production is obtained by increasing the use of external inputs and is leading to a decrease in their efficiency and hence an increase in pollution.
- Use of pesticides in the developing countries is increasing exponentially, just as is their negative impact on the health of people and the environment.
- As specific crops are expanded beyond their "natural" ranges to areas of high pest potential, or with limited water, or low-fertility soils, intensified chemical controls are required to overcome the limiting factors.
- High-input monocultures depend increasingly on fossil energy and lead to depletion of soil organic matter, which in turn contributes strongly to climate change.
- Lower prices of agricultural products were particularly beneficial to urban populations, but have not had the same effect in rural areas. On an average, around 50% of the rural population in many places in the world remain to be poor. The most affected regions are Sub-Saharan Africa and South Asia.
- Dietary consequences of monocultures are substantial. Reduced crop and natural biological diversity has resulted in decreased dietary diversity. Eating more maize, rice or wheat has actually increased micronutrient malnutrition, especially in Green Revolution areas, termed as 'hidden hunger' (IRRI, 1999).

About two-thirds of the agricultural lands have been degraded to some degree in the past 50 years by erosion, salinisation, compaction, nutrient depletion, biological degradation, or pollution; about 40% of these lands are strongly or very strongly degraded. Unlike more complex agroecosystems, high-input monocultures are not capable of providing multiple functions of ecological and economic value. If we choose to continue the current patterns of resource use, we will be faced with the decline in the ability of agroecosystems to yield their broad spectrum of benefits – from clean water to stable climate, fuelwood to food crops, timber to wildlife habitat (World Resources Report, 2000).

Sustainable alternatives possible

In many places in the world it is already happening! Out of economic and ecological necessity, farmers and development supporters are trying to move away from high-input monocultures. Different approaches are being followed, e.g. Resource Conserving Agriculture, Evergreen Revolution, Agroecology, Permaculture, Regenerative or Organic Agriculture. There are important differences between these approaches but they all have a common denominator: resource conservation.

The transitions described in the articles lead to: reduced and more efficient use of agrochemicals, fossil energy, irrigation water and seeds; storage of carbon in soil organic matter and biomass (which reduces climate change); reduction of soil degradation. But at the same time they lead to higher production and lower costs and labour! This is true for zero tillage in rice-wheat production (p.8), ecological intensification of rice production (p.11 and 12), diversification of the production of rice (p.15), sugarcane (p.23), groundnut and cotton (p.19-20). This is contrary to common belief!

Monoculture or polyculture?

But what type of biological diversity is needed for ecological sustainability? Wood (1998) challenges polyculture as a means of sustainable production of annual cereals in the light of many natural grass monocultures. What can farmers learn from these natural monocultures to improve the productivity, stability and ecological sustainability of the present high-input monocultures? Wood states that single crops have self-regulation through high crop-associated biodiversity, in the soil as well as in the vegetation, in and outside the field. It is this associated biodiversity that is strongly influenced and reduced in high-input monocultures, due to agrochemicals, intensive tillage and the large-scale. The cases show that higher productivity and reduced losses and costs can be achieved by: combining different varieties of e.g. rice (p.12), intercropping, e.g. cotton, cereals, legumes and oilseeds (p.36), organic soil management (p.20) or diversification of rice production by reintroduction of fish, vegetables and trees (p.15).

Much can be learned from the experiences of traditional and ecological farmers, e.g. how traditional farmers in Kalahandi, Orissa (p.13) and Narayan Reddy, ecological farmer near Bangalore (p.30), manage their cultivation. Do they mimic natural monocropping or do they consciously combine annual cereals with other crops to enhance productivity, stability and sustainability? How do these farmers manage their crops and why are they successful, e.g. how and why do ecological farmers in Madagascar get higher rice yields than Green Revolution farmers? (p.12). The System of Rice Intensification (SRI), is now being successfully tried out in many other countries as well. Other cereals, e.g. wheat, millet, sorghum, can be produced in a similar way. Clover or other leguminous cover crops used in e.g. rice-wheat production (p.11) may be an interesting additional element to the zero-tillage approach presently being developed, among others, in the Indo-Gangetic Plains (p.8).

Ecosystem approach needed

A shift to resource conservation requires, first and foremost, a reorientation on how we look at (agro-) ecosystems - we need to view their sustainability as essential to our own. Adopting an "ecosystem approach" means that we evaluate our decisions on land and resource use in terms of how they affect the capacity of ecosystems to sustain life - not only human well-being but also the health and productive potential of plants, animals, and natural systems (World Resources Report, 2000). 'Agroecology' is based on a detailed understanding of ecosystems and the complex interactions of soil, water, plants, animals and farmers; it involves the whole farm and landscape system, and is far more holistic than the conventional crop ecology approach. This requires a scientific re-orientation as well. In essence, the optimal behaviour of agroecosystems depends on the level of interactions between the various biotic and abiotic components. By assembling a functional diversity it is possible to initiate synergisms which support agroecosystem processes by providing ecological services such as the activation of soil biology, the recycling of nutrients, the enhancement of beneficial arthropods and antagonists, and so on. Today, there is a diverse selection of practices and technologies available, although they vary in effectiveness as well as in strategic value. (Altieri, 2000; Gliessman, 1999). Making monocultures sustainable is not just replacing chemical inputs by organic equivalents, but a systematic farmer-led conversion process. It requires gradual re-modelling of the agro-ecosystem by testing various options to improve ecological and economic performance as in conversion to organic agriculture (p.22).

The design of farm implements adapted to ecological practices, such as zero-tillage (p.8) and polyculture is often very important, not only for conditions where mechanisation is needed, but also for those in which hand labour and animal traction prevail.

Old truths to be revised

The acceptance of the narrow scientific logic of conventional agriculture restricts the real possibility of implementing alternatives that challenge this logic. Some opposing practices are:

- Intensive seedbed preparation –zero-tillage (p.8).
- Use of herbicides – use of mulches and cover crops (p.11).
- Continuous irrigation – rice production in aerated soil conditions (p.12).
- Practices that inhibit tillering in cereals – practices that stimulate tillering e.g. in rice (p.12).
- High density row planting in grains – low density planting e.g. in rice (p.12).
- Use of agrochemicals to fertilise the soil and control pests and weeds – use of cover crops, mulches, and functional biodiversity.

The time is ripe to revise such old truths as the alternatives are resource conserving and have the potential to increase production in a competitive way. Yet, much remains to be learned about sustainable agriculture, thus further research is essential and urgent (Global Forum for Agricultural Research, 2000).

The experiences show that there is great potential in agriculture based on resource conservation and agroecology. Unleashing this potential reduces the need to introduce genetically modified varieties, before taking the time to analyse and discuss possible risks. This may prevent disaster caused by genetic modification.

Towards biodiversity based agriculture

Merely introducing alternative agricultural designs will do little to change the underlying forces that lead to high-input monocultures, and will not improve the situation long-term. Ecological degradation is not only an ecological process, but also a political, economic and social process. Many national and international policy changes, e.g. regarding pricing and incentives, research and extension, agricultural trade and education are necessary to create favourable conditions for development of sustainable agriculture (Altieri, 2000).

Transforming monocultures needs large-scale and intensive involvement of all stakeholders. Participatory learning, research and extension programmes that can reach and mobilise large and diverse groups of farmers are needed. Supporting farmer learning and experimentation through, for example, Farm Planning, Sustainability Analysis (p.27), Participatory Research and Farmer-to-Farmer approaches (p.8) and the use of mass communication and information technology can be important elements of a large-scale, cost-effective strategy to make the shift.

A mass movement needed!

However, this cannot happen without a mass movement of farmers and consumers convinced of the dead-end road of high-input monocultures. Broad coalitions of development workers, researchers, policy makers and funders who support such a movement and create a critical mass against prevailing economic and conventional scientific forces are needed.

■

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Other references see p.31

Monocropping: Boon or bane

Virendar S. Khatana and Prabhat Kumar

Agriculture production began with the gathering of the edible grains/ leaves/fruits from the forest and later on shifted to domestication and production of selected crops to meet the requirement of the family/tribes. Subsistence agriculture gave way to other selected crops to fulfill the demand of the growing population. The country faced acute shortage of food grains and also famines in the 18th and 19th centuries. Increasing shortage of food grains with rapid growth of population, particularly after 1950's, lead to the firm belief that only food grains production, particularly cereals, could cope with such adverse situation. 'Grow more food to achieve food self-sufficiency' became the central dogma for the governments in the region as well as in India. Land being limited, the efforts were to increase productivity and land use efficiency. High yielding varieties (HYVs) of various crops were developed. Agronomic practices to get the maximum yield potential from the HYVs were developed. Thus the Green Revolution of 1960s was based on input intensive agriculture. Proportion of area under HYV, quantity of chemical fertilizers used per unit area and level of mechanization became the indicators of agriculture development.

The use of HYVs, following intensive management practices where chemical inputs played an important role, helped in increasing the yield as well as profits significantly. Government agencies and input manufacturers like fertilizer companies laid demonstration trials and did extensive field work to popularise the use of these inputs. These efforts coupled with the higher productivity and profits from the use of input-intensive agriculture resulted in popularisation of HYV, chemical fertilizers and chemical pesticides among the farmers. Subsidies on various chemical fertilizers and pesticides also went a long way in making these inputs widely popular.

Farmers started replacing the area under traditional varieties usually grown as inter-crops and mixed crops to HYV varieties of crops like wheat and rice. HYV wheat and rice became popular in almost all the irrigated areas of India. There was need for mechanization to cultivate large areas and tractors and other implements became popular in areas having irrigation facilities. Mechanization also encourages monocropping. It makes the agricultural operations easier and faster. But there are some demerits of this system. Harvesting with the help of combine harvesters has resulted in loss of fodder to the cattle. In case of mechanised harvesting of paddy, the farmers burn the paddy straw left in the field after harvesting. This leads to loss of organic matter on one side and results in environment pollution on the other. All the trees are removed from the field to facilitate mechanised operations. Removal of trees force the birds and other natural predators which live on trees to leave the place.

Even the small farmers found it profitable to grow monocrop and work as labour to supplement his/her income in the time that would be saved by doing monocropping instead of intercropping. Development of new varieties in non-cereal crops also helped in mono-cropping even in rainfed areas. Groundnut was a profitable crop but being spreading type its cultivation was difficult and farmers grew groundnut only on part of their land and often intercropped with millets and pulses. Development of bunch type variety of groundnut made its cultivation easier and it replaced many other crops in the rainfed areas of Deccan Plateau. The crops which were replaced were mainly the minor-millets and pulses. These played crucial role in the food security and nutritional security of the farm families. The type of cereals available in the public distribution system (PDS) further helped in strengthening the farmers in their decision to go for monocropping of groundnut. It was after the development of HYV cotton that many farmers in the irrigated areas of Deccan Plateau went for cotton cultivation on large tracts. The studies on cropping systems reveal that there emerged large monocropping tracts of particular crops and the number of crops grown on significant areas in different parts reduced. Popularity of a particular crop depended on the profitability of that crop in that area and farmers' choice from the options available and in the given knowledge system.

Growing monocrop year after year has resulted in degraded lands and farms have started becoming unprofitable, particularly for the small holders located in the rainfed areas as the depletion of forests and soil fertility did not allow them to have a successful crop every year. Over the years more and more area has come under mono-cropping and/or the density of intercropping has become too sparse and farmers have become more vulnerable to risk due to climatic factors, pests and diseases and fluctuation in the market prices. The Green Revolution helped the country not only in attaining self-sufficiency in foodgrain production but also in creating the buffer stock. The increase in profits led to establishment of input-based and agro-based industries in the areas where Green Revolution had its impact. The rapid increase in industry based agri-inputs created a chain effect of urban, semi-urban and rural employment opportunities. The quality of life in the areas improved considerably. It also gave impetus to research in agriculture and the country developed a strong base in agriculture research. But the research was primarily aimed at developing monoculture based farming research, where most of the breeding was done to build horizontal resistance in the varieties. This resulted in the appearance of new diseases.

It was after about two decades of introduction of Green Revolution that researchers started pointing towards negative impact of input-intensive mono-cropping. Decreased on-farm biodiversity made crops more vulnerable to widespread pest and disease infestation. Use of pesticides to control pests and diseases and weedecide to control weeds, created an imbalance in ecology and reduced the presence of soil micro flora and fauna resulting in poor soil dynamism and water holding capacity. Agro-ecological niche for the predators is also lost with the loss of biodiversity (in crops, weeds, trees on farm) and thus the threat of widespread disease and pest attack increased.

Being dwarf variety, most of the HYVs produce less biomass compared to the traditional varieties and thus less organic matter in the field due to falling of leaves and also less fodder. The availability of fodder is further reduced by the use of combine harvesters. This lead to increase in fodder prices, making it difficult for small and marginal farmers to rear cattle and this had a chain effect: less fodder - less cattle - less cattle dung- low organic matter in soil - poor moisture retention capacity - poor yields/crop failure - migration - dropouts from schools, and so on.

Use of same genotypes season after season led to degradation of natural resource base by way of depleting particular nutrients and micro-nutrients. The behavioural change among the farmers towards use of packaged nutrients coupled with less availability of organic matter on farm has led to imbalance in soil nutrients, and reduced moisture retention capacity. Increased use of nitrogenous fertilizers result in faster burning of the already scarce organic matter.

Input-intensive monocropping and the mechanization that accompanied it, has also hit the social fabric of the society. It widens the gap between resource-rich and resource-poor farmers. Large areas of monocropping sometimes led to imbalance in supply and demand and thus gluts in markets forcing the farmers to sell the produce at much lower prices. This has led to resentment and demonstrations by the farmers in many areas. Chand (1999) notes that Punjab agriculture where 70% of the area is under rice and wheat has already reached a plateau and its sustainability is under question. He held it responsible for the rise in discontent among farming community.

It is not only the biodiversity in terms of type of crops grown but the genetic base within a same crop variety is being narrowed down with the help of genetic engineering. This increases the risk of heavy loss in case of pest and disease infestation if and when these varieties become popular in future. Genetically modified varieties have genes for higher nutrient use-efficiency and will deplete the particular nutrient.

Monocropping has, no doubt, helped the world to increase availability of food but it is also a well-documented fact that it has increased the use of chemical inputs leading to severe damage to the environment and ecology. Lots of traditional varieties with the potential genes for insects, pests, diseases and drought resistance and host of nutritional qualities have also been lost forever. While pests have developed resistance against pesticides, these pesticides are causing various health problems to the human beings. Reports of skin diseases from the rice dominant Gangawathi area of Karnataka and children with crippling limbs and mental retardation from cashew producing areas of Kerala are some of the many examples. Monocropping which once was considered the boon as it significantly increased the production is proving a bane these days as the production in some crops has already started declining and pests and disease are becoming uncontrollable. It is because of these reasons that some of the researchers have started thinking about bringing diversity in mono-cropping.

There are few examples where farmers have successfully developed diversified farms, which are economically profitable. Some NGOs are also working to revive traditional varieties, intercropping and farm diversification, where trees producing biomass and fruits, etc. are an integral part of the farming system. BAIF-Tiptur has helped small farmers in village

Manjunathpura to plant biomass producing trees and teak on the boundaries. Mango, coconut and jasmine are planted at a spacing of 30 x 30 feet in the main field. Cowpea, horsegram, groundnut and ragi intercropped with crops like castor and pigeon pea, etc. are being grown in fields having fruit and flower trees as the tree size is not too big. This intervention, which started about 8 years ago has successfully stopped the seasonal migration from the village as these farmers had some work on the farm and some income from it almost throughout the year (information collected during field visit). These examples may provide inspiration to others to work towards more diverse and sustainable agriculture. ■

Virendar S. Khatana and Prabhat Kumar
ame

Groundnut seed workshop, 27th –28th September 2001, Ashirvad, Bangalore

The Groundnut Working Group (GWG) comprising of various stakeholders involved in Groundnut production meets annually to review the PTD experiments, discusses problems faced by the farmers in Groundnut production and facilitates evolving solutions by collaborative action. One of the issues identified for exploring further by GWG was: *Seed Production.*

Farming communities need timely access to good quality seed and the breeders would like to develop varieties appropriate for various conditions. The varieties need to be tested in ‘ground realities’ rather than ‘ideal conditions’. Not only the good varieties need to be identified but enough quantities produced. This can happen only with active involvement of all. Most importantly, it was felt that this could be possible by stimulating organized efforts by the farming communities themselves at local level.

To identify various seed village processes, various stakeholders were invited for the workshop. viz., farmers, NGOs, breeders, representatives from banks, academic and research institutions and Government departments from Karnataka, Tamil Nadu and Andhra Pradesh. The workshop was facilitated by ame.

Many varieties of Groundnuts have been developed by several research institutions across the country, which due to some reason or the other have failed to gain currency with the growers. Although the farming community has their own methods of seed production, there has been very little systematic approach towards popularizing the new varieties being developed. The workshop intensively discussed various critical factors involved in the seed production processes. Action plans were evolved for collaborative action.

The major issues discussed were:

- Choosing the right variety
- Ensuring purity and viability
- Assesing the needed quantities for Kharif and rabi seasons
- Social organization for seed production and managing financial transactions
- Local production processes
- Financing the production process at local level
- Storage and distribution mechanisms

All the issues were discussed in small multidisciplinary groups, comprising farmers, breeders, bankers and scientists. This ensured that farmers’ perspectives were taken seriously by various stakeholders. Action plans were drawn taking into account the operations, the financial aspects, Partners, their roles & responsibilities.

Specific discussions regarding selection of farmers, acreage, choice of varieties, the quantities required, the suppliers, the financiers have been planned.

Report by: **Bishwadeep Ghose,** ame

Sustaining the Green Revolution by resource conserving technologies:

The Rice-Wheat Consortium's example

Peter R. Hobbs, Raj Gupta, J.K.Ladha and Larry Harrington

The Indo-Gangetic Plains of Pakistan, India, Nepal and Bangladesh are endowed with plentiful natural resources, deep productive soils, sufficient good quality water, climatic conditions that permit multiple-cropping, high population densities and relatively good infrastructure. The Green Revolution (GR) of the 1970s and 1980s radically changed the traditional agricultural system of this region. Now, about 13.5 million hectares of land are in continuous rotation of irrigated rice and wheat, providing food and livelihoods for many millions. Between 1960 and 1995 rice yields increased from 1.55 to 2.66 tonnes/ha and wheat yields from 0.84 to 2.34 tonnes/ha. The majority of the farm households have less than 5 ha of land, whilst a minority have more than 20 ha. All farmers use improved varieties of wheat with fertiliser. In rice, some farmers still grow traditional, fine quality varieties like *Basmati* as they fetch higher market prices. Mechanisation levels are high, especially in the western regions, with resource-poor farmers renting tractors and threshers for tilling and harvesting. Animal power is still common in the eastern regions, but farmers complain of the increasing costs of maintaining draught bullocks. Many farmers are moving to contract ploughing with tractors; dairy cows are acquired in place of draught bullocks.

Rice-wheat a safe system

The main factors for the initial success of the GR and the emergence of the rice-wheat system were the introduction of high-yielding, semi-dwarf varieties and chemical fertilisers. Pesticides, investments in irrigation infrastructure, political commitment and policy support played a lesser role. Free irrigation water, cheap agrochemicals, subsidised power supply and low-interest farm credit were some of the crucial supports provided by South Asian governments that made intensive rice-wheat production profitable and a safe system for farmers.

Stagnation of production growth

However, in the past several years the productivity growth of wheat and rice has declined and the expansion of rice and wheat area has halted due to many reasons (Hobbs and Morris, 1996). Ecological degradation of the natural resource base has occurred as farmers using conventional technologies harvest up to 10 tonnes of cereal per year. Long-term rice-wheat experiments have shown that yield growth declines at constant input levels. Unbalanced use of fertiliser and delayed planting of crops are cited as major factors. Profitability has dropped as more inputs are needed to get the same yield. Input subsidies that favoured the GR have lacked farm-level incentives for efficient input use.

Rice at harvest time grown on beds? in the Indian Punjab (9t/ha crop, 50% water savings)

Photo : Rice-Wheat Consortium

The price of rice and wheat has declined steadily over the last 30 years. Partial removal of subsidies and ecological problems have put stress on the economy of farmers.

Ecological degradation

Resource degradation in the rice-wheat system can take many forms: loss of organic matter; mining of soil nutrients; build-up of weeds, diseases and pests; waterlogging, salinity and sodicity. Additional problems that reduce system productivity are: low nutrient and water use efficiency associated with delayed crop establishment, driven in turn by inappropriate tillage practices (delays in sowing wheat after rice can reduce yields as much as 1.5% per day); flat sowing and flood irrigation causing nutrient leaching; puddling leading to formation of a ploughpan, reduced soil permeability and enhanced soil cracking; and restriction of plant root and shoot growth and chlorosis due to temporary water stagnation. To compound these problems, *Phalaris minor,* the major weed in wheat has developed strong resistance to the commonly used herbicides and farmers have had to shift to new, more expensive herbicides. Excessive pumping from wells is leading to declining water tables in fresh water aquifer zones, while inadequate drainage is causing waterlogging and salinity in others. Many of these problems are interrelated and tend to be concentrated in areas where farmers practice continuous rice-wheat rotations (Pingali and Shah, 1999).

The Rice-Wheat Consortium

The concern today is to continue the GR sustainably – to make agricultural practices ecologically sound and more efficient while increasing productivity and profitability, improving farmer livelihoods and reducing poverty. As population in the region swells, a yearly cereal yield growth of about 2.5% will be needed to meet food demands. The Rice-Wheat Consortium for the Indo-Gangetic Plains (RWC) is an institutional mechanism created to deal with these issues in SE Asia. It is a partnership of national programmes (Bangladesh, India, Nepal and Pakistan), international centres (CIMMYT, IRRI, ICRISAT, IWMI and CIP) and various advanced institutions (Cornell, CABI Bioscience, IACR, Rothamstead, and IAC Wageningen etc.). The RWC believes that the key to a sustainable Green Revolution lies in Resource Conserving Technologies (RCTs).

Participatory research

A stakeholder participatory approach based on strong partnerships is being used to develop and promote new technologies. Stakeholders include researchers, extensionists, local manufacturers, NGOs and farmers. Farmers experimenting with technical options are proving more successful than researcher demonstrations of "finished" technologies. With access to the necessary equipment, farmers are adapting practices to their own situations and providing valuable feedback to the other stakeholders. This approach required a change in paradigm that increased the mobility of stakeholders, decentralised decision making and allowed for strong partnership and trust building. The long-term implications of farmer tested technologies on the environment are being closely monitored by a team of scientists.

Promising technologies

Promising technologies to ensure timely sowing and good plant stands, crucial for rice-wheat system productivity and efficiency, are being tested. RWC scientists have developed new tillage and other resource conserving options, such as surface seeding, zero / reduced tillage, bed planting, mechanical transplanting, laser levelling, dry seeding rice, etc. These options have opened up "space" (time, labour, land and water) for farmers to experiment with more diverse cropping systems.

Sowing wheat before harvesting rice

Surface sowing of wheat on to unploughed, wet soil before or after rice harvesting is working well in heavy, poorly drained soils. This technique is particularly relevant to farmers with small land holdings and little or no power sources. In the 1997-98 wheat season, farmers in Nepal using surface weeding were able to get their crop planted on time, despite continued rain, and harvested an average of 4 tonnes/ha. Farmers who used traditional methods were unable to plant a crop at all.

Zero tillage and stubble sowing

Zero tillage and sowing of wheat in standing rice stubble using a seed drill, locally manufactured in India and Pakistan, is a key technology for farmers with access to tractors. This drill, a modified version of the local *rabi* drill, costs US$400. Resource- poor farmers are able to rent them. In a variant of zero tillage (reduced or minimum tillage) a rotovator stirs a thin layer of soil in a strip ahead of the seed drill. Although it delays planting by 4-5 days compared to zero tillage, reduced tillage may be the preferred system for areas with post-rice harvest weed problems. There is also a "strip-till" version that cultivates only the area where the seed is placed and not the entire area. Both 2-wheel and 4-wheel versions are available for these reduced tillage systems. Such technologies open the door to improvements in resource efficiency leading to timely sowing, water savings, higher fertiliser efficiency, reduced weed germination, less herbicide use, reduced residue burning, lower fossil fuel use, decreased air pollution – and higher yields!

Farmers are very enthusiastic about the technologies as they save money and increase production. For example, current land preparation practices for wheat after rice requires nearly 12 tractor passes, whereas zero-tillage only one. This saves up to 100 litres of fuel per hectare, approximately 1 million litres of irrigation water and wear and tear of tractor parts. This is roughly a US$50-60 or 30% saving in production costs per hectare while increasing production simultaneously. The acreage of zero-till has risen from a few hectares in 1996 to 10,000 hectares in 1999 and over 100,000 hectares in 2000 in NW India and Pakistan. The main constraint now is the availability of sufficient good quality seed drills.

RWC scientists and farmers are trying to cut down on the burning of crop residues, which amounts to nearly 10 tonnes/ha. Leaving the stubble on the field as straw mulch and seeding wheat into this residue, rather than burning it, could improve soil structure and fertility, reduce water use and create a habitat for beneficial insects. This technology, however, is still in the experimental phase.

Broadcasting rice seedlings

Raising of seedlings in beds and transplanting them into puddled soil is the predominant method of cultivating rice. Puddling destroys the soil's physical properties and gets more expensive as real rural wages increase. Direct sowing has system benefits and is an attractive option when the problem of weed growth is tackled. Research is underway to find integrated ways to control these weeds. Broadcasting of rice seedlings, a system common in China, reduces labour even further.

Modified bed planter

Traditionally, wheat is planted by broadcasting on flat land. Research has proven that this method is not ideal for enabling uptake of nutrients and controlling of weeds. Bed planting was introduced by scientists as an alternative, and is being used by farmers in Mexico on about 0.5 million hectares of irrigated lands. Here, a machine makes two beds of about 70 cm width. The technology has interesting advantages: it saves seed rate by about 40-50 %; saves water by about 30-40 %; gives higher yields; reduces lodging; enhances mechanical weeding; overcomes temporary water logging problems; promotes rain water conservation and allows subsurface fertiliser placement for reducing N losses in rice and wheat.

The technology is mainly used in wheat, but is being adapted to rice. Costs of making the beds after every rice harvest is to be reduced by permanent beds on which each successive crop will be planted on the previous residue. Bed planting would enable crop diversification in rice-wheat areas with the introduction of soybean, maize, cotton, mungbean, vegetables, and canola on beds. It also has great potential for expanding the acreage of hybrids with reduced seed rate. The latest – modified – version called the PAU bed planter is manufactured locally in Amritsar, Punjab, India at a cost of about US$ 425 *ex-factory.* A similar model is available in Pakistan. To help make seed drills, hand tractors, and tractor implements more widely available, RWC staff are linking with and advising farmer groups, local machine shops, and agricultural engineering specialists.

Integrated Pest Management

To minimise the use of chemicals, the RWC is developing integrated control measures for pests, weeds, and diseases in the rice-wheat system. Planting wheat in beds facilitates mechanical weeding and provides good weed control without the use of herbicides. In farmer-participatory trials, zero-tillage reduced *Phalaris minor* populations by two-thirds in the first year.

Photo : Rice-Wheat Consortium

Pau bed planter for no-tillage wheat production

Growing early planting varieties (late October) means that the wheat crop is well established and can suppress *P. minor* as it emerges in mid-November. Crop diversification with sunflower, sugarcane and other crops helps reduce losses to weeds. Stemborers survive in rice crop residue, but zero tillage practices actually help reduce this problem by leaving the rice stubble standing or as a mulch, providing a habitat for beneficial insects that control stemborers.

Integrated Nutrient Management

Balanced and efficient use of organic and inorganic fertilisers is crucial in making the rice-wheat system sustainable and profitable. The reduced use of cattle manure over the years has resulted in a decrease of soil organic matter. The use of zero-tillage and the halt to burning of crop residues will improve this situation. Soil organic matter dynamics are being studied and monitored in fields with new tillage options, rotations and crop technical innovations. The RWC is also working on on-farm development of Site-Specific

Nutrient Management. SSNM builds on: 1) crop nutrient requirements based on economically efficient yield targets; 2) estimation of potential soil supply of N, P and K; and 3) plant N-status during critical periods of growth. The technique permits an estimation of leaf nitrogen content at specific stages in plant growth by measuring leaf greenness. This gives farmers an idea of when to apply fertiliser and in what quantities. Simple colour charts that help better targeting of fertiliser applications are being introduced to farmers. (Ladha et al. 2000).

Biotechnology will be needed

Further increasing the yield potential of rice and wheat seems inevitable. This can be done by using hybrids, synthetics or improving the photosynthetic efficiency of crops. While traditional plant breeding has been effective in improving crop yields, biotechnology can make this more effective, e.g., through marker assisted selection. Biotechnology can play a role in providing needed resistance for various pests, diseases and other biotic stresses. Herbicide resistant crops may finally enable farmers to use direct seeded rice without weed problems. Insect resistant crops could help reduce the application of pesticide sprays. A combination of biotechnology and resource conserving technologies may give the best perspective on continuing and sustaining the GR. Although investments in biotechnology are increasing fast, major benefits for the rice-wheat system are still to come. Of course, any research and release of genetically modified crops should adhere to biosafety and bioethics standards, and must be acceptable to civil society.

Policies needed

Policies concerning pricing, incentives, research, agricultural education, funding etc. are essential if the efficient use of inputs and RCTs are to be enhanced. The case of the Indian Punjab demonstrates how the efficient use of water is hampered when farmers are given water free of charge. Such a subsidy should be more production oriented and linked to water saving practices. The same applies to pricing of fertilisers and other inputs. Fertiliser subsidies could be easily used to regulate fertiliser application, to encourage the switch from prilled urea to urea super granule (USG) or slow release forms, and to promote machines that help deep placement of fertiliser to reduce ammonia volatilisation and nitrogen leaching. Easier credit to purchase equipment would certainly be a better policy than subsidies on equipment.

Making the shift to resource conservation

A major bottleneck in large-scale adoption of RCTs is the mindset of farmers and other stakeholders on, for example, the age-old practice of excessive tillage. The shift to RCTs requires a reorientation and retraining of all stakeholders. Integration of RCTs into the respective curricula will enable extension workers, scientists and farmers to learn the benefits and needs of these technologies. Public awareness on the benefits of RCTs at the farm, village, country and global level is needed. Reaching out to more farmers requires innovative ways of scaling up RCTs based on participatory approaches involving all stakeholders.

Can we make it?

Farmers who have experimented with these technologies show tremendous enthusiasm in adopting it and sharing it with fellow farmers. The RWC believes that these technologies will become common place in South Asia in the coming years. Similar successes of farmer led technology adoption are seen in Brazil and Argentina where conservation tillage has been adopted on millions of hectares of land. However, one note of caution needs to be made. Unless the population growth in South Asia is reduced in the next 2 decades, it will not be possible to produce sufficient food without degrading the environment. ■

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Effective Micro-organisms Technology

EM-Technology was developed by professor Dr. Teruo Higa in 1980 at the University of Rhyukyus, Japan. At the First International Conference on Nature Farming held in Tahialand in 1989, the Asia Pacific Natural Agriculture Network (APNAN) was formed. This network established an international programme for promoting research, education and extension of nature farming with EM-Technology.

EM contains photosynthetic bacteria *(Rhodopseudomonas spp.)*, lactic acid bacteria *(Lactobacillus spp.)*, and yeast *(Saccharomyces spp.)*. It also supports the activities of other microbes. It is claimed that EM promotes germination, growth, flowering, fruiting, and ripening in crop plants. It enhances the photosynthetic capacity of plants and the efficiency of organic matter as fertilisers. EM develops the resistance of plants to pests and diseases and suppresses soil borne pathogens and pests. It can also be used in human and animal health care. A good introduction on EM-Technology can be down loaded from www.agriton.nl/higa.html

In Pakistan EM-Technology is being promoted by Nature Farming Research & Development Foundation (NFRDF) which set up the Nature Farming Research Centre and the EM-Technology Training Institute. In the last 8 years extensive experimentation has led to some important innovations in EM-Technology. Now a wide network of EM suppliers and technology transfer officers are available for the thousands of farmers who have begun using EM-Technology.

In January 2000, the EM World Journal (ISSN: 1562-255X) was launched by Nature Farming Research & Development Foundation, 41-X-101, Susan Road, Madina Town, Faisalabad, 38060 Pakistan. Fax: +92 41 613507; nature@fsd.paknet.com.pk

The Journal contains research articles on EM-Technology in agriculture and health. One of the articles: Technology of Effective Micro-organisms as an alternative for rice and wheat production in Pakistan by Tahir Hussain et al., reports on a long-term field experiment at Faisalabad, Pakistan, to determine the agronomic and economic merits of EM-Technology. Results were, among others: EM applied in combination with NPK fertilisers, Green Manure (GM) and Farm Yard Manure (FYM) caused significant increase in grain and straw yield and in nutrient uptake by the grain and straw of each crop following the order NPK+EM > GM+EM > FYM+EM. The GM+EM treatment produced grain and straw yields of each crop that approached those for NPK alone. A comparative economic analysis of the treatments showed a significantly higher net return due to EM. The average net profit from rice and wheat production using EM was US$44.90 / ha and US$62.35 / ha , respectively, compared to about nil for the conventional rice-wheat system with optimal fertilisation and management.

No-tillage rice/wheat cultivation

The one straw revolution

Chris Evans

The natural farming rice-wheat no-tillage system was developed over 3 decades by Japanese philosopher and natural farmer Masonobu Fukuoka. His philosophy evolved as he saw the reductionist nature of modern science and the distancing of society from nature as root causes of humanity's many problems. This led him to search for better ways of farming that work more with nature, not against it. He realised that many of our current agricultural needs are met by too much hard work and high inputs. Instead, he reasoned that nature should be allowed to do more work in the farming system, which it has been "designed" to do anyway.

JPP Background

The Jajarkot Permaculture Programme is a grassroots NGO working in 4 districts of Nepal. As its name suggests, it is based on Permaculture, a technique of sustainable systems' design using the direct application of the principles of ecology. Thus its philosophy also embodies observation of and working with nature as the primemodel of sustainability.

The JPP gained its first experience of no-till farming during a visit in 1988 by the author and co-founder of the JPP to Japan. After this trip, a trial plot was set up on JPP's Farm #2 Resource Centre (RC) in Jajarkot. The farm is about 1 acre of land consisting of irrigated rice-wheat and dryland crops. Later a second trial was started at Sita Paila RC in Kathmandu.

The Fukuoka System

The plot was ploughed one last time, sown with wheat and white clover, then mulched with the straw from the previous rice crop. Weeding was necessary until the clover was established.

The wheat sprouts vigorously while the clover forms an undercover, acting as a green manure. This conserves moisture, fixes nitrogen and suppresses weeds - all needs, which the farmer normally tries to fulfil through labour and external inputs. By letting the clover and the straw do this work, inputs are lowered and the soil is not disturbed, allowing it to create its own system of fertility management, as in a natural undisturbed soil.

There is no further work until the wheat harvest the following spring. At this time, the wheat is cut, and rice is sown into the stubble and clover, with the wheat straw mulched on top. There is a risk that the clover smothers the young rice plants. Fukuoka floods his fields which weakens the clover and allows the rice to get away. After 1-2 weeks he drains the field allowing the clover to recover while the rice gains height. At farm #2 there was not enough water to do this; instead we grazed cattle on the clover briefly, a few days after the rice had been planted. At Sita Paila RC in Kathmandu, the clover was cut for rabbit fodder. Either way, the clover is controlled while the rice is given a chance to establish. For both rice and wheat, it is advised to coat the seed in a mixture of powdered clay and water to protect it from birds. When the straw is applied, it is possible to apply small amounts of well rotted compost (Fukuoka uses chicken manure) to help with its decay.

Ms Man Maya Gaha, JPP technician, with no-till showing wheat with clover under-storey

In this way, transplanting is completely eliminated, while weeding is reduced almost to zero. And there is no need for extensive flooding of rice paddies as its purpose in the traditional system is weed control.

Experience and lessons

The no-till system as adapted by the JPP has been extremely successful in that it really takes much less work to produce yields which are equal to and in some cases greater than the conventional/traditional methods. Because of the healthy soil, plants are robust and diseases are almost non-existent. It has worked consistently at Jajarkot's Farm #2 since 1989 and at Kathmandu RC since 1996. But the technique hasn't caught on by itself in the communities surrounding the RCs. This is partly due to the traditional use of straw as livestock fodder, and a lack of clover seed. Therefore, JPP has been reluctant to carry out extension of the method until sufficient alternative fodder can be obtained from agroforestry (AF) systems. Extension of AF thus takes priority over no-till, until the time is right for introducing the latter. The no-till method is so radically different that a major cultural shift is needed to enact it.

There are many ways of adapting the method, as JPP was able to do from the original system of Fukuoka. Timing of sowing is important, and it is possible to sow rice into wheat, and vice versa, when the previous crop is still standing. In Jajarkot we had a problem that the wheat ripened earlier than in surrounding fields, thus increasing its susceptibility to bird predation. The solution was found by either delaying sowing or using a longer rotation variety. Alternatives to clover need to be tried out – plants, which fulfil the same functions but are suitable to different environments, especially hot tropical/sub-tropical, which clover does not like. Perhaps vetches are a possibility. This method emphasises skill in observation of the crop and its environment, and ability to find plants and cropping systems, which mimic relationships and patterns found in nature.

■

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Update on the System of Rice Intensification

Photo : Association Tefy Saina

Well-developed SRI rice plant

The ecological System of Rice Intensification (SRI) developed in Madagascar gives remarkably good results. Hundreds of farmers have increased their irrigated rice yields to 6–10 and even 15 tonnes. The main characteristics of the approach are: capturing full potential for tillering by early transplanting, planting one by one with wide spacing; providing full potential for root growth by creating aerobic conditions, alternative wetting and drying of the field, minimum irrigation and early and frequent weeding. A comparison of some parameters:

	Conventional	SRI
Seed requirement (kg/ha)	80 to 120	5 to 10
Transplanting after days	20 to 30	8 to 15
Spacing cm	10x10 to 20x20	25x25 to 50x50
Transplants per clump	3 to 4	1
Plants/m2	75 to 150	4 to 25

A full description of the SRI approach has been published in the LEISA Newsletter Vol.15 3&4, pp.48-49, "Revolution in rice intensification in Madagascar", by Justin Rabenandrasana.

There is an increasing interest in the approach, as confirmed by Norman Uphoff of CIIFAD in a recent update on SRI trials, which states:

Madagascar: In January 2000, Robert Hirsch did a report for the French Development Agency, *"La Riziculture Malgache Revisitée: Diagnostique et Perspectives,* 1993-1999," He reported that over the period 1994-99, the average yields of farmers using SRI had ranged between 6.7 and 11.2 t/ha.

In contrast, the SRA system of rice improvement, recommended by the government and uses HYVs and fertiliser, produced average yields ranging from 3.12 to 4.92 t/ha in the same irrigation systems. Traditional practices averaged 2.78 t/ha.

China: The first willingness to test SRI outside of Madagascar was at Nanjing Agricultural University. Dr. Ding Yanfeng in the NAU Department of Agronomy set up SRI trials in June-October 1999. With plant spacing 25x25 cm and 20x30 cm, the yields were 9.5 t/ha and 9.2 t/ha, but with spacing of plants 30x30 cm, the yield was 10.5 t/ha. This is well above the current national average of 6 t/ha, but more important, it was obtained with about half as much water as usual. More trials are being undertaken during 2000.

Indonesia: During the wet season 1999-2000, Central Research Institute for Food Crops (CRIFC) conducted SRI trials at Sukamandi station, with a yield of 9.5 t/ha. Nearby farmers' yields with SRI methods were 5.9-6.9 t/ha. CRIFC now plans to conduct SRI trials at its stations throughout the country during 2000, if possible in all provinces, to assess any variations in ecosystem suitability.

Ivory Coast: The West African Rice Development Association (WARDA) conducted a series of tests during the 1999 season, which were characterised at first as "disastrous." Yields from two different varieties with SRI methods were only half as much as with WARDA varieties and methods.

However, WARDA conducted the trials without water control, so seedlings were inundated for much of their early growth period, nullifying the synergistic effects of SRI methods, which require well-drained soil.

WARDA has designed three sets of trials comparing SRI with conventional methods for testing in 2000.

Also in Nepal (CIIFAD), Cambodia (CEDAC), Sri Lanka (Ministry of Agriculture), Cuba (The Institute for Investigation of Rice), Sierra Leone (World Vision International), Bangladesh (CARE International), India (ActionAid), Colombia (CIAT), Honduras (Pan-American School of Agriculture at Zamorano), South Africa (Agricultural Research Council of the University of Pretoria) and Ghana (Ministry of Agriculture) trials have been or will be started.

Trials that we do not know about may be going on in other places, since papers on SRI have now circulated fairly widely. ■

For more information:

- Cornell International Institute for Agricultural Development (CIIFAD), Box 14, Kennedy Hall, Cornell University, Ithaca, NY 14853, USA. Email: ntu1@cornell.edu

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Genetic diversity and disease control in rice

Scientists from the Philippines-based International Rice Research Institute (IRRI) have found a new way to control a major disease in rice without using any chemicals. By planting different types of rice alongside each other, they could almost completely control the spread of rice blast, a disease that can cost the rice industry millions of dollars a year.

A small scale experiment in 1997 suggested that interplanting could achieve 92 to 99% control of rice blast, as well as an unexpected double success by boosting farmers' yields by half a ton to 1 ton per hectare.

In 1998, 812 hectares were planted with hybrid rice and glutinous rice, four rows of one and one row of the other. The crop was sprayed with fungicide only once. Yields reached 9 tons of hybrid rice and nearly 1 ton of glutinous rice per hectare. Even more impressive was the fact that, within the interplanted crop, the incidence of blast fell to 5 percent from a common level of 55 percent and the yield loss dropped from 28 percent to nothing at all. In 1999, the area grew to 3,342 hectares, and the farmers involved boasted that interplanting was providing them with about US$150 more income per hectare. By the end of 2000, the IRRI-Yunnan research team plans to extend the scheme to cover up to 60,000 hectares and continue to expand it into the Philippines, Thailand, and other rice-producing nations.

IRRI's Director General Ronald P. Cantrell says, "The days of unsustainable high-input rice production are a thing of the past!"

For more information:

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Cultural and Socio-economic Dimensions of Paddy Cultivation in Kalahandi District

S.N.Mishra and M.M. Hossain

Kalahandi is among the very few districts of Orissa state which regularly contributes paddy to the central pool. The district is well-endowed with vast tracts of forest and is rich in natural resources. Forests , which are home to Kutia, Madang and Dangaria Kandh tribes, cover about 47 percent of the total geographical area. Paddy, which is one of the major cereals grown (61% of the total cropped area) in this district is replacing the minor millets even in the tribal areas. It has become the staple food for majority of the inhabitants of the district. Most of the paddy (about 60%) in this district is grown on the upland locally known as Bhatta (Att and Mal) and remaining 40 percent is grown on Berna (Medium land) and Bahal (Low land). Usually monoculture is practiced in most of the paddy cultivated area of the district.

Area, production and productivity of Paddy in Kalahandi district.

Year	Area (ha)	Production (t)	Productivity (t /ha)
1994-95	224334	83536	1.7
1995-96	233549	413702	1.8
1996-97	227186	258232	1.1
1997-98	230160	481034	2.1

Source: *Directorate of Economics & Statistics, Orissa.*

Local festivals associated with paddy cultivation

Since time immemorial, the farmers of the district celebrate various festivals linked with various crop production activities. Paddy cultivation is also linked with various festivals, some of which are:

Bihan Chhina Yatra: The festival falls on 3rd day of the bright fortnight of Jyestha, i.e. in the month of June. This is considered the auspicious day and the head of the family worships the land by offering unboiled milk, rice and flowers, and sows the seeds. Goats or sheep are also sacrificed on this occasion. No seeds are sown or given to anybody before this ceremony.

Nua Khai:. After harvesting the upland paddy, people worship paddy to honour their first production of the season. This festival is known as Nua Khai or Nabanna and it is celebrated with great pomp and splendour. It falls during the bright fortnight of Bhadrava. On visits to places of Gods and Goddesses (temples), members of every family sit in a row facing east and accept Nabanna (new rice).

Practices followed for paddy cultivation and storage

Popular belief in the area is that the summer ploughing should be done before the month of June. Farmers use cows and she-buffaloes also besides bullocks, for plouging. The only manure used here is cow dung.

After the Bihan Chhina Yatra, farmers directly broadcast seeds in the range of 55 to 65 kg per acre in the uplands. More quantity of seed is used in order to suppress weed population. Seedlings for transplanting in mid-land and low-land are raised in the uplands. This helps in better root growth as well as make the seedlings more drought resistant.

Fresh cow dung extract is usually applied (Box 1) to control Bacterial Late Blight (BLB), which is a common disease in the upland as well as transplanted paddy. Twigs of *karada* (*Cleistanthus Collinus*) and *kochilla (Strychnos Nuxvomica*) are placed in the field to encourage spider population (Box 2). Spiders help in controlling the caseworms and leaf folder. Moreover, incorporation of these twigs in the field during puddling helps in controlling *chhada* species (Algal parasites of paddy).

Farmers of this area realise the importance of organic matter application in the field. They harvest only the panicle portion of paddy with a special type of bent sickle leaving the straw portion in the field. This practice is linked with a popular religious belief and therefore all the farmers follow it. Giving fodder to the cows is considered religious and this is the reason that the paddy straw is left in the field. The straw in the field attracts cattle and the field gets cattle dung. Cow's urine and its walking in the field also helps in faster decomposing of the left over straw in the field. This increases the soil fertility. Adopted by 19% i.e. 1,64,000 cultivators, this practice is on the decline owing to use of straw for other purposes.

> Box 1: **Control of BLB**
> Application of cow dung for control of BLB. *One kilogram of fresh cow dung is mixed thoroughly with 10 liters of water and strained twice through a fine cloth. The solution is sprayed at the early stage of BLB affected paddy crop. Thus 20 kilograms of fresh cow dung and 200 liters of water are required for spraying 1 acre of paddy field. The process is repeated after 8-10 days after the first spray for better results. Adopted by 15% i.e. 27,400 cultivators. Popular, but needs proper straining and effective spraying of cow dung.*

> Box 2: **Planting twigs of *karada* and *kochilla***
> Usually the farmers plant the twigs of karada and kochilla 10-15 metres apart on the ambasya (no- moon day) in the month of Shrabana (June-July) after worshipping the village Goddesses. In case of severe infestation the twigs are planted 3-5 meters apart. Adopted by 10% i,e, 18,300 cultivators. Availability of the twigs is on the decline.

Traditional tools used

Most of the farmers use wooden plows for cultivation besides using many types of traditional implements. They use a type of flattened and nailed wood called '*danti kopper'* for leveling of the land. A special type of bent sickle called '*ila'* is also used for harvesting. Paddy is usually stored in locally made containers called '*olia'* and '*puda'* which are made up of bamboo, rope and paddy straw. Puda and olia has the capacity of 400 kg and 350 kg respectively. *Neem* twigs and leaves are put inside the paddy or rice container or even in the store-house to protect it from various insects and pests (Box 3).

> **Box 3: Traditional tools and practices**
> About 250 grams of sun-dried neem leaves are crushed manually and mixed with 50 kg. of rice.
>
> Another local practice is that about 3 to 4 kgs. of sun-dried neem leaves are placed in 3 layers in paddy (at the bottom, in the middle and at the top) stored in, 'Puda'. In both the cases, neem leaves act as repellant for various stored grain pests.

Role of farm women in paddy cultivation and economic development of their family

Women play a major role in paddy cultivation in this area. Activities like uprooting the seedlings from the nursery and transplanting them in the main paddy field, weeding and harvesting are done exclusively by them. Besides, they also help the men in all other operations related to paddy cultivation. It is clear from the above discussion that all the operations of paddy cultivation are closely linked with the socio-cultural life of the people of the district where women have a pivotal role in every aspect. These socio-economic and cultural dimensions of paddy cultivation, though traditional have a scientific correlation for getting higher yield on sustainable basis. ■

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SEED PRIMING - For increased vigour, viability and productivity of upland rice

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Rice, which plays an important role in providing food to the majority of the world population, is cultivated in a wide range of ecosystems. In India, out of the 42.7 million ha of land under rice, about 21.9 percent of the area is exposed to risk prone upland ecology (Mishra, 1999). More than 80 percent of the upland rice areas are concentrated in the north eastern parts of the country.

The productivity of the upland rice is very low because of a host of problems among which soil moisture stress, poor native soil fertility and heavy weed infestations are the important ones. Under upland situation, moisture stress is likely to occur during any of the growth stages of the crop which may adversely affect the growth and yield.

Importance of seed priming

Seed priming increases the competitive ability of seedlings. The protoplasm of hardened plants is found to have a lower viscosity and exhibits higher permeability to water and nutrients and is able to hold water against dehydrating forces. Hardening treatment improves germination, promotes plant and root growth and increases crop survival under water stress conditions.

Method

Soaking in water itself is very effective for germination of most seeds but further beneficial effects are noted with very dilute solutions of a number of chemicals such as sodium phosphate, sodium chloride (NaCl) and potassium chloride (KCl). Studies conducted at the College of Agriculture, Thiruvananthapuram, Kerala Agricultural University have led to the development of a simple soaking /drying method for the maintenance of vigour and viability of seeds of upland rice which the cultivators would find useful.

Procedure

The seeds of the upland rice variety, Matta Triveni (PTD-45) was soaked in 1.0 and 2.5 percent KCl solution for 15 hours. The seeds were then dried under shade to the original weight and was dibbled @ 85 kg ha^{-1} at 20x10 cm spacing. The experiment was replicated thrice and observations were collected on various growth and yield attributing characters of the crop.

Importance of drying back

It is absolutely necessary to dry back the seeds after soaking as storing of seeds not properly dried will do more harm than good. Artificial drying facilities would be the ideal solution but presently such facilities are not available to most cultivators and seed producers and sun drying is the only alternative. The soaked seeds should not, however, be straight away placed in the sun. After draining out the soaked water, the seeds should be dried for about an hour in an airy space in shade and then dried back to the original weight in the sun. It is better to treat seeds in small lots instead of soaking the whole lot at a time because of the risk involved in sun drying.

Results

Seed priming with 1 percent KCl for 15 hours registered an appreciable increase in plant height, leaf area index and dry matter production at 30 DAS, 60 DAS and at harvest. The effect was also significant on chaff percentage, nutrient uptake, water use efficiency and yield. Similar positive response to seed hardening have been earlier reported by a number of research workers (Dakshinamoorthy and Sivaprakasam (1989), Sheela and Alexander (1993).

The positive influence of seed priming could be attributed to the well developed root system of the treated plants which might have improved the nutrient uptake by the plants which in turn improved the growth characters and hence the dry matter production and yield.

Conclusion :

The field experiment on seed priming of upland rice conducted at College of Agriculture, Kerala has been found to increase the grain and straw yields which in turn increased the net income and benefit: cost ratio. So seed hardening could be identified as a procedure for increased returns on rainfed upland rice.

■

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Photo : Billy Howard Esq./courtesy CARE, c2000

Rice - fish integration increases production and income

Ecologising rice-based systems in Bangladesh

Marco Barzman & Luther Das

The Green Revolution in Bangladesh altered highly diversified agroecosystems that were strongly dependent on natural processes. A wide variety of vegetables such as lentil *(Lens esculenta)*, eggplant *(Solanum melongena)*, amaranth *(Amaranthus tricolor)*, chilli *(Capsicum annuum)* and okra *(Abelmoschus esculentus)* were grown as field crops in the middle elevation areas between the homestead and the rice fields. Climbing vines such as bottle gourd *(Lagenaria siceraria)*, bitter gourd *(Momordica charantia)* and country bean *(Dolichos lablab)* were grown in the highest elevations, using trees and houses as support. A wide variety of trees usually surrounded the homestead areas. Oxen, goats, and chickens were abundant. Irrigation networks covered only 15% of the country's cultivated land. A single annual crop of rain-fed rice was grown during the monsoon and rice fields were mainly confined to low-lying areas. Native wild fish and other aquatic organisms entered rice fields freely. The fish actively migrated and settled in the fields to breed.

Rice farmers exploited this source of protein and made sure to open their dikes at the beginning of the monsoon. They also placed branches in their flooded fields to create a habitat more attractive to gravid brood fish. The use of composted cow-dung and legumes such as *Sesbania rostrata* along with regular silt-laden floods maintained soil fertility. The absence of pesticides favored a balance between pests and natural enemies. These traditional systems provided a sustainable supply of fruit, vegetable, grain, meat, eggs, fish, fodder, fuelwood, construction material and animal power.

Green Revolution changes

Today, irrigation networks extend over 40% of Bangladesh's cultivable land. Rice areas have been gradually extended, two crops of rice per year is now the norm. Increased production is nearly meeting the needs of 130 million people. There have been, however, serious unforeseen agro-ecological consequences. Vegetable production for household consumption, now confined to the homestead, no longer meets the requirements of the rural population. The number and diversity of trees has reached catastrophically low levels generating a fuel crisis and a scarcity of fruit. With a scarcity of fodder, oxen are difficult to maintain and are increasingly replaced by mechanical tillers. The small quantity of dung still available is used almost entirely as cooking fuel, leaving little for organic fertilizer. Elevated roads, flood control, pesticide residues and eutrophication from fertilizers stopped the migration of fish from rivers to rice fields. Populations of native fish species *(Channa spp., Heteropneustes clarias, Anabas testudineus)* are now endangered and the traditional rice-fish systems have disappeared.

The system is already showing signs of unsustainability. Most rice farmers are dependent on insecticides for pest control. A 1995 CARE survey of rice farmers in Comilla district—a high-input use area—showed that 96% used insecticides during the dry season. But despite—or due to—the prevalence of insecticide use, old farmers report that insect pests are now more difficult to control than in their youth. They also report increasing fertilizer dosages for the same yields and are nearly unanimous in saying that their soils "are tired".

The decrease in the ability of rural households to produce vegetable, fruit, and high-protein food has contributed to an unbalanced diet, over-reliant on rice. The increased rice yields, on the other hand, have not translated into either improved nutrition or income.

CARE's Agriculture and Natural Resource sector realized that some of the elements of diversity and natural pest control from traditional systems could be restored to the intensive rice monoculture systems. The "ecologised" rice-based systems would help to increase the availability of diversified food while making the systems more sustainable. Using the Farmer Field School approach, the New Options for Pest Management (NOPEST) project introduced farmers to the ideas of integrating vegetables, fish and trees in their rice systems using a natural pest control approach. The "new-old" techniques have been widely adopted by more than 40,000 farmers without negatively affecting rice yields.

Reverting to natural pest control

Starting in 1995, the project promoted non-chemical means of pest control in rice. As a result, 85% of participating rice farmers completely left out the use of synthetic insecticides within a single season, and continued to practice natural pest control 5 years later. They rely on natural enemies and on the ability of the rice plant to compensate for insect damage, with no negative effects on their yields. The yields of project participants using no insecticide

Table 1. Rice yield differences between users and non-users of insecticides.

	Dry season 1998 Mean rice yield (t/ha)	Monsoon 1998 Mean rice yield (t/ha)	Dry season 1999 Mean rice yield(t/ha)
Project participants using no insecticides	4.66 (n=134)	3.28 (n=172)	5.11 (n=114)¨
Non-participants using insecticides	4.18 (n=155)	2.73 (n=172)	4.71 (n=152)

Table 2. Rice yield differences between rice-vegetable and rice-only systems.

	Monsoon 1998 Mean rice yield (t/ha)	Dry season 1999 Mean rice yield (t/ha)
Participants' rice-vegetable	3.61 (n=13)	5.82 (n=10)
Participants' rice-only	3.66 (n=17)	5.16 (n=14)

Table 3. Rice yield differences between rice-fish and rice-only systems.

	Monsoon 1998 Mean rice yield (t/ha)	Dry season 1999 Mean rice yield (t/ha)
Participants' rice-fish	3.04 (n=35)	5.25 (n=35)
Participants' rice-only	3.66 (n=17)	5.16 (n=14)

Table 4. Rice yield differences between rice-fish-vegetable and rice-only systems.

	Monsoon 1998 Mean rice yield (t/ha)	Dry season 1999 Mean rice yield (t/ha)
Participants' rice-fish-vegetable	3.30 (n=3)	5.59 (n=10)
Participants' rice-only	3.66 (n=17)	5.16 (n=14)

are consistently higher than those of non-participant insecticide users (see Table 1). Since the project participants also modify other practices, besides foregoing insecticides, it cannot be said that the yield increase is due entirely to the absence of insecticides. It does show, however, that insecticides are not needed to obtain yield increases. Project participants have higher net returns than insecticide users. In 1998, the average net return from the rice crop of participants, if they sold the entire crop, was Tk.5,373 (=US$107) per farmer per season, as opposed to Tk.3,443 (=US$69) per farmer per season of insecticide users.

Photo : Billy Howard Esq./courtesy CARE, c2000

Planting vegetables on rice bunds to improve nutrition and income

Integrating vegetables

In 1991, a group of agronomists from CARE visited Sitakondo (Chittagong District), in the southeast of Bangladesh. They found what appears to be an indigenous dike crop system. Covering several kilometers, dikes between and surrounding rice fields are occupied by rows of country bean grown on simple supports. Local growers did not know the origin of the method and believed it to be ancient, attested to by the large number of country bean varieties in the area.

This system, along with experimental dike cropping systems from Indonesia prompted CARE staff to initiate a pilot project involving this technique. In 1995, the project began exposing men and women farmers to such cropping systems using the Farmer Field School approach. Since then, at least 40% of participating farmers are growing vegetables on the dikes of their rice fields, by elevating and widening their dikes. The most successful crops have been country bean, yard-long bean, bottle gourd and okra, all of which, except for yard-long bean, are traditional crops.

Data of 1998 and 1999 show either no difference or a slight increase in the rice-vegetable systems, in spite of the area lost to dike crops, i.e., the entire rice-vegetable field—the check plus the wider dikes—is producing at least the same total quantity of rice (see Table 2). The net returns from the vegetable crop that farmers would obtain if they were to sell the entire crop—they usually sell 1/4 of the crop—is Tk.733 (= US$15) per farmer per season, an added value of 14% to the rice crop. Rice-vegetable growers eat vegetables more frequently and share the surplus with neighbours, friends and relatives.

Trees-on-dikes

The project also introduced the idea of growing trees on the dikes without affecting the rice crop, using cultural practices, such as periodical pruning of roots and branches. This type of pruning is perfectly appropriate to trees producing timber, cooking fuel and fodder. Now, 35% of project farmers are growing bokain *(Melia azidirach)*, shishoo *(Dalbergia sissoco)*, mahogany *(Swietenia macrophylla)* and acacia *(Acacia auriculiformis)*, and continue to tend them long-term. Although it is too early to formally evaluate the benefits of this technique, the number of farmers planting trees on their dikes is growing and many have initiated small-scale tree nurseries to supply their community with planting material.

Integrating fish in rice-based systems

ICLARM and the Bangladeshi Government's Fisheries Research Institute were among the first to experiment with integrating fish in flooded rice systems in Bangladesh, but their ideas were not extended to farmers. In the 1992 dry season, CARE conducted pilot activities in which 180 farmers experimented with rice-fish using non-native fish species as common carp *(Cyprinus carpio)*, tilapia *(Tilapia spp.)* and sharputi *(Puntius gonionotus)*. These early trials showed that rice yields were increased by 16% with rice-fish relative to the previous dry season with rice-only, 6% of which was attributed to presence of fish in the rice field.

In 1998 and 1999, yield data of project participants practicing rice-fish compared to those practicing rice-only shows that rice-fish causes no significant decline in rice yields, and in some cases even an increase. The rice yields presented here are under-estimated by about 5% because the ditch area in the rice-fish field was not taken into account when calculating rice yields (see Table 3).

The net returns from selling all the fish average Tk.7,354 (= US$147) per farmer per season. This is more than the returns from rice and it is perfectly compatible with rice production. Although not all rice fields are feasible for rice-fish systems, 30% of project farmers are practicing it and their numbers are constantly increasing. As with vegetables, rice-fish farmers eat fish more frequently and donate much of it to their social networks.

Integrating both vegetables and fish

Of course, both vegetables and fish can be integrated into the rice monoculture and we estimate that 18% of project farmers have done so. As expected, their rice yields are not inferior to those of farmers practicing rice-only (see Table 4).

In conclusion

Cereal crops are frequently considered to be obligate monocrops. Our experience, however, shows that there are many ways in which rice can become part of a more diversified agroecosystem. The "ecologised" monocrop becomes more productive, it offers more services to the farmer household, and the multiple ecological interactions within the system increase its sustainability. The successes we obtained in diversifying rice monocultural systems still represent the initial stages in making small-scale agriculture more sustainable. Areas that require future attention include use of native fish species, integration of livestock, interactions between the home garden and the rice field, and scarcity of organic inputs for soil fertility management in rice. In other words, there are probably still many possible beneficial options that could further diversify and "ecologise" these systems. ■

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Photo : Bert Lof

The experience of family farmers from Tauá, Brazil

Organic cotton

Pedro Jorge B. F. Lima,
Teógenes Senna Oliveira

For more than two decades now, the so-called 'cotton crisis' strikes in the semi-arid Northeastern region of Brazil. This crisis has touched many sectors of the region's economy, but the burden lies mostly with the family farmers who usually plant cotton as their most important market crop. Since 1986, when the boll weevil *(Anthonomus grandis Boheman)* spread throughout the region, the crisis became even worse. The boll weevil was neither the only nor the main cause of the crisis, but it made the cultivation of traditional cotton crops (mocó, perennial cotton *(Gossypium hirsutum L. r. marie galante* Hutch) almost impossible.

In 1990, a local NGO, ESPLAR, began researching and developing agroecological alternatives for cotton cultivation in the semi-arid region. This was before the first demands for organic cotton in Brazil emerged. The initiative was a response to the demand of family farmers from two municipalities of the Ceara interior, in the Northeast of Brazil.

First steps

Between 1990 and 1996, ESPLAR carried out a Research & Development project titled "Ecological management of perennial cotton". Family farmers from different municipalities of Ceara took part in the discussions on what strategies for agro-ecological management to adopt and how to carry out the experiments. The management alternatives consisted of intercropping the perennial cotton, planting of an early maturing variety, removal of affected flower buds, and soil conservation measures.

The chosen alternatives found many barriers during experimentation. Farmers did not adopt all the recommended technologies, especially the removal of flower buds, which is crucial to the control of boll weevils. A long tradition of relatively extensive cultivation of perennial cotton made it difficult to cater to the additional labour needed.

However, in 1994, on the basis of the first results, diffusion of the proposed technologies took place. It was supported by a loan of US$150/ ha. 130 farmers cultivated almost 250 ha of crops. Although they did not reach the expected cotton production levels, the alternative management system resulted, in many cases, in the restoration of soil fertility, and in the continued maize and beans intercropping. Besides, substantial increases in the intercropping of Leucaena *(Leucaena leucocephala)* and the making of contour lines were observed (Sousa, 1999). It was the start of a gradual change of mind and an inversion of the predominant logic of many farmer-researchers.

Despite the limitations in production, the merit of this initiative was the exposure of ESPLAR and the farmers' organization of Tauá (ADEC) to the emerging market for organic cotton. Thus, in 1993 and 1994, ADEC sold 10.5 tons of cotton fibre, produced without any chemical input, for the production of organic cotton T-shirts for Greenpeace Brazil.

A new R & D project

In 1997, ESPLAR started a new project to develop cropping systems of both perennial (mocó) and herbaceous cotton on an agroecological basis. At that time there was deep discouragement amongst the farmers to continue growing cotton, due to consecutive crop losses.

The new practices to be tested included planting of annual, herbaceous cotton at the beginning of the wet season, always in association with maize, beans and/or sesame, besides legumes such as *Leucaena* and/or *Cajanus cajan*. Cotton is planted in strips of 5 or 6 lines, alternated by strips of the other crops. Contour lines and other soil conservation practices are adopted where necessary. Fertilization is done with farmyard manure, depending on the quantity available to each grower, as well as with biofertilization of the leaves with fermented fresh manure mixed with other mineral, vegetal and animal components that are found locally. Pest management is based on the removal of flower buds affected by the boll weevil and on monitoring of the boll weevil population by means of pheromone traps. Moreover, farmers make use of *Trichogramma* spp. to biologically control *Alabama argilacea* and other harmful insects. Sprayings with Neem *(Azadirachta indica)* leaf extract are also used to control worms and as a repellent for the white fly. After harvesting, cattle graze on the crop residues in the fields. During the wet season the pruning of *Leucaena* is recommended for use as mulch.

In order to stimulate the farmer-researchers to apply most of the practices, ESPLAR has established a "risk contract", which gives each of them R$150 on a loan basis. After harvesting, the cotton goes to ADEC to be ginned and accounts are settled. The surplus is paid to the grower, but when the production value is lower than the debt, ESPLAR bears the loss.

Participatory research and extension: its results

Despite 3 consecutive years of drought, from 1997 to 1999, the number of growers using soil conservation practices, associated crops and ecological pest management in cotton production has increased considerably, from 4 to 154 in the year 2000. Some of them have been certified as organic cotton growers. All of them received technical support from ESPLAR. In the same period, the cultivated area increased from 2 ha to almost 180 ha, as is shown in Table 1. This indicates that the research strategy of associating participatory experimentation with the extension of the agroecological practices was successful.

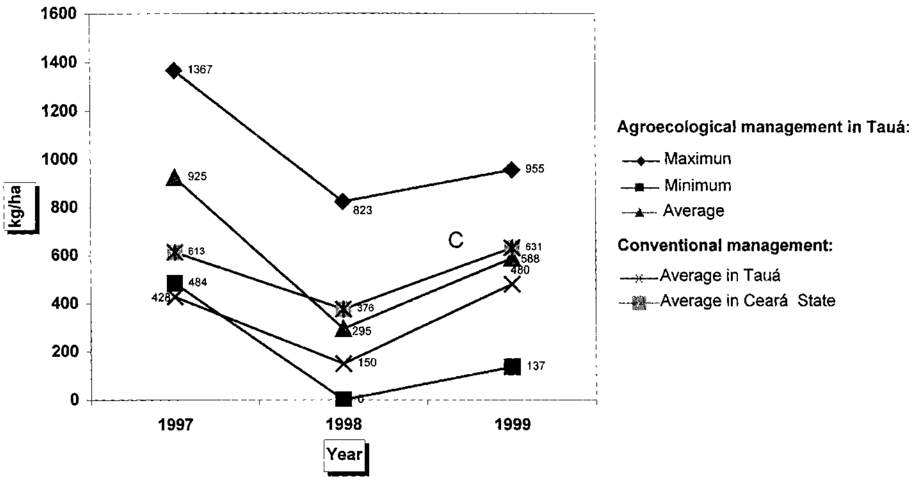
The results obtained with the 4 original farmer-researchers in 1997, positively influenced dozens of other farmers. These farmers decided, often after years of abandonment, to start growing cotton again. In addition, the price for certified organic cotton, which reached a premium of 30% above the price of conventional cotton, was an extra incentive. Around 70% of the farmers indicated that they had been directly influenced by the 4 original farmer-researchers.

The average yields of the ecologically grown cotton in the experimental areas, during the 1997-1999 period, were always higher than the average yields obtained in Tauá for conventional cotton in monoculture (Figure 1). When compared with the yields of Ceará state, the experimental fields in Tauá were yielding higher in 1997, whereas the Ceará average surpassed the experiments in the two following years. It should be noted that due to intercropping, it was possible to harvest additional crops such as maize, beans, sesame and *Cajanus cajan*. They are, despite their small quantities, important contributions to the food needs of the farmer families.

In this organic cotton production system, boll weevil control is still a bottleneck, as there are no specific techniques on how to grow cotton together with the pest. Thus, in the dry years, 1997 to 1999, the recommended practices showed a relatively easy control of the insect. In a wet year with a much higher incidence, as in 2000, the control becomes more difficult.

Until now, the volume of organic cotton harvested has been relatively small, but has good market prospects with organic textile factories, both national and international. Several textile companies, from Brazil and abroad, have contacted ESPLAR for buying organic cotton. However, the current supply in Tauá is not enough to meet all the demands. Even if the potential to increase production in Tauá is considered, it will hardly exceed some tons of fibres per year. Nevertheless, Tauá is gradually becoming a reference point for organic cotton production in the semi-arid region of Ceará and the Northeast of Brazil. In 1999 ADEC made one more step ahead in aggregating value to the organic cotton, when it contracted the spinning of 3 tons of organic fibre.

Figure 1 – Yield of herbaceous cotton with agroecological management in the experiments in Tauá and with conventional management in both Tauá and Ceará state, 1997-99.



Another relevant result of the research is related to the ecological control of the white fly *(Bemisia spp.)*. The farmer–researchers are encouraged to carefully observe the interaction between insects, spontaneous and cultivated plants. In 1998 it was observed that the white fly strongly prefers sesame (Sesamum indicum). The infestation levels in sesame in 7 systematically monitored intercrops were 6 to 20 times higher than in cotton.

It was also verified that two spontaneous plants with fuzzy branches and leaves, known as "gervão" or "rabo de raposa" (Stachytarphetta cayenensis) and "pega-pega" or "amor de velho" (Mentzelia fragili), attract and kill adult white flies. This opens up possibilities to effectively control this cotton pest by incorporating these plants in crop associations.

Progress, limitations and prospects

Research to design, test and diffuse agroecological alternatives for organic cotton growing, with the direct participation of family farmers in the semi-arid region of Ceará has faced serious difficulties. They are inherent to the environmental conditions of the region, to the poverty situation that excludes most of the population from formal credit, and to the unsustainable practice of traditional cotton production.

10 years later, it is observed that an increasing number of farmers are gradually adopting the agroecological practices. They are driven by the need to preserve the scarce natural resources and stimulated by the possibilities of an emerging organic market, offering higher prices.

Presentation of the results through the media and at several technical and scientific events, in and outside Ceará, roused the interest of many technicians, cotton growers, municipalities, NGOs and even the regional bank, in the organic cotton experience. This opened up the prospect of expansion to other states in the Northeast of Brazil. Furthermore, partnerships with official education and research and development institutions were established. ■

Table 1: Evolution of the number of family farmers adopting agroecological management with cotton consortia, according to certification results, Tauá - CE, 1997-2000.

Year	No of Farmers			Area (ha)		
	Total	Organic	In conversion	Total	Organic	In conversion
1997	4	4	0	2	2	0
1998	69	18	51	103	27	76
1999	104	42	62	144	57	87
2000	154	*	*	182	*	*

**Numbers not available yet, until the certification by the IBD - Instituto Biodinâmico, from Botucatu, São Paulo.*

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Groundnut and Cotton Cultivation: technologies worth trying

S Balaji Rao, S S Kandagal, H Lanting

ame has been supporting Participatory Technology Development (PTD) in various crops primarily in three states of South India. During the past five years, beginning with a single crop as an entry point and gradually moving towards IFS, ame has been focusing on improving and stabilising LEISA technologies for specific crops (groundnut, cotton, paddy, ragi, green gram, red gram, bajra, jowar and vegetables).

The technologies are developed and implemented in collaboration with various stakeholders, primarily farmers and NGO networks. Specific technologies emerging from the field are taken up for further intensive study by academic and research institutions participating in the crop based working groups. Some parts of the programmes are sponsored by Government, NGO networks and independent institutions.

Data on agronomy and production in experimental and control plots are regularly collected and fed into computerised data base. The analysis is discussed at the crop based working groups.The understanding thus generated is the basis for training. Training materials and production manuals are produced after a few years of PTD with farmers, to ensure that the technologies promoted are firmly embedded in farmers' field realities.

The total outreach in Groundnuts and cotton is around 9000 and 13000 farm families respectively.

GROUNDNUT PROGRAMME

The objectives of the groundnut programme are to:

- increase the yield of groundnuts through improved water, soil fertility, pest and disease management in combination with improved genetic material,
- increase the biodiversity in and above the soil through organic matter application and production; mixed/inter cropping, restore rotation with cereals in the cropping pattern and thus reduce area under groundnuts whilst maintaining the total yield,
- introduce village level quality seed production through buy back agreements,
- introduce value adding post harvest storage and processing technology,
- increase biomass production on bunds and other parts of the farm.

The PTD process involves the following events/activities: Participatory Problem Analysis, Social Organisation, Participatory Technology Development, Season Long Training, Farmers' Field Days, Self Help Groups evaluation sessions, Farmers' Melas, Groundnut Working Group Consultative Meetings and Annual Workshops.

The technologies being tried out by farmers are:

- new varieties(K134, K1128, etc),
- seed coating with Rhizobium,
- seed dressing with chlorpyriphos,
- application of magnesite and gypsum,
- intercropping with pigeon pea,
- Using the seed cum fertilizer drill (in few areas only).

Tikka spot (ELS/LLS) control

Tikka spot is a fungal disease caused by *Cercospora arachidicola*. The brown spots are seen primarily on the leaf surfaces. The size, depth of the colour and dimension depend on its early or late infestation. Severe attack leads to premature shedding of leaves.

Started in 1997 and financed by ame, a collaborative programme with ICRISAT sought to control Tikka spot through early detection of unfavourable weather conditions, integrated nutrient management focusing on magnesium and calcium (Collaboration with UAS Dharwad), variety testing and appropriate control measures with chemical as well as botanical means (ICRISAT).

Present status:

- Weather based system to forecast spread of Tikka spot is performing well and has proven to be economical
- Application of 100 kg of magnesite per acre controls Tikka spot economically
- Some botanical extracts are promising good control but further testing is required
- a selection of IGCV tikka resistant varieties perform well in different environments

Inter-cropping/border-cropping

From 1997 onwards inter-cropping for pest control (cowpea, pearl millet, castor) has been promoted. From 1999 onwards also cash inter-crops have been promoted (particularly pigeon pea and castor). It has been conclusively proven that in poor soils under rainfed conditions inter-cropping is a must for profitability.

Present status:

- one row pigeon pea per seven rows of groundnut improves income considerably
- cowpea when included serves as a trap crop for controlling leaf miner
- bajra (pearl millet) as border crop controls bud- and probably also stem-necrosis
- *calotrophis* as border crop can help in providing materials to control red-hairy caterpillar
- castor intercropping intensity is being tested, but surely adds considerably to income and helps to control white grub, RHC and *Spodoptera*.

White grub control

In 1998 a collaborative project of All India White Grub Control Programme in Jaipur with ICRISAT and ACIAR was started to control white-grub damage in groundnuts. ame and its partners assisted in collection of adults, on-farm experiments, Participatory Technology Development experiments, knowledge and skill dissemination.

Present status:

- standard control with 3-6ml of Chloropyriphos per Kg of seed is economical in most fields;
- a pheromone has been identified and is being tested;
- application of organic manure might offer alternative food source for white-grub. This is presently under testing with ame partners.

Variety testing and seed village promotion

From 1999 onwards varieties from ANGRAU, TNAU, UAS, BARC and ICRISAT have been tested for performance under rainfed, poor quality soil conditions. Some better performing varieties have been multiplied by farmers, with assistance from scientists for roguing, on contract with SHG guaranteed by NGO.

Aflatoxin surveillance and control (NATP/NRCG/ICRISAT; NRI/ICRISAT)

Aflatoxins are contaminants produced by fungi in various commodities. They reduce the quality of groundnuts.The affected produce loses value in export and domestic trade. Aflatoxin type B1 is considered to be the most toxic. They impair human and animal health. Young animals are more susceptible to aflatoxins. In humans, liver cirrhosis and cancer have been reported to be related to aflatoxins.

Since 2000, ame is involved in collection of samples under the NATP and DFID-sponsored Aflatoxin Projects in collaboration with ICRISAT and NRCG. ame's involvement in AP is in Chittoor and Anantapur Districts. The 3 year study aims at identifying 'hot spot' areas in regard to aflatoxin in groundnut at various stages - harvest, wholesale storage etc. and arriving at solutions to reduce occurrence and spread of the toxin.

Present status:

- Serious aflatoxin levels are found in storage samples with whole sale traders
- Considerable infestation in some fields, especially in pods remaining in fields after harvest
- High levels of Aflatoxin in small pods left on haulms stacked for feeding to cattle

Stem necrosis control (ICRISAT/DoA-Karnataka)

In 2000, Anantapur and Kurnool Districts were plagued by stem-necrosis caused by Tobacco Streak Virus. It is now clear that the virus is spread from sunflower and a vast number of weeds. Parthenium takes a special place in this. In a collaborative effort with ICRISAT (Dr. DVR Reddy) experiments are carried out to reduce the incidence of the virus infection (border rows of Bajra). Suspected samples are collected by ame partners and sent for diagnosis. This should give a picture of the spread. Awareness campaigns with DoA have been organised and work will be done to start controlling parthenium and a number of other weeds.

Value adding through decorticating of groundnuts

Tests have been run with decorticator

COTTON PROGRAMME

The main objectives of the cotton programme are as follows:

- Reduce the costs of production;
- Increase profit margin; grow healthy crop
- Reduce the risk of cotton production;
- Increase water holding capacity and micro-nutrients in the soil through OM application;
- Increase bio-diversity both above and in the soil, thus enhancing natural competition between harmful and beneficial organisms;
- Decrease reliance on external inputs by replacement with locally available materials;
- Reduce the area under cotton in farming systems to at the most 50% and introduce cereals into the system.

The process involves the following Approaches and events: Social organisation, Participatory Problem and Gender Analysis, Farmers' Field School, Agro-Eco-System Analysis, Participatory Technology Development, Farmers' Field Days, monthly review meetings by trained NGO staff, Integrated Crop Management (IPM, IDM, INM); Cotton Consultative Committee (twice a year), Technical Committee (once a month), NGO-Network review meet (once a month), Farmers' Self Help Group meetings and Farmer Field Schools (once a week), Farmers' Mela (once a year), Cotton Round Table (once a year). Advisory services from ICRISAT were sought on specific issues. In some areas, the programme is jointly sponsored by ame, Government and independent donors.

The technologies being tried out by farmers are:

Land preparation

Under rainfed and sloping conditions it is recommended to work on water retention through life bunds, dead furrows and across the slope ploughing and planting. Under irrigated conditions emphasis is laid on proper drainage structures.

Integrated Nutrient Management

Emphasis is on organic matter application, meso (Mg and S) and micro nutrients (Zn, B). In addition timing of N and K applications are being considered. Organic manure is recommended to be incubated with Phosphobacteria, Azospirillum and Azatobacter. A study (by Dr A Reddy of ICRISAT) is underway to ascertain whether a white grub (*Holotrichia fissa Brenske*), found in organic manure, can attack the roots of cotton.

Variety selection

The network promotes Desi cotton for dryland conditions with low to moderate yields.Major problems surfaced in obtaining seed of Desi cotton. Varieties are promoted in any other condition where yield is not expected to go beyond 12 quintals of seed cotton per acre. Testing of a compact cotton variety (developed by Dr SS Patil, UAS Dharwad), that should escape the main attack of bollworm, is underway.
A need for a cotton seed production programme is emerging due to difficulty to obtain seeds of Desi and variety cotton as well as poor germination of much of the seed available on the market.

Seed treatment

Seed treatment with Trichoderma or chemical fungicide and neo-nicotinoids (Goucho, Cruiser) and also neem based botanical powder is recommended.

Inter-cropping

Inter-cropping and border-cropping are being promoted. Various spatial arrangements are being tested. The main reason is that farmers face problems with bullock-drawn equipment when inter-crops and border-crops are raised. We promote a lot of Bhendi (Ladies finger) and Cereals to ensure habitat for Lacewing and Trichogramma. This usually builds up sufficient population to control the common bollworm and reduces the need for augmentative biocontrol.

Pest management

The first attacks are by aphids and jassids. The strategy is to promote lady-bird-beetle through inter-cropping cowpea and grow a border-crop of Bajra (Pear Millet, 8 rows densely planted) as a physical barrier against the spread of jassids. Management of the pests in the first 40 DAS is only through 5% Neem Seed Kernel Extract as a last resort.

We adhere to the principle that class I pesticides will not be recommended. Farmers do however appreciate the growth stimulating action of monocrotophos, usually applied at about 25-30 DAS. We recommend alternative of diluted cow-urine spray for the same effect.

Between 40 and 70 DAS *Helicoverpa armigera* larvae start appearing. We are testing whether introduction of H-NPV (UV-stabilised with Blue Fountain Ink and applied in evening)at this stage will create an epidemic that will carry over to next generations. Similarly other (botanical) products and concoctions are being tested. A trap-crop of stagger-planted sunflower is recommended to divert H.armigera egg laying on cotton.

It is noted that spotted bollworm (*Earias sp)* is developing into a pest already at this stage at certain South Western locations. A trap crop of inter-planted Bhendi is recommended. In later stages also Pink Bollworm is noted especially in fields that did not receive any spray with chemical pesticides. We are testing Pheromones and botanicals to control Pink Bollworm.

The technology is fairly well developed till 85 DAS for all situations. Under irrigated conditions with large tracts of contiguous cotton we observe problems with control of *H. armigera*. We avoid pyrethroids till day 100 and recommend ovicidals to prevent multiple generations living at the same time. We might resort to spray of pyrethroids, combined with pongemia or neem oil, in later stages. Much of the technology to be used between 85DAS and harvest is still under testing.

Conclusion

ame has deliberately chosen the entry point approach to first build up/ restore confidence in the farmers in adopting LEISA technologies in the crops they are already growing and wish to grow. Lot of efforts were made in establishing forward and backward linkages (seed production, post harvest, value addition, marketing, etc.). New problems and solutions shared during the annual workshops form the basis for further experimentation. Based on the knowledge and understanding built along with the various stakeholders, ame along with its partners is now guiding farmers to move towards Integrated Farming Systems. IFS may therefore be viewed as an extrapolation of farm activities into larger spheres of Natural Resources Management (NRM). ■

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The Cuban response to scarcity of inputs

Crop associations

Maria de los Angeles Pino and Humberto Rios Labrada

Until 1989, Cuba's agricultural system was characterised by its dependency on foreign external inputs. This system covered over 70% of the country's arable land. In some parts of the country, such as in the eastern region and in the western province Pinar del Rio, traditional agriculture still played a dominant role. It was official policy to reduce the land share of small farmers: producers had to either pass on their land to state farms or form co-operatives (Trinks and Miedema, 1999)

After the collapse of the socialist countries in 1989, the share of monoculture-based agriculture diminished drastically. The use of fuel, the main agricultureal input, fell from 13.0 to 6.1 million tonnes in two years. In the same period, the amount of fertiliser used fell from 1.3 to 0.3 million tonners and expenditure on pesticides from 80.00 to 30.00 million USD (Resset and Benjamin, 1993).

At the same time, farmers and scientists in Cuba began to look for alternatives that would protect plants from biotic and abiotic stresses. They attempted to use the land efficiently and experimented with low input leavels. In these experiments, farmers' knowledge, understimated for so long, played an essential role once again.

Traditional crop associations, such as maize-beans and maize-pumpkin that had been used before by small farmers, became a common practice in large areas. At the same time, unusual crop combinations, such as carrot-cabbage, lettuce-cabbage, carrot-garlic, tomato, sweet potato-pumpkin, maize-tomato, banana-beans, banana-taro-beans-maize, sugar cane-beans, began to apper in areas that had long been dominated by monoculture practices. Even though most of the work by formal research institutions was still directed towards monocultures, many areas started to produce food in a manner that remained invisible to formal statistics by the early 1990s.

In this new situation of virtually no external inputs, most of the new crop associations werefound to be more productive than monocultures. Many farmers practising crop associations were able to obtain two or more crops on the same piece of land, previously monocropped. The different crop production schemes made it possble for farmers to operate in different ways: first, to produce and sell the entire harvest of the pricipal or "duty" crop to the state market at very low prices, as is obligatory; second, to produce and sell on the free market, with strong price incentives. For instance, in huge sugar cane tracts, one or two rows of beans or cowpea were planted between two rows of sugarcane. In this way, farmers who sowerd beans at the start of the growing period of sugarcane could either be self-sufficient in beans or sell them on the free market. Thus, poly cropping allowed farmers to produce one official crop, and at the same time secure an income through selling secondary crops.

Polycropping also led to better control of pests and disease in the absence of chemical pesticides, to more efficient use of very scarce inputs and ot higher economic profitability. The polycropping approach quickly spread all over Cuba as a way of alleviating the consequences of the external input crisis. Scientists joined the movement and started research on this method.

Tomato and maize: an unusual association

Tomato (*Lycopersicion esculentum* Mill) was a typical monoculture in Cuba before 1989. This crop requires a combination of temperature, radiation and relative humidity that is optimal between October 21 and December 20 in Cuba. Producing tomatoes out of season, through extremely lucrative, is very expensive, as the production should, ideally, be in greenhouses with high-energy consumption.

The solution to this problem was found in using maize as natural shade for tomato, and thus modifying the microenvironment favouring tomato production off-season. Different spatial arrangements of tomato-maize were tested under small farm conditions. Fertilisation was done with a combination of biofertiliser and 90 kg/ha Nitrogen (120 kg/ha of Nitrogen (120 kg/ha of Nitrogen being the normal recommendation).

The most productive spatial arrangement was three rows of tomato planted between two rows of maize (see Figure 1.) Maize was sown 30 days before tomato was transplanted. Every row was oriented from north to south.

This spatial arrangement led to a reduction of the radiation intensity by about 25% and a temperature decrease of approximately 3^0C. Yields of tomatoes produced under maize shade increased by 5-6 tonnes/ha in comparison with tomatoes grown as a monoculture. The tomato-maize association decreased adult white fly presence by some 24% and reduced virus infections by 6%. Fruit quality was found to be better.

The main advantage for farmers is in being able to plant before and after the optimum sowing period, allowing them to market fresh tomatoes off-season and threeby increase income. In the transition from tomato grown as a monoculture to the tomato-maize crop association, the benefit-cost ratio increased from 1.9 to 3 when sown after the optimum moment or from 2.4 to 3.5 when sown before the optimum sowing time. At the same time, some maize was produced for home consumption or sale on the free market. (Pino, 2000, in preparation).

The once unusual combination tomato-maize is becoming more and more common in small, private farms (with, on average, one hectare of land) of the San José de Las Lajas municipality. One of the principal obstacles to further spreading of this crop association has been the difficulty of mechanisation. It is interesting to note how quickly farmers have adopted this and other low input systems, in a setting where few Cuban functionaries realised the advantages of corp associations as a principal component of the new Cuban agriculture. In spite of the fact that such alternative pratices in agriculture have contributed to a slight recovery of the Cuban economy and to higher food security, policy makers still advocate a backward move towards use of high external inputs. In order to avoid a renewed dependency on external inputs, the challenge now, for researchers and farmers alike, is to gather more evidence on successful crop associations.

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Conversion to Organic Farming

A project approach from China

Johanna Pennarz

The Organic Farming Development Project co-operates with advisory staff and experts from agricultural universities and local government to support farmers in converting to organic farming.

Initial situation

Following the high demand for organic products on the international markets, traders are the dominant actors in the organic farming movement in China. They try to identify farm products, which are on a low external input regime already and thus respond to the minimum requirements of international certification bodies. They are not interested in lengthy conversion processes and leave the solving of technical problems to farmers. There are no experts or technical staff specialised in organic farming yet. Staff who lack expertise in dealing with the highly diverse problems in organic farming, advice farmers to simply replace conventional inputs with biological ones. Farmers request blueprint solutions from experts and advisory staff and are not well prepared to start indigenous innovation processes themselves.

The project: conversion as a process

The project has introduced conversion to organic farming as a process in Yuexi, Anhui Province, with the followingm objectives:

- to develop an extension methodology on conversion, based on a participatory approach,
- to stimulate technical innovations in local farming systems,
- to organise smallholders for internal quality control, technical support and marketing, and
- to attract political support to organic farming.

Extension methodology on conversion After the pilot villages in Yuexi county were selected, a first assessment of the potentials and problems for development of organic farming was conducted in 1998. This did not provide farmers with a ready-made solution, but proposed a number of options for conversion. The framework elaborated by the advisors made clear that the conversion would be a farmer-led process of gradually modelling the organic farming system by testing various options and possibilities.

At the time, the advisors could only refer to a few experiences in organic farming available in China. The first workshop, held in Yuexi in 1998, provided farmers with a basic understanding of the organic farming concept. It encouraged them to work on specific technical issues like inter-cropping, biological pest control, and green manure. A second training was held in 1999. Meanwhile, farmers fully understood the principles of organic farming and undertook organic practices. They selected the technical innovations they were going to try out during the coming season. A third workshop, held in early 2000, evaluated the experiences gained during conversion. Workshops served as focal points to summarise and exchange experiences and document the joint decisions made in the communities. Apart from these formal training workshops, the advisors have undertaken regular visits to the pilot areas to discuss the ongoing experiments and propose additional options. Through the process, they have developed methods to systematise information on local farming systems and feasible options for conversion.

Stimulating technical innovations

During the process of conversion, farmers have gained experiences with a number of organic farming techniques. They have become more self-confident and are willing to solve problems locally. Their production systems have improved significantly, and some innovations have already spread to their neighbours following conventional practices. In order to cope with the higher demand for organic fertiliser, farmers have increased their livestock production and integrated green manure into their annual cropping cycle. Green manure was common in traditional agriculture, but has been replaced by chemical fertiliser during the "green revolution". As a result, traditional manuring techniques have fallen into oblivion and seeds of green manure plants have disappeared. Initially, some varieties were made available by the project, but then farmers started searching for seeds of traditional varieties from their region. Experiments with green manure have been very successful and others who wish to purchase seeds of green manure varieties are approaching the organic farmers now.

Even though the conversion process started just three years ago, farmers are already experiencing a visible improvement of the agro-ecological environment. They find that the biodiversity is enriched by beneficial organisms, which have returned to their gardens after a long absence: bees now replace the artificial pollination of the kiwi flower and snakes control the population of rodents. Farmers have become more aware of soil fertility issues. The project has introduced the spade analysis as a simple tool for monitoring processes within the soil, and farmers have learned that the texture and consistency of the soils under green manure has greatly improved within this short period.

Organising smallholders

In the beginning, conversion was confined to a demarcated area of land on which a single crop is converted to organic production. But, the project has encouraged a voluntary approach with only those farmers who are interested in organic farming participating. As a result, some farmers within the designated area have been sticking to conventional production, while others outside this area have converted to organic farming. Altogether, a higher number of farmers and a higher acreage have been converted to organic farming than originally planned. The voluntary approach with dispersed plots has placed higher demands on the organisation of the internal control and certification system.

Farmers in Yufan Village have established the first association of organic kiwi growers in China with the objective of providing technical support and information, and organising marketing of organic products. The kiwi farmers now plan to establish a direct marketing outlet in the provincial capital. The Organic Kiwi Association has put much effort in the development of their own requirements and in the internal documentation system. Each member keeps his own records on inputs and outputs. Recently, those farmers who have been participating in the conversion from the beginning received organic certification.

Attracting political support

The objectives and framework of conversion planning have been carefully communicated with the State Environmental Protection Administration (SEPA) in Beijing, which showed great support for the development of organic farming. The conversion plan resulted from a months-long communication process between project staff and the farmers. Finally, the conversion plan has been integrated into the master plan for ecological reconstruction of Yuexi. The political support has raised the significance of the conversion process for environmental policies and further motivated the administrative staff engaged in this process. At the same time, Yuexi has gained importance as a national pilot area for organic farming.

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From sugarcane monoculture to agro-ecological village

Lindsey Mulkins and colleagues

The island of Negros is known as the sugar basket of the Philippines. More than half of the available agricultural land in the lowlands is devoted to sugarcane cultivation. The social and ecological problems associated with monoculture sugarcane production pervade the island. Negros became infamous in the 1980s when the collapse of the sugar industry led to the starvation of thousands of sugar workers and their families. Today, much of the landscape of Negros remains in monoculture sugarcane production under the control of wealthy plantation owners known as *hacienderos*. Many landless labourers continue to toil in the cane fields for 1.50-2 US$/day and are locked into a cycle of poverty, indebtedness and physically gruelling work.

For some of the sugar land communities of Negros, however, there is a positive transformation underway. One such community is the Flora community near Kabankalan in southern Negros Occidental. In 1997, through the Philippine government's Comprehensive Agrarian Land Reform Program (CARP), 76 hacienda workers and their families (approximately 375 people) were awarded an 87 hectare former sugarcane plantation, which they divided into individual farms of 0.82 hectares, and a collective farm of 17.7 hectares.

Photo: REAP-Canada

Conventional sugarcane production in the Flora community is now being transformed into sugar-cane trash farming

The Flora community has since diversified the former hacienda and is following an ecological approach to increase its food self-reliance and make more efficient use of its production capacity. To create a more organised and collective decision making structure, the community has formed a farmers association called PAGLA-UM. The community has also benefited from the presence of a number of organisations specialising in sustainable farming systems research and development. These include PDG, MAPISAN, MASIPAG, REAP-Canada and University of the Philippines in Los Baños, Department of Agronomy.

The Agro-Ecological Village

The Flora community's efforts to create internal food and energy systems are gradually resulting in a more ecological way of living. This approach, which emphasises community self-reliance, is called an 'agro-ecological village'. The general characteristics of agro-ecological villages are outlined and compared to conventional approaches in table 1. The community is using the approach to achieve empowerment, increase financial security, and minimise vulnerability to vagaries in the weather or fluctuations in the market. Sugarcane production has been reduced in scale and ecologised through the implementation of alternative production systems. It still remains a vital crop for the community, providing (outside) income, feed for 145 draught animals and organic matter to maintain soil fertility. In fact, sugarcane's capacity to produce large amounts of biomass for decomposition drives nutrient and organic matter cycles that are critical to the sustainable production of other crops like maize, grain legumes and vegetables.

Modified sugar production

The traditional form of cane production in Negros has led to serious environmental degradation. Sugarcane fields are frequently burned before or after harvest, resulting in reduced soil fertility. Between the early 1970s and 1988, soil organic matter declined by 26% in one of the main cane growing regions of Negros. Reduced soil fertility has led to lower cane yields, and consequently, higher application rates of fertilisers. Current estimates of sugarcane fertilisation levels in the Philippines are 209 kg N / ha, 55 kg P205 / ha, and 74 kg K20 / ha per year. Additionally, cane production in upland areas causes erosion, resulting in the siltation of water bodies. Ground water has also been contaminated by the high application rates of nitrogen fertiliser and persistent herbicides such as simazine. Trash burning has reduced biodiversity and is leading to respiratory ailments, eye disease and increased incidence of cancer among the people.

The alternative practice of pre and post harvest trash (crop residue) cane farming is beginning to be implemented in the Flora community. Three months before harvest, dead leaves are manually removed from the cane stalk (detrashed) and left to decompose on the soil. After harvest, the residual sugarcane biomass is maintained on the field. Through the decomposition process, the trash fixes nitrogen and increases soil organic matter content, reducing application rates of nitrogen fertiliser. Trash farming also enhances weed control, preserves soil moisture, minimises erosion, protects canes from lodging during typhoons, and significantly reduces harvesting time.

Trash farming is known to increase sugarcane yields, particularly those of ratoon crops (regrowth of cane after harvest). In Southeast Asia, yields increase on average by 5.8% in the planted crop and 21.1% in the first ratoon crop. Trash farming reduces the yield decline traditionally associated with ratooning, enabling sugarcane to be cropped an additional one to two ratoon cycles before yields become economically non-viable. If practised over a long time scale, sugarcane trash farming in communities such as Flora has the potential to create a positive feedback system where continuous improvements in soil fertility will lead to increased productivity, reduced input requirements and longer ratooning cycles. The Flora farmers are currently using less than half the amount of urea used by conventional sugarcane growers. However, with changing cultural practices, the optimal fertilisation level is yet to be determined.

The main disadvantages of trash farming are an increased risk of fire and higher labour costs. Cane trash is usually piled in alternate rows to minimise fire risks and enable cultivation between every other row. Labour costs of trash farming are offset by reduced input costs and increased cane productivity. Currently, average yields in the community are about 70 tonnes / ha.

Flora's production of rice and maize

The introduction of rice farming is central to the Flora community's move toward food self-reliance, enabling members to satisfy about 75% of their current rice needs with 3.8 ha of rice. The farmers have successfully implemented an organic rice farming system developed by MASIPAG (see ILEIA Newsletter Vol.14 3&4, p.47), the national ecological farmers' association in the Philippines. The MASIPAG programme emphasises the use of locally adapted varieties of rice selected under organic production systems, facilitating the management of rice without the use of synthetic fertilisers, herbicides or pesticides. Similar to sugarcane trash farming, Flora farmers maintain soil fertility in the rice paddies by mulching the rice straw back into the paddies after harvest. Whereas 90% of rice straw in the Philippines is burned, the mulching system has enabled the community to completely eliminate burning and inorganic fertiliser inputs, as the rice straw fixes nitrogen during decomposition. More nitrogen is provided by azolla, a nitrogen-fixing aquatic plant that grows during and after the rice harvest. Recycled rice hull ash from household cooking and mud press from sugarcane processing are also added to the paddies to maintain fertility.

In the MASIPAG system, the rice is transplanted in rows 30 cm apart. Farmers plough the ground deeply to help the rice crop form deep roots to improve nutrient uptake. Disease pressure is minimised by maintaining low plant density, wide row spacing, and planting disease and pest resistant rice varieties. Fields are planted in an east-west orientation to facilitate air movement through the paddies and minimise crop shading. A MASIPAG trial farm of up to 50 rice cultivars is maintained by the community each cropping season.

In Negros, the most serious pest problems of rice are black bug and golden snail. Black bug is managed by manipulating water levels at critical periods of rice development. Golden snail populations are controlled by maintaining low water levels after transplanting. They are also lured away from the rice seedlings by supplying taro leaves, a preferred food of the golden snail, for a period of 25 days after transplanting.

The Flora farmers intercrop glutinous and sweet maize with the sugarcane crop for home consumption and fresh market sale. To minimise competition effects, maize is harvested after 60 days and is only planted in alternate rows of cane. The community is currently testing alternative cropping systems for more ecological maize production, including intercropping white grain maize, pigeon peas and squash or sweet potato.

Vegetable Production

The Flora community grows a wide variety of vegetable crops for home consumption and fresh market sale, including eggplant (12 ha), squash (5 ha), daikon radish (2 ha), bitter gourd and peppers. The large production of vegetables not only serves the farmers by improving their diets and income levels but also increases the supply and affordability of vegetables in local markets.

Of all the crops grown in the community, vegetables are sprayed with the most pesticides. The farmers' lack of experience with larger scale vegetable production and the absence of locally adapted seeds have prevented the fully organic production of vegetables. Farmers are intensively experimenting with new vegetable varieties and alternative pest controls.

Social and Ecological Implications

Through modified sugarcane cultivation and crop diversification, the Flora Community is enhancing the quality of life of its residents, while reducing the environmental impact. The health of the community has improved as the people have secured a reliable and diverse source of food. The new approach has resulted in a system of labour that better matches the working capacity of the community. Since cane detrashing usually occurs during the rainy season when labour demand is low, it enables farmers to divide work throughout the year. Unlike sugarcane monocultures, the community's diversified agricultural production offers many more opportunities for the involvement of women in all aspects of food cultivation, including cane detrashing, seed collection, planting, marketing and value-added processing.


Photo: REAP-Canada

Sugarcane trash farming

In Negros, men and women who were once marginalised are becoming full participants in the region's economy. Rising income levels amongst the rural poor increase demand for basic consumer goods, and higher education for children. The combination of agrarian land reform and the ecologisation of monoculture production systems in Negros thus appear to have the potential to create socio-economic benefits beyond those at the farm production level. Although the Flora agro-ecological village is still evolving, it already seems to provide a promising model as a development strategy for communities dependent on monoculture agriculture systems.

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Table 1. An agroecological approach to rural development in the Philippines

Activity	Agroecological system	Conventional approach
Approach	• Emphasises self-reliance and empowerment through optimal use of on-farm resources • Orientates market development towards import displacement • Minimises human impact on local environment and biosphere	• Emphasises development of export markets to pay for imported goods • Communities are vulnerable to external forces and loan-dependent • Degrades local natural resources and biosphere
Food Supply	• Internal and plant-based, on-farm production of seasonal vegetables, rice, corn, fruit, fish and eggs	• Much food imported, including rice, canned and dried fish, processed foods, livestock feeds
Soil tillage and on-farm hauling	• Carabaos (water buffalo)	• Tractors
Seeds	• Community seed banking of open pollinated seeds, new seeds assessed in trial farms, farmer driven participatory plant improvement	• No local adaptation trials, plant improvement or seed saving. Imported hybrid seeds dominate plantings
Soil Fertility	• Maintained through trash farming, nitrogen fixing legumes, azolla, mudpress, carabao dung, rice hull ash. Soil erosion minimised.	• Urea, phosphorus and potassium fertiliser
Insect and disease control	• Biological control strategies, resistant cultivars, balanced fertility	• Insecticides and fungicides
Weed control	• Mechanical weeding devices, crop rotation, good soil fertility management, trash farming	• Herbicides and tillage
Household cooking	• Use of rice hull cookers, efficient wood stoves, biogas, with all fuels farm-derived	• LPG fuel stove, open fire cooking, kerosene as fire starter
Marketing	• Emphasis of internal self-reliance and import displacement with value-added processing	• Monoculture production, products sold to distant markets

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The information in this article is based on the report **Towards an Agro-Ecological Village at the Flora Community** by the same authors, which is available on the REAP-Canada website at www.reap.ca

Mahaweli settlers in Sri Lanka diversify their farms using Farm Planning

Alice de Jonge

The Promoting Multifunctional Household Environments (PMHE) project, implemented by ETC-Lanka, was operational in Mahaweli System C in Sri Lanka, from 1991 to 2000. This article deals with Farm Planning for Sustainable Farming, an approach towards sustainable development of farms, initiated by the author and developed further in the project, which resulted in farmers moving away from a monoculture of paddy, to more integrated farming.

Paddy – main cash crop

Mahaweli System C is part of a large agricultural settlement scheme in the "dry" zone of Sri Lanka. Between 1980 and 1990 nearly 22,000 settler families arrived from various parts of the island to become paddy farmers. Each settler family was entitled to 1 ha of irrigated paddy land and 0.2 ha of highland for a homestead. The settler farmers were in turn supposed to transform Mahaweli System C into one of the key rice producing areas of the country. Agricultural extensionists of the Mahaweli Authority of Sri Lanka (MASL), were equipped to support farmers in cultivating rice.

Low profitability of paddy farming

After the first 2-3 years (5-6 seasons) of paddy cultivation, the majority of farmers began to see drastic yield decreases due to loss of soil fertility. Maintaining yields of around 4 to 5 tonnes per ha, much lower than the initial yields of 6 tonnes per ha, required application of increased quantities of inorganic fertiliser. With the price of fertilisers escalating steadily, the returns from paddy farming were marginal. Added to this was the lack of experience amongst farmers on how to maintain soil fertility under conditions that differed considerably from their areas of origin. The extension package offered by the MASL was hardly conducive in developing location specific farm systems suited to the different soil and water conditions in Mahaweli System C.

Finding alternatives to paddy

The deteriorating economic situation of the farmers, sub-optimal use of resources and degradation of the resource base prompted PMHE to consider principles of ecological farming and low external input and sustainable agriculture for developing alternatives to the existing farm system. Farm Planning for Sustainable Farming evolved through intensive interactions between farm families, MASL and PMHE extension staff and developed into a participatory extension methodology and a farmers' tool for resources management and farm development. (see box)

Photo: Aliece de Jonge

Farm planning a family affair

Farm planning helps farm families to search for alternatives and combinations of crops that would bring them more returns than paddy. It also helps them to find ways of utilising resources more efficiently. The families realise that bio-mass has to be created to make up for the nutrients that leave the field in the form of paddy grain.

Farm Planning and ecologisation

Farm Planning for Sustainable Farming is based on ecological principles (see box) and as such it contributes to develop a farm system in a more ecological way. In Mahaweli System C, it contributes, in combination and synergy with all of PMHE project activities, to the ecologisation of the paddy mono-crop in the irrigated tract. This is however inspired in the first place by an economic motive: how to get more returns from farming and how to reduce costs. Aspects of environmental conservation and health are of secondary importance. Based on ecological principles, Farm Planning enhances the awareness among farm families on the optimum, instead of maximum use of the environment.

A recent study shows a remarkable difference in ecological practices between farms of families practising Farm Planning and their neighbours without a Farm Plan. Almost 100% of the farm families involved in Farm Planning practise recycling of organic matter to improve the soil fertility of their paddy field - against hardly 50% of those not acquainted with it. Incorporation of paddy straw has become an established practice among farm planning families in place of the former habit of burning it. Banana, peanut and vegetables are being grown in the irrigated fields alongside paddy. Some families have successfully incorporated livestock in the farm system. Glyricidia is planted along the bunds of the paddy field to serve many purposes: fodder, green leaf manure, trails for climbing annual crops, firewood, etc. In this way certain needs of the farm are fulfilled by material produced on the farm itself, which reduces the cost of and the need for external inputs. A majority of the farm planning families considers soil fertility as the most important criterion for sustainability of the farm. Despite the home garden and paddy field being located apart, farm families bring surplus organic matter from paddy field to home garden and vice versa to improve soil fertility.

An important effect of Farm Planning is that the paddy land is observed and analysed: which parts are suitable for paddy cultivation and on which parts other crops or even perennials would do better? While diversifying the paddy mono-crop, the ecological principle of a site-specific choice of plant species is increasingly practised.

A young farmer's story

Mr. Jayasinghe, a young farmer from Mahaweli System C, changed his entire approach to paddy farming, remarkably, since he started with Farm Planning in 1996. After analysing the situation he improved the paddy field step by step. By levelling his land in a planned way over different seasons, he is now able to control weeds by flooding. He has planted a plot of about 1/2 acre, less suitable for paddy cultivation, with banana, inter-cropping the young banana plants with vegetables at first. Gliricidia is being established on the bunds of his field. Jayasinghe uses the gliricidia leaves, together with the rice straw, to improve the soil fertility in poor plots. In the banana – vegetable plot he uses cow dung. He has also started to plant arecanut and coconut in his paddy land, thus diversifying his income and spreading the risk.

His external inputs have decreased considerably. " I use straight chemical fertiliser, which gives a good result in combination with the straw and leaves. Insecticides and herbicides are used only when necessary. I follow an IPM course with the extension officer", says Jayasinghe.

In the early years of settlement Jayasinghe sold his paddy crop directly from the field, like all his neighbours did at that time, and received the lowest price. In his Farm Plan he planned for storage of his paddy, to get better returns by selling it at the right time. Now he is a seed paddy farmer, delivering high quality seed to the South of Sri Lanka.

Jayasinghe is very clear about the benefits of Farm Planning for his farm and life: "After Farm Planning I have better results and I am more focused in my work. In the beginning, however, I had the feeling that I had lost my freedom, that I was trapped in a 'cage'. But now I have realised that it is my own plan, and that I can change it whenever I want."

Asked in which way his farm has become more sustainable, he answers: "When you plan your farm, you should use all your own resources first, before buying any inputs. I am now using all the crop and farm wastes, which I did not do earlier. I have been able to reduce my costs so much that I am no longer taking crop loans."

At the end of every season, the young farmer evaluates his well-kept records, to plan for the next season. "If you don't plan, you can't do all your activities in time, you miss things. It is also important to put your plans on paper, so that you can look at your objectives from time to time and build up your motivation". That maybe the reason why Jayasinghe has put his marriage into the plan for the near future: he has understood that Farm Planning is more motivating when it is a family affair.

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Key elements of "Farm Planning (FP) for Sustainable Farming"

1. Learning from the forest for the farm.

Before starting a farm planning process in a farm, farm families and extension staff learn from the example of a natural forest as a sustainable environment. The most important ecological processes through which the natural forest sustains itself and creates a balanced environment are in brief:

- Bio mass production
- Diversity and Complexity (a web of relations in unity)
- Living soil as a major component of soil fertility
- Recycling of all organic matter
- Efficient use of all the resources
- Site specificity of plant and animal species chosen.

By discovering and analysing these processes and their linkages in a natural environment, families and extension staff draw learning points for sustainable farming. Efficient resource use serves as the starting point for FP. The unity in a natural forest environment as a system with a web of interactions between its elements is also important. Likewise, in FP the farm is considered in a holistic way, as a system with flows of material and energy between all the different farm enterprises.

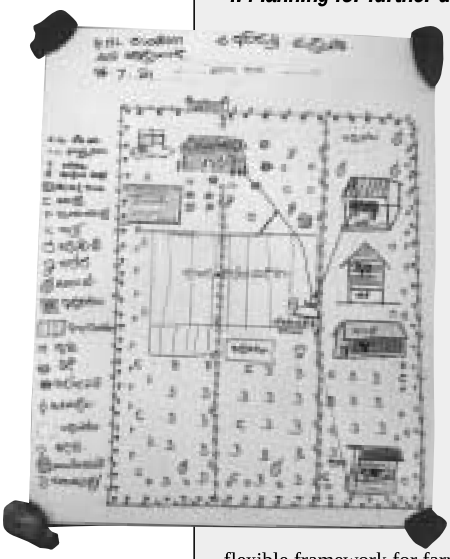
2. Observation and analysis of the existing situation of the farm.

The planning process starts from the existing situation on the farm, which is carefully observed and analysed. How does the present farm system work and what are the available resources? The farm family members are the most important resource persons in the exercise of observation and analysis of resources, processes, practices, opportunities and problems in their own farm. Extension staff act as facilitators. Together they document the analysis of the farm system in maps, flow charts and written or "symbolised" text: this is the first part of the farm document.

3. Exposure visits to farm families who successfully developed their farms.

Groups of farm families who have mapped the existing situation of their farms visit others who are in the process of successfully developing their farms, and collect ideas for their own farm plans.

4. Planning for further development of the farm.



Farm plan of a diversified home garden

Before making the Farm Plan, farm families and facilitators discuss about planning in relation to needs, goals, dreams, and vision on the future. Planning starts with the 'here and now', the existing situation, and reaches a final goal. It describes changes and improvements in different feasible steps, keeping in mind the lessons learned from the natural forest environment and utilising available resources optimally.

In a Farm Plan this final goal, the more sustainable situation of the farm, is put on paper. Then, with the help of simple formats, often designed by the farm families themselves, the different steps of systematic development of the farm over several years, towards the desired situation, are chalked out: the long-term plan. The long-term plan is divided in seasonal work-plans, in which the activities for the season, the necessary resources and the expected returns are documented. This is the second part of the farm document made by the farm family.

This farm document, the Farm Plan, is not a blue-print but a flexible framework for farm development, which can be adapted to changing situations (e.g. weather conditions, availability of resources, changing views and priorities, new ideas, etc.). This makes Farm Planning an ongoing process.

5. Implementation of the Farm Plan.

Implementation of Farm Plans is the responsibility of the respective farm families. Their Farm Plan is a documented commitment to the systematic development of their farm. It increases the confidence of the farm families: "We can reach this goal on our farm with our own resources". At the end of each season the outcome of the seasonal work-plans is reviewed and new work-plans are made, based on the results, and with reference to the long-term plan.

Farm Planning for Sustainable Farming is a family affair, involving women, men and children and their experience, knowledge and views of the farm. The planning process, the plans and their implementation are 'owned' by the family and facilitated by extension staff.

Evaluating the sustainability of integrated peasantry systems

The MESMIS Framework

Santiago López-Ridaura, Omar Masera and Marta Astier

How can the sustainability of an agroecosystem be evaluated? How does a given strategy impact on the overall sustainability of the natural resource management system (nrms)? What is the appropriate approach to explore its economic, environmental and social dimensions? These are unavoidable questions faced by any project dealing with complex agroecosystems. In Mexico, a number of development institutions, working on alternative agroecological strategies in a wide range of eco-zones, have joined forces to develop a Framework for Sustainability Assessment, the MESMIS framework.

The MESMIS project is an interdisciplinary and multi-institutional effort led by GIRA, the Interdisciplinary Group for Appropriate Rural Technology, a local NGO based in Western Mexico. The project originated in 1994 with the objectives of: a) developing an evaluation framework to assess the sustainability of alternative natural resource management systems; b) applying the framework to different case studies; c) training of individuals and institutions interested in the topic; and d) generating and disseminating materials to facilitate the application of the framework. Box 1 gives an example of how the Sustainability Assessment was put into practice by GIRA in the State of Michoacan, Mexico.

Sustainability evaluation

Most conventional evaluation approaches (e.g. cost-benefit analysis) are not always appropriate for addressing the challenges of analysing complex agroecosystems. A qualitatively distinct conceptual and practical approach is required. The MESMIS evaluation framework is such an attempt. It is a methodological tool to evaluate the sustainability of natural resource management systems, with an emphasis on small farmers and their local context (Masera et al 1999).

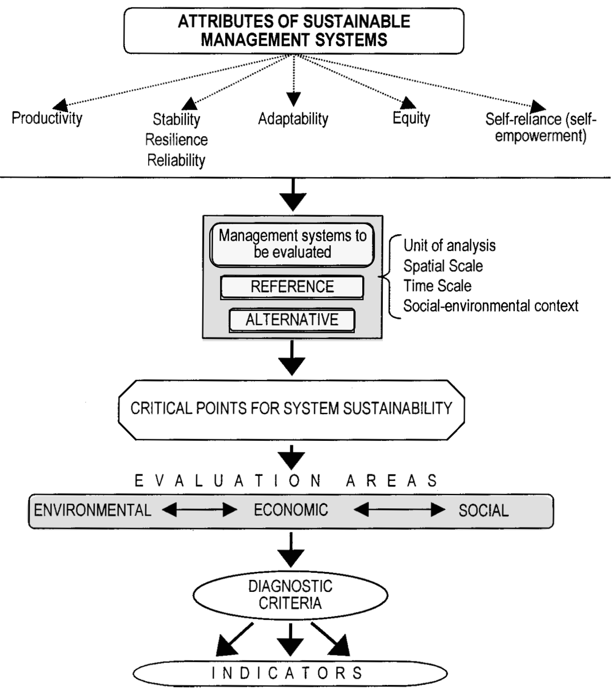
The framework is applicable within the following parameters:

1. Sustainability of NRM systems is defined by seven general attributes: productivity, stability, reliability, resilience, adaptability, equity and self-reliance.
2. The assessment is only valid for a management system in a given geographical location, spatial scale (eg. parcel, production unit, community etc.) and determined time period.
3. It is a participatory process requiring an interdisciplinary evaluation team. The evaluation team usually includes outsiders and local participants.
4. Sustainability is not measured *per se,* but is done through the comparison of two or more systems. The comparison is made either cross-sectionally (eg. comparing an alternative and a reference system at the same time), or longitudinally (e.g. by analysing the evolution of a system over time).

Figure 1 indicates the general structure of the framework. On the basis of the 7 attributes, a number of *critical points* for the sustainability of the system are identified, which are then related to three *areas of evaluation* (environmental, social and economic). In addition, for each evaluation area, diagnostic criteria and indicators are defined. This procedure guarantees a consistent relationship between the sustainability indicators and general attributes.

By providing an integrated strategy for sustainability assessment and evaluation, the MESMIS project has generated increased interest within academic and extension organisations. Several farmer organisations, research institutions and NGOs are currently using the MESMIS framework as a tool to evaluate sustain-ability. Since 1996 it has been applied in more than 20 case studies in Mexico and Latin America. It has also been used in more than 30 courses, workshops and seminars, and included in 14 university programmes in Latin America and Spain. The project has resulted in 15 publications, including one book on the MESMIS framework (Masera et al 1999), and another describing five case studies of sustainability evaluation within Mexico (Masera and López-Ridaura 2000).

Figure 1. General Structure of the MESMIS. From Attributes to Indicators



Implementing the Framework

The operational structure of the MESMIS framework consists of an evaluation cycle of six steps.

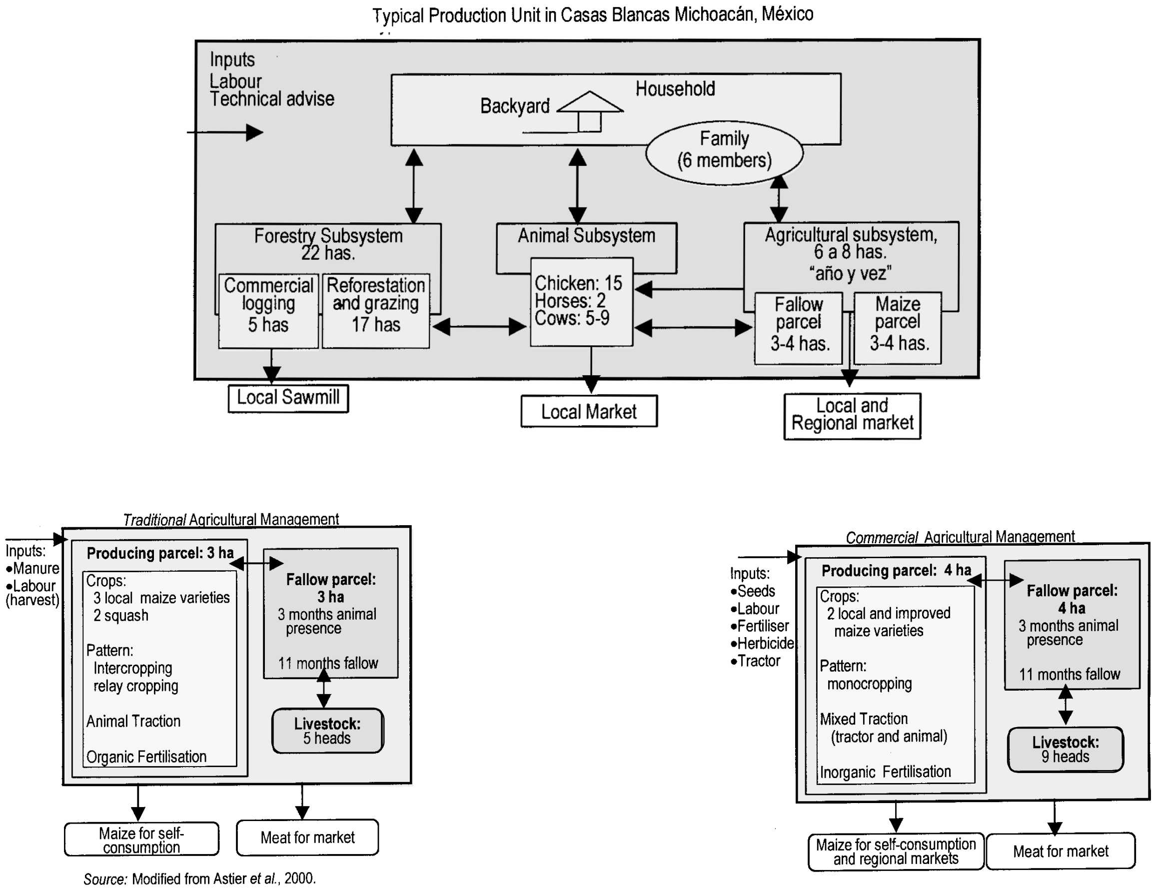
Step 1 Definition of the evaluation object

In this first step, the evaluation team characterises the system under study (both reference and alternative), as well as the socio-environmental context and scope (spatial or temporal) of the evaluation. An accurate description should include: the components of the system (subsystems), the system's inputs and outputs, the main management and productive activities in each subsystem and the main social and economic characteristics of the stakeholders and the form of organisation they have.

Step 2 Determination of the critical points

The critical points of a system are the main features or processes threatening or

Figure 2. Characterization of Casas Blancas production unit.
***Traditional* and *commercial* agricultural management**



Source: Modified from Astier *et al.*, 2000.

strengthening the system's sustainability. Identification of the critical points will focus the evaluation process to the most important aspects of the system under analysis. Some key questions in identifying critical points are: What makes the system vulnerable? What particular problems are presented? What constitutes the strongest, most prominent feature? Examples of critical points are low yield and product quality (productivity attribute), soil loss, deforestation and pest damage (stability, resilience and reliability), or peasant indebtedness (self-reliance).

Step 3 Selection of diagnostic criteria and indicators

The diagnostic criteria elaborate on the seven attributes of sustainability. They represent a level of analysis more detailed than attributes, but less than indicators. Diagnostic criteria serve as a necessary intermediary link between attributes, critical points and indicators, enabling a more effective and coherent evaluation of sustainability. The set of indicators used in an evaluation process is specific for the system under analysis. They should be easy to measure, possible to monitor, derived from available and reliable information, and clear and simple to understand. E.g.

Box 1 THE MESMIS FRAMEWORK IN PRACTICE

In the Casas Blancas *ejido*, an indigenous community in the Purhepecha Region of Michoacán State, GIRA has facilitated the development of alternatives for an agrosilvopastoral system. This was done by diversifying the cultivated plots *(milpa)* in order to obtain better stubble quality, avoid extensive grassing and control erosion. (Masera and López-Ridaura 2000).

The Casas Blancas *ejido* is representative of how many communities in the region manage their natural resources. Each farmer manages approximately 30 hectares - about 70% being forested (logging and reforestation) and 30% used for maize production and cattle raising. The agricultural management system, known as *año y vez*, consists of mainly maize production on one parcel for a year and a fallow for 1 to 3 years. In Casas Blancas, a *commercial* and a *traditional* strategy can be identified. They differ mainly in the type of fertilisation (inorganic or organic) and use of seeds (local or improved varieties), the type of traction (animal or tractor), the source of labour (wage or family), and the main objective of agricultural production (market or self consumption) (Figure 2).

A number of critical points were identified jointly by farmers and an external team through surveys, interviews and workshops. For each critical point, the evaluation team selected the diagnostic criteria and the indicators to be measured. Table 1 shows the critical points, diagnostic criteria and indicators used in this case study (Astier 2000). Figure 3 presents an AMOEBA diagram with the results from some of the indicators used.

The first evaluation cycle of the Casas Blancas case study helped in designing an alternative system, considering the strengths and weaknesses of the two different management strategies. The alternative system, now adopted by farmers is the focus of a second evaluation cycle, which proposes: a) the diversification of agricultural production by re-introducing amaranth and two edible leguminous species as intercrops, b) the use of organic and inorganic sources of fertilisation with special emphasis on phosphorus, c) the use of mixed traction for ploughing, and d) the introduction of leguminous cover crops and controlled grazing in the fallow parcel.

Table 1. Critical points, diagnostic criteria and indicators for sustainability evaluation in Casas Blancas Michoacán.

Attribute	Diagnostic criteria	Critical points	Indicators	AE[1]	MM[2]
Productivity	Efficiency	Low agricultural productivity	1 Grain yield	A	i,a
			2 Harvesting index	A	i,a
		Low animal productivity	3 Fodder availability	A	a,f
			4 Animal pressure capability	A	j
		Low profitability	5 Production costs	E	a,b,c
			6 Income	E	a,b
			7 Utility	E	k
			8 Cost/benefit ratio	E	k
Equity	Costs and benefits distribution	High costs for commercial systems adoption	9 Grade of adoption	S	g
		Limited basic grain supply	10 Grade of grain self-reliance	S	a,b,l
Stability	Resource conservation	High risk of erosion	11 Soil erosion control	A	m, d
		Soil degradation	12 Stability in nutrient balance	A	a,f,m
	Space and time diversity	Monocropping domination	13 Species diversity in parcel	A	a,f,b
Adaptability	Innovation capability	Failure of technological packages	14 Grade of technological innovation	S	a,b,e
			15 Permanence in technological packages	S	b,e
			16 Capability to adapt to environmental and political changes	S/A	a,b,m
Self-reliance	Participation, control and organisation	Lack of co-operation among farmers	17 Participation in "ejido" assemblies	S	g
			18 Number of farmers in workshops	S	h
			19 Grade of External input dependence	S	a,b

(1) Areas of evaluation
E Economic
S Social
A Environm

(2) Measuring Methods		
a Survey	e meetings with farmers	i Random grain sampling (C.P., 1986)
b Interviews	f Direct field measurements	j Calculation as Trillas (1982)
c Workshops	g Assemblies archives	k Calculation as Masera *et al.*, (1999)
d Field visits	h Registry of participation farmers in workshops	l Calculation as Alarcón (1997)
		m Literature review

Source: Astier *et al.*, 2000.

A common diagnostic criterion for the stability attribute is *Diversity*. Indicators reflecting this criterion are the *Number of species* in the environmental area, or *Number of markets* in the economic area.

Step 4 Measurement and monitoring of indicators

This step includes the design of analytical tools and the methods of data collection. Indicators can be measured in a variety of ways. Methods that have been used in the MESMIS case studies include direct field measurements, setting-up of experimental plots, literature review, surveys, formal and informal interviews and participatory group techniques. Selection of the type of measurement depends on the availability of human and financial resources. A combination of direct and indirect measurement techniques is advised in applying the MESMIS framework. Here, farmer participation is important as has been proven by the great accuracy of the indicators selected and measured by them.

Step 5 Presentation of results

At this stage, the results obtained are summarised and integrated. Generally speaking, there are three techniques for presenting the results: quantitative, qualitative and graphical techniques. When properly designed, graphical techniques may provide the most effective way for identifying problems. In the MESMIS framework, an AMOEBA-type diagram is recommended. This diagram shows, in qualitative terms, how far the objective has been reached for each indicator by giving the percentage of the actual value with respect to the ideal value (reference value). This enables a simple, yet comprehensive comparison of the advantages and limitations of the system under evaluation.

Step 6 Conclusions and recommendations.

Step six recapitulates the results of the analysis. Firstly, the evaluation team appraises how the reference and alternative systems compare in terms of sustainability. Secondly, they discuss the main elements that enhance or inhibit the alternative system compared to the reference system. Based on these conclusions and considering the needs and priorities of all stakeholders, the evaluation team proposes recommendations to improve the system's sustainability. Step six is also the phase for reflection upon the evaluation process itself, its logistical and technical aspects.

Making sustainability evaluation a permanent and cyclic process

An evaluation process is considered successful when it helps to improve the social and environmental profile of a NRMS. In other words an evaluation should aim not only at *qualifying* management options, but also at effectively helping to formulate an action plan geared towards improving the management system. Evaluating sustainability must be, ultimately, a *tool for planning and design.* Its success lies in its ability to be applied in the day-to-day activities of agroecological projects. Consequently, in the MESMIS framework, evaluation is not conceived as a linear process but as an iterative spiral. The conclusions and recommendations obtained form the starting point of a new cycle. ■

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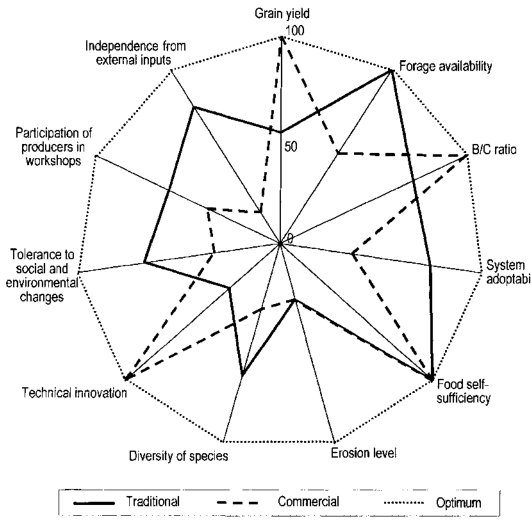
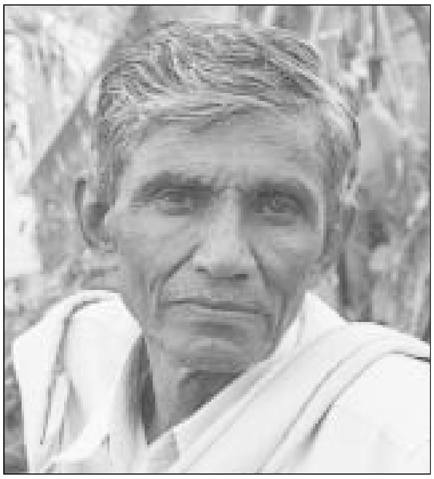
Figure 3. AMOEBA-type diagram for the evaluation of agrosilvopastoral systems in Casas Blancas Michoacan



The Narayana Reddy Column

Give up monocultures, move to Polycultures



Mechanisation, promotion of agrochemicals, biotechnology, hybrid, genetically manipulated seeds, liberalisation and globalisation of trade in agricultural products, subsidies to promote export commodities like sugar, cotton, maize, tobacco, coffee, tea, etc, privatisation, of agricultural research and extension have encouraged monoculture and specialisation and factory type of agricultural and livestock production. Even though such specialised agricultural production is rewarded by economics and contributes significantly to national agriculture to compete in international markets, everyone has to accept that the system has reduced biological diversity, has led to the degradation of natural resources, and affects small farmers. Huge dams have been built under the influence of sugar and liquor lobbies to encourage vast areas of sugarcane cultivation resulting in the submergence of fertile rainforests, displacing a large number of tribals, and destroying a wide range of biodiversity. In the command area, wet deserts have been formed after 30-35 years of cultivation with high external inputs like mechanisation and agrochemicals resulting in salinity and sodicity problems. In Karnataka, command areas of Bhadra, Thungabhadra, Krishnarajasagar, sugarcane thrash and even paddy hay are being burnt away instead of using as manure due to lack of time and labour. Undue importance given to the cultivation of cash crops for export have resulted in accumulation of huge stocks of sugar and tobacco. Most of the sugar factories have not been able to pay the arrears of sugarcane growers as they are not able to sell or export their sugar. But around 30% of the population is starving due to lack of purchasing power.

Since the farmers adopted high cost external input green revolution model, market oriented monoculture crops became prominent and both crop and animal diversity decreased. The use of machines, agro-chemicals, hybrid seeds reduced even natural biodiversity. Use of herbicides have destroyed a wide range of annual medicinal plants and greens which were consumed by rural population as food and medicine. The cultivation of soya in Madhya Pradesh, rice and wheat in Uttar Pradesh and Punjab, tobacco in Andhra Pradesh, cotton in Gujarat and Maharashtra have reduced biological diversity, degraded natural resources, mostly affecting small and marginal farmers. Even though there was an increase in yields in the beginning years of green revolution, the yields have dwindled inspite of 50 to 60% of increase in the use of agrochemicals, causing heavy economic losses and desperation among farmers, and irreparable loss of soil health and productivity. Modern agricultural systems delinked the complementary relationship of the soil, water, trees, crops and animals. Recycling of water, energy, by-products and wastes have increasingly become difficult. Use of agrochemicals in excess than needed in the developing countries, has caused a negative impact on the health of people, animals and the environment. Monocropping has caused pest and disease problem in a large scale and as a result use of excessive pesticides has become imminent. Small farmers have become the victims of lower prices of agricultural products, while urban population is benefitting. During the last 50 years, variety of cereal food crops has come down from 15 to 3 i.e., maize, rice and wheat. Hence the policy makers, agriculture scientists, farmers and NGOs have to work together to revise the old truths which could be appropriate for the present situation and find suitable alternatives for mechanisation, agrochemicals and help shift from monoculture to polyculture. It has to become a mass movement to introduce polyculture associated with livestock production, tree cropping and allied activities which can coexist and support farming. Thereby the recycling of byproducts and wastes can be done efficiently and economically, without exploiting the natural resources. Even due to circumstances some farmers are compelled to cultivate monoculture, they should minimise the ploughing of land, avoid burning away their byproducts, use water very efficiently, avoid weedicides by mulching, and recycle farm wastes to protect the soil, health and productivity. Instead of growing the same crop again and again it is better to grow mixed crops and crops in rotation to get the benefit of recycling nutrients and lesser pest problems. It is economical and also risk free to grow inter crops like maize-beans, maize-cucurbits, maize-tomato. Many farmers want to grow tomato during April-June, during which both high temperature and whitefly are severe problems. But if one North-South row of maize is grown, with two North-South rows of tomato, because of the partial shade from maize, the temperature will come down by 3-4 ^{0}C and whitefly havoc too will reduce by 25%. Similarly, if onion and carrot are grown together much of the shootfly problem on both the crops will be reduced. So farmers should give up monoculture and start polyculture, for sustainable agricultural production for food security and better environment. ■

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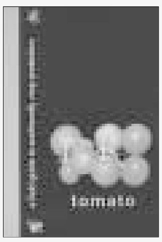

Tomato—a field guide to ecofriendly crop protection is an illustrated hanbook of insect pests and diseases most commonly found in the tomato-growing regions of India. This books aims to promote organic plant protection practices. It does not aim to cover all the other aspects of organic tomato farming, but encourages adoption of many useful organic plant protection practices through minimal use of chemicals. For each important insect pest, disease or nematode, the reader will find recommendations and strategies for appropriate biocontrol, and simple instructions for the peparation of bio-inputs. This guide is primarily intended for tomato growers in India and their service groups-agricultural extension workers, farm managers, horticulturists, agronomists, tomato processing units, agro-input manufaturers and seed companies. Its main objective is to serve as a quick reference tool for effective and ecofriendly management of the more economically important and prevalent pests of tomato in India.

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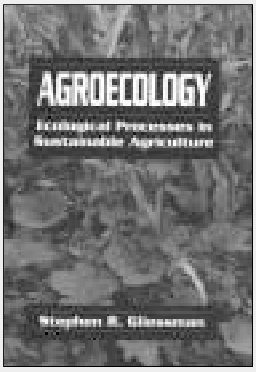
Agroecology : ecological processes in sustainable agriculture
by *Gliessman SR. 1997. 357 p. ISBN 1 57504 043 3 : USD 49.95. Ann Arbor Press, 121 South Main Street, Chelsea, MI 48118, USA.*
This basic textbook on agroecology is on the interaction of agriculture and ecology, purposes to promote a sustainable way of agriculture. It is



divided into four sections. First it describes the concept of agroecosystems and why it is an answer to the failures of convential agriculture. Then subject-wise that plant and its response to variations in environmental factors such as light, temperature, humidity and rain, wind, soil, water in the soil, fire, biotic factors and environmental interaction are dealt with. The third section is on system-level interactions, on how groups of organisms (e.g. species, a diversity of crops) interact in the cropping environment. Finally parameters for sustainability are introduced and is proposed how the issue of sustainable agriculture should be broadened to include the whole food system. This book is written in the first place for students, but offers everybody interested in agroecology a very complete picture in an attractive manner. Every chapter concludes with a list of recommended reading. By the many case studies it appears to be creative in a farmer's search for solutions. (IHG)

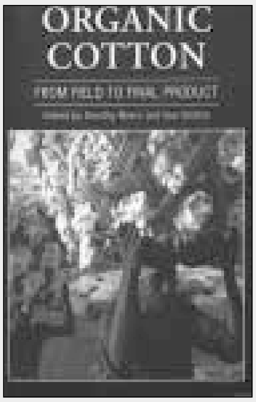
Agroecology : researching the ecological basis for sustainable agriculture *by Gliessman SR (ed.). 1990. 380 p. ISBN 0 387 97028 2. Sustainable Agriculture Information Project, Agroecology Program, University of California, Santa Cruz, Cal 95064, USA. (Ecological studies ; 78).*

This is an important overview of recent agroecological research in both the North and the South. Part 1 deals with basic ecological concepts in agroecosystems: Part 2 with agroecosystem design and management. The contributors (34 in all) are agronomists and ecologists who have begun to bring their respective strengths and approaches together to address the serious problems that test the world's ability to sustain its food production systems. Topics include research methodology, theoretical aspects of crop diversification and biological control, low-input ideotypes, analysis of traditional farming systems, and theoretical explorations of variability, stability and risks. Practical cases are reported from Mexico, India, Netherlands, USA, China and Thailand.

The book is presented just as a beginning. Agroecology is a field in its formative stages: it is more than ecology applied to agriculture, since it takes on a cultural perspective as it expands to include humans and their impact on farming environments. The book concludes by stating that it is one thing to express the need for sustainability and yet another actually to quantify issues such as nutrient cycling, energy flow, and population dynamics. There is a long way to go, and this book gives a challenging contribution along the way.

Organic cotton : from field to final product *by Myers D, Stolton S (eds). 1999. 267 p. ISBN 1 85339 464 5 : GBP 16.50. The Pesticides Trust, Eurolink Centre, 49 Effra Road, London SW2 1BZ, UK. Intermediate Technology Publications (ITP), 103-105 Southampton Row, London WC1B 4HH, UK.*

As cotton is one of the world's major cash crops, many farmers are confronted with the negative environmental impacts of its production such as reduced soil



fertility, loss of biodiversity and especially the problems related to pests and pesticide use. Also further in the processing chain pollution takes place, especially by bleaching and dyeing the cotton fabrics. This book describes organic cotton production and processing and is the first complete overview of its kind, since the first organic cotton was marketed some 10 years ago.

Still in a rather preliminary stage, there are signs that it is moving into a mass market. The book provides a very good and complete picture of the insights gained till now, and case studies from all over the world are compiled. Besides cultivation (including the growing of genetically engineered cotton) and processing, attention is paid to economic and marketing aspects, the conversion process, certification and support requirements for projects. Judging from the questions about environmentally friendly grown and -processed cotton that reached ILEIA in recent years, we predict this book will become a best-seller.(IHG)

Alternatives to conventional modern agriculture for meeting world needs in the next century. Report of a conference on Sustainable agriculture: evaluation of new paradigms and old practices, April 26-30, 1999, Bellagio, Italy. *Copies can be obtained from Cornell International Institute for Food, Agriculture and Development, Ithaca, NY 14853, fax: +1 607 255-1005, ciifad@cornell.edu. The full report can be down loaded from http://ciifad.cornell.edu/ciifad .*

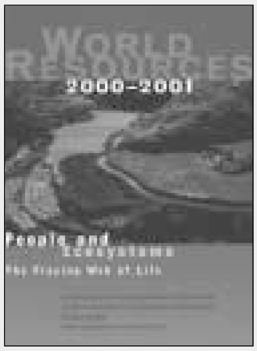
The potential of agroecology to combat hunger in the developing world *by Miguel A. Altieri, Peter Rosset and Lori Ann Trupp. Available on: www.cnr.berkeley.edu/~agroeco3/*

The authors state that evidence suggests that the Green Revolution approach is unlikely to be the appropriate strategy to end hunger and that the agroecological approach offers several advantages. The principles of agroecology are explained and several examples from different parts of the tropics are given. Thousands of farmers are following the agroecological approach, thus showing its potential. The authors point at the necessity to increase investment and research into this strategy and to scale-up successful practices. (CR)

Rice: Hunger or hope? IRRI 1998-1999. 2000. *International Rice Research Institute, MCPOBox 3127, 1271 Makati City, Philippines, irri@cgiar.org*

World Resources 2000-2001 People and Ecosystems: the Fraying Web of Life
World Resources Institute in collaboration with the United Nations Development Programme, The United Nations Environment Programme and the World Bank,2000. Paperback version 400p.ISBN 1 56973 443 7: US$27.00. World Resources Institute, 10G Street NE, Washington DC 20002, USA.

This millennial edition of the World Resources takes stock of the condition of the Earth's ecosystem and draws lessons from global experience in managing and protecting them. It focuses on five critical ecosystems that have been shaped by the interaction of physical environment, biological conditions and human intervention: croplands, forests, coastal zones, freshwater systems, and grasslands.



Three steps to good management of ecosystems are proposed in the report. The first is to acknowledge the value of goods and services provided by these ecosystems and the tradeoffs that are often made among them. The second is to base decisions on current information about the capacity of ecosystems to continue to provide goods and services. The final step is an "ecosystem approach" that explicitly recognises the interaction and tradeoffs among these goods and services, as well as the political and social context in which environmental decisions are made. Like the previous eight editions, this edition also presents an overview of current global environmental trends in population, human well being, food and water security, consumption and waste, energy use, and climate change.

Modern agriculture: ecological impacts and the possibilities for truly sustainable farming *by Miguel A. Altieri, Division of Insect Biology, University of California, Berkeley, USA. Available on: www.cnr.berkeley.edu/~agroeco3/*

The article discusses the development and impact of monocultures and the ecological problems they are creating. The author identifies an array of alternatives to conventional agriculture and discusses barriers for the implementation of alternatives. (CR)

The Center for Agroecology and Sustainable Food Systems of the University of California in Santa Cruz, USA. Its website www.agroecology.org is an information resource for developing sustainable ecosystems, emphasising international training, research and application of agroecological science to solving real world problems. The site provides information on related short courses and international events. An interesting series of practical case studies and a glossary of agroecological terms help understand the principles of agroecology as also explained in the textbook Agroecology: Ecological processes in sustainable agriculture by SR Gliessman (see next page). Very handy is the page on Agroecology Links www.agroecology.org/links.htm which makes it possible to make direct links to the main university, farmers and general sites on agroecology in USA.

Agroecology in action is the website www.cnr.berkeley.edu/~agroeco3/ of University of California in Berkeley, USA. This site gives access to the latest articles by Professor Miguel A.Alteiri and colleagues, among others, on agroecology and modern agriculture; agroecology and small farmers in the developing world; agroecology and biotechnology; agroecology and pest management (see next page). There is also a video on agroecology and biotechnology.

The International Maize and Wheat Improvement Center's website www.cimmyt.mx is quite elaborate and provides information on its worldwide programmes, contacts and publications. Information on the various resource conserving technologies that CIMMYT is developing together with wheat and maize farmers can be found on the site. CIMMYT's Natural Resources Group collaborates with national researchers, farmers and non-governmental staff in increasing and sustaining the productivity of maize and wheat systems while protecting resources. Some of this work is well described on the website.

Global Programme on Direct sowing, Mulch-based systems and Conservation tillage (GP-DMC) has been launched during the Global Forum on Agricultural Research, May 2000. In many countries DMC practices have fostered higher productivity, improved resource conservation, lowered food costs for consumers, and improved incomes for producers. The global-partnerships programme features a bottom-up process of learning and synthesis by analysing and comparing experiences with DMC in different regions. A facilitation unit is to be created. Stakeholders with relevant practical experiences are requested to join the open action group.

Further information: Larry Harrington, chair of the Interim Steering Committee, CIMMYT, Apdo. Postal 6-641, 06600 Mexico, D.F., Mexico. Fax: +52 5804 7558; l.harrington@cgiar.org

African Conservation Tillage Network launched

The purpose of the network (ACT) is to identify, disseminate and promote the adaptation and adoption of soil and water preserving tillage in Africa. The Network intends to create national networks for the exchange of information and experiences among researchers, extensionists and practitioners and to encourage farmers to experiment with the approach. A monthly, down loadable newsletter, Act Now, and training materials will be produced and pilot projects will be initiated to test and compare technologies. There will be an E-conference as well.

For more information: Edward Chuma, ACT Secretariat, IES/University of Zimbabwe, P.O. Box MP 167, Harare, Zimbabwe, Tel: +263-4-302603, Fax: +263-4-263433, Email: chuma@africaonline.co.zw and actnownews@africa.com

International Course on Integrated Pest Management will be conducted by The International Agricultural Centre from March to June 2001. The course deals with the effective implementation of IPM programmes, looking at technical as well as socio-economic aspects. It consists of 6 main modules: introduction; plant protection disciplines; development of IPM; pesticide management; IPM research, extension and implementation and IPM project proposal development.

More information and applications can be obtained from the IPM Course coordinator, International Agricultural Centre, P.O.Box 88, 6700 AB Wageningen, The Netherlands
Phone: (31)(0)317-495495
Fax: (31)(0)317-418552
e-mail: training@iac.agro.nl
website: www.iac-agro-nl

21st training in interdisciplinary team research for agricultural development will be organised by ICRA, International Centre for development oriented Research in Agriculture in 2002. It is a professional experiential learning programme in which participating researchers enhance their capacity to develop research proposals that meet the needs of clients and beneficiaries and contribute to sustainable development. Through workshops in the Netherlands and professional field work for a client agricultural research institute in the South, participants enhance their capacity to work in interdisciplinary teams, to use systems approaches for the analysis of agricultural change and to involve stakeholders in the planning and implementation of research. Course dates: January 17 – July 25, 2002 (English) and January 21- August 1, 2002 (French). Applications close 1 October 2001. Fellowships available.

Details and application forms: ICRA, P.O.Box 88, 6700 AB Wageningen, The Netherlands.
Phone: (31)(0)317-422938
Fax: (31)(0)317-427046
e-mail: icra@iac.agro.nl
internet: http://icra.agropolis.fr

AREOL 13 - action research and evaluation on line is a free on-line course offered as a public service by the Southern Cross University, Australia. Beginning late February 2001, the course will run over 4 months on the theme, "Integration of effective change with rigorous research". The course will allow participants to understand some processes that combine action research, and can be used in practice. The course, however, does not attempt to cover all types of action research, nor does it analyse its philosophy.

More details and course materials can be found on www.scu.edu.au/schools/gcm/ar/areol

Centre for Alternative Agricultural Media, CAAM has been launched on 3 December 2000 in Dharwad, Karnataka, India. The first of its kind in the country, the centre's focus is on farmer friendly communication systems. Promoting alternative efforts in agricultural communication, encouraging self-help journalism among farmers, bridging the communication gap between farmers and scientists/ government, focusing on farmer innovations and pro-farmer issues feature among the centre's many objectives. Its website www.farmedia.org will focus on several aspects of alternative agricultural media. Regular e-bulletins will be released for networking with like minded individuals/ organizations engaged in innovative alternative efforts in the farm journalism sector.

For more information contact: Dr. Shivaram Pailoor, Director CAAM, Krishnalaya, 1st main, 4th cross, Narayanapur, Dharwad 580008, Karnataka, India. E-mail: caam@vsnl.net

International Society for Nature Farming (ISNF)

This society has as objective to promote teaching, research and extension activities of nature / organic farming. It creates awareness about the role of nature farming in sustainable and eco-friendly agriculture and encourages the adoption of the concepts. It also provides a forum for exchange of experiences and information and publishes two Newsletters: Prakritik Kheti (in Hindi) and Nature Farming (in English). The Society will shortly launch the 'Journal of Agriculture and Environment' and is organising, in collaboration with the Haryana Agricultural University, the International Conference on Nature Farming and Ecological Balance (ICNFEB-2000), March 7-10, 2001 at Hisar, Haryana, India. At the same time there will be an electronic conference on the same themes:

Food production, quality and marketing; Land use planning and resource management; Organic farming systems and ecology; Indigenous knowledge and nature farming; Biodiversity and rural development; Government policies and extension programmes.

More information: ISNF, c/o Dr. IS Hooda, Dep. of Agronomy, CCS Haryana Agricultural University, Hisar – 125004, Haryana, India, icnfeb@hau.hry.nic.in
or www.geocities.com/icnfeb2001

Integrating Sustainability in Higher Agricultural Education. AFANet has developed a key activity to conceptualise sustainability in agriculture and to integrate it in the curricula of higher education in agriculture, forestry, aquaculture and the environment. AFANet, an EU SOCRATES Thematic Network, aims to stimulate co-operation in universities and colleges in Europe. The recently published book **Integrating concepts of sustainability into education for agriculture and rural development** edited by Bor, Holen, Wals and Filho, 2000, Frankfurt/M, Peter Lang Publishers (see ILEIA Newsletter Vol.16, No.3, p. 34), was the first main outcome of this AFANet activity. Part one of the book attempts to conceptualise the issues surrounding sustainability in higher agricultural education whilst part two provides case study examples from around the globe of the integration of the concept of sustainability into curricula. As a follow-up to the book, two dissemination activities were developed: an on-line discussion about the main outcomes of the book and an international seminar which focused on both the book and the results of the on-line discussion. The international seminar took place recently in Krakow, Poland, as part of the Euro-Eco 2000 conferences and was attended by university faculty members from 12 countries.

It was reconfirmed during the on-line debate and the Krakow seminar that the concept of sustainability is ill-defined. It should be realised, however, that this vagueness has an enormous strength if it is systematically used as an operational device to exchange views and ideas, and to make sustainability meaningful within a specific context.

Colleges and universities in the tropics could join this debate or start their own.

For more information: http://www.clues.abdn.ac.uk:8080/demeter/
The on-line debate can be visited on: http://www.lei.wag-ur.nl/sustainability/

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Small holding up *by Zarb J. 2000. In: The Ecologist, ISSN 0261 3131; v.30 no.9, p.40-44.*
In this article Dr. John Zarb, consultant researcher in sustainable farming, states that modern agriculture is in a crisis and that the alternative is: to move towards sustainable farming, not only in the "South" but also in the "Developed " world. He describes several examples in which the agroecological approach succeeded in developing a sustainable, self-supporting agricultural system using renewable resources. If sustainable technologies have brought significant improvements in agriculture under crippling economic, environmental and political conditions, then application in Europe or US, where structures like transport systems and markets already exist, should be successful. (WR)

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Women, land and agriculture *by Sweetman C (ed.). 1999. 72 p. ISBN 0 85598 400 7 : USD 12.95. (Oxfam Focus on Gender). OXFAM Publications, 274 Banbury Road, OX2 7DZ Oxford, UK / bebc@bebc.co.uk.*
This book appears in the series Oxfam Focus on gender. It is composed of nine articles on agriculture, land rights and gender relations in countries in Africa, Asia and South America.

The articles assert that women's contribution to global agricultural production for food and for profit continues to be largely unacknowledged and undervalued, and that their ability to farm is constrained, because the resources they need are often controlled by others. Independent land rights, which enable women to decide on the use of land and keep the proceeds from such use, are still a dream for women in many countries, despite their increasingly central role in agriculture. Two articles shed light on methodological issues for development policy-makers and practitioners. Some tools have been developed to assist the process of integrating gender issues into planning and implementation. (WR)

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Social responsibility in the global market : fair trade of cultural products *by Littrell MA and Dickson MA. 1999. 366 p. ISBN 0 7619 1464 1 (pbk) : GBP 18.99. Sage Publications, 6 Bonhill Street, London EC2A 4PU, UK / orders@sagepub.co.uk / www.sagepub.co.uk.*

This book is about fair trade from the angle of all the stakeholders: the producers or artisans, the alternative trade organisations and the consumers. Their needs, interests and preferences and business practices within the trade system are studied. There is a special focus on fair trade organisations that market cultural products from developing countries into the United States, but the themes covered (e.g. artisan empowerment and organisational sustainability) are of general interest. (IHG)

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Policies for soil fertility management in Africa *by Scoones I and Toulmin C. 1999. 128 p. ISBN 1 899825 41 X. International Institute for Environment and Development (IIED), Drylands Programme, 3 Endsleigh Street, London WC1H 0DD, UK; Institute of Development Studies (IDS), University of Sussex, Falmer, Brighton BN1 9RE, UK.*

Fifteen case studies from 12 African countries (south of the Sahara) have been carefully analysed to: a) identify the key factors to explain patterns in soil management, b) give criteria for the need for public intervention and c) assess the options available for the determination of the intervention strategy. The conclusion presented is a very complex and diverse picture, which is in contrast to the generalisations often made in the international debate regarding the crisis in African agriculture. Recommendations are made to test ways to work with farmers more effectively, to promote a greater stakeholder involvement in discussions of policy options and the design of interventions aimed at generating a more sustainable agricultural sector. A thorough study that will take an important place in the African soil fertility management debate. (IHG)

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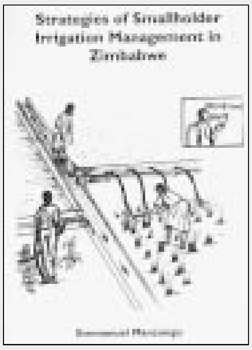
Strategies of smallholder irrigation management in Zimbabwe *by Manzungu E. 1999. 200 p. ISBN 90 5808 145 1. Emmanuel Manzungu, 1606 Marapa Road, New Houghton Park, Harare, Zimbabwe.*

Emmanuel Manzungu presents a detailed study on operational irrigation management in Zimbabwe in accordance with his thesis in Wageningen University. This study seeks to understand the implied management problem in both government and farmer-managed smallholder irrigation schemes. Empirical evidence was gathered with



respect to Mutambara, Chibuwe and Fuve Panganai irrigation schemes, between 1994 and 1996 and included at least two wet and dry seasons. His major conclusions are that the state tended to administer rather than manage irrigation schemes. In contrast farmers easily engaged with operational aspects of irrigation management. Farmers, however, had their shortcomings in relation to extra-local factors. Emmanuel states: the beginning of management wisdom is the awareness that there is no one optimum management system. (WR)

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Moving methodologies : learning about integrated soil fertility management in sub-saharan Africa *by Defoer T. 2000. 189 p. ISBN 90 58082 319 5. Royal Tropical Institute (KIT), PO Box 95001, 1090 HA Amsterdam, The Netherlands / kitpress@kit.nl, www.kit.nl/books.*

Toon Defoer, the first editor of "Managing soil fertility: a resource guide for participatory learning and action research, has written this book in accordance with his thesis in Wageningen University. The resource guide, volume 1 of the thesis has been reviewed already in ILEIA Newsletter 16(1) p.25. It provides user-friendly ways to gather, manage and analyse information, using participatory learning and action research. Moving methodologies is volume 2 of the thesis and describes the development of the participatory learning approach through the analysis of 3 case studies. Factors are analysed that have given direction to the adaptations and site specific configuration of the approach and applicable field tools. Two complementary interfaces are taken into account: the field teams interacting with farmers and the field teams as part of wider institutional settings. The book also deals with the impact of participatory action research in terms of changes in farmer learning, knowledge and innovation. The thesis concludes with discussing the major learning points in facilitating farmer learning and analysis of the major implications and issues in extending the approach.(WR)

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How to convert sea water into drinking water : an easy-to-use manual *by Ryan F. 1998. 43 p. ISBN 81 87380 07 1 : USD 5.00. Books for Change, 28 Castle Street, Bangalore 560 025, India.*

This booklet is a handy guide for grassroot workers, trainers and the urban or rural poor to make healthy drinking water available in every home with little effort and almost no investment. Fourteen simple methods are explained with drawings and a clear description. Most methods described require only household utensils like pots, vessels and plastic sheets, and can be used for sea and brackish water, but also for tap water below the quality standard for human consumption. (WR)

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Comics with and attitude... : a guide to the use of comics in development *by Packalén L and Odoi F. 1999. 96 p. ISBN 951 724 271 9. Ministry for Foreign Affairs of Finland, Department for International Development Cooperation, Kanavakatu 4-A, FIN-00160 Helsinki, Finland / kyoinfo@formin.fi.*

This book is meant as a source of inspiration for people searching for new cost-effective ideas to get the (development-related) message across. Comics draw the reader's attention, as

they are a quick and easy way to tell a story in a humorous or dramatic way. The author emphasises that comics should be simple, have a good story behind it and that the target group should be clear. Often, when local artists are involved the stories become more meaningful, and this book is full of such examples, ranging from campaign material on health, agriculture and environment to human rights, democracy and civil society. One chapter shows the complete procedure of making a comic with an attitude, of course in the form of a comic! At the end of the book references are given to more books and internet sites on comics. This book itself has an internet version on the internet site of the Department of International Development Cooperation of the Ministry of Foreign Affairs of Finland. (IHG)

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Green beginning : joint forest management in Jhabua. *2000. 185 p. ISBN 81 85419 67 1. Tata Energy Research Institute (TERI), Darbari Seth Block, Habitat Place, Lodhi road, New Delhi - 110 003, India / mailbox@teri.res.in , www.teriin.org; SIDA.*

This book tells the rather successful story of the Jhabua forestry department in restoring land use possibilities in the Jhabua district in the state of Madhya Pradesh, India, with the use of a participatory approach: joint forest management and watershed programmes. The Jhabua district was suffering under frequent droughts and poor productivity of natural resources. The joint forest management program attempted to stop forest destruction, but also aimed at poverty eradication and generating employment to reduce pressure on natural resources. The history of the district and the whole process of implementing the programme is described in the book. Attention is paid to the role of women's self-help groups. What is achieved in Jhabua, so far, is that the district is green again and that the peoples income is raised.(WR)

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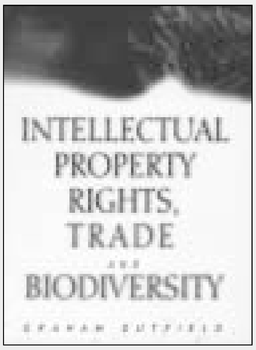
Intellectual property rights, trade and biodiversity : seeds and plant varieties *by Dutfield G. 2000. 238 p. ISBN 1 85383 692 3 : GBP 35.00. The IUCN Project on the Convention on Biological Diversity and the International Trade Regime, International Union for Conservation of Nature and Natural Resources (IUCN). Earthscan Publication, 120 Pentonville Road, London N1 9JN, UK / orders@lbsltd.co.uk.*

Patents and intellectual property rights in relation to the biological diversity of seeds and plant varieties are critical issues in the controversy between interests of trade and environment. The book deals with this controversy, looking at all its different aspects and from all angles. International agreements such as the Convention on Biological Diversity, the TRIPS agreement of the World Trade Organisation, and the Convention of the International Union for the Protection of New Varieties of Plants (UPOV) are examined and ways of



narrowing the gap between their interpretations are considered. Examples of genetic resource access and benefit sharing (ABS) laws, which are being used by some countries to place conditions on the exercise of intellectual property rights are given, as well as examples of NGO initiatives to influence the international agreements. A very important book, balanced in its opinion and providing a complete update on the complex subject matter, including a very well annotated bibliography. (IHG)

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Participatory forest management : implications for policy and human resources' development in the Hindu Kush-Himalayas. Volume I: workshop proceedings *by Bhatia A and Karki S (eds). 1999. 83 p. Volume II: China by Bhatia A and Ya T (eds). 1999. 65 p. Volume V: Nepal by Bhatia A (ed.). 1999. 41 p. ISBN 92 9115 970 0. International Centre for Integrated Mountain Development (ICIMOD), 4/80 Jawalakhel, GPO Box 3226, Kathmandu, Nepal / distri@icimod.org.np.*

These publications together are the proceedings of the regional workshop on Participatory Forest Management: Implications for Policy and Human Resources Development, held in May 1998, Kunming, China. The workshop brought together forest management personnel from various parts of the Hindu Kush-Himalayas. The basis of their discussions was the people-centered forest policies that have emerged in many countries of the region and their objectives of supporting and strengthening participatory forest management to ensure that the needs of mountain people receive the priority they deserve. Volume 1 is the workshop document, which gives an overview of the workshop and the participants. Volume 2 deals with China and concerns forest policies in China in general, and participatory forest management especially in Yunnan Province and in Tibet. Volume 5 deals with Nepal and describes the role of forests in the livelihood strategies of mountain people and the status of community forestry in Nepal. Volume 3 Eastern Himalayas, Volume 4 India and Volume 6 Pakistan complete the series. (WR)

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Manual on contour hedgerow intercropping technology *by Ya T ; Pandey A (ed.). 1999. 29 p. International Centre for Integrated Mountain Development (ICIMOD), G.P.O. 3226, Kathmandu, Nepal / distri@icimod.org.np / www.icimod.org.sg.*

This easy to use manual on hedgerow intercropping explains the benefits of the system for the land and the farmer in an illustrative way. The technology for hedgerow planting and management is explained clearly and illustratively. Recommended for trainers, extension workers and farmers in mountain areas. The contour hedgerow intercropping technology is a soil-conserving technique. It involves planting double hedgerows of nitrogen-fixing plants along the contour lines of a slope at a distance of four to six meters. Space between the contour hedgerows is used for crops. The plants for the hedgerows are selected according to the needs for fuel or fodder, and also for their soil-conserving attributes. (WR)

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The participatory learning and action CD-ROM *is a new product from the Resource Centre for Participatory Learning and Action at IIED, the International Institute for Environment and Development, 3 Endsleigh Street, London WC1H 0DD, UK e.mail claudia.sambo@iied.org*

This new CD-ROM contains a database of 2000 bibliographic references on participatory methodologies and approaches, including a whole index of PLA Notes with abstracts.

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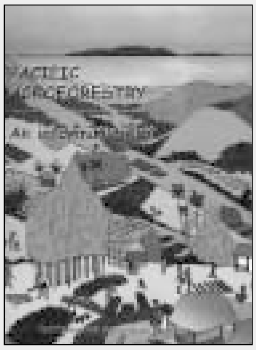
Pacific agroforestry : an information kit *by Rogers S and Thorpe P (eds). 1999. 200 p. ISBN 982 343 038 1 : 40 credit points / CTA no.975. Pacific Regional Agricultural Programme (PRAP), Suva, Fiji Islands. Technical Centre for Agricultural and Rural Co-operation (CTA), PO Box 380, 6700 AJ Wageningen, The Netherlands.*

This information kit is the result of a workshop with agriculturalists from the different South Pacific Islands, for compiling their knowledge on agroforestry. As a farming system, the use of trees in farming has not been emphasised in this region until recently, although there is a great need for



sustainable forms of agriculture in these fragile island ecosystems. The kit proves that both indigenous and technical knowledge is (still) available, and that it is very timely for these agroforestry practices to be spread among a larger circle of extensionists. This glossy manual has a beautiful lay-out with a lot of instructive drawings and pictures. Technical information is interspersed with case studies, and the last chapter deals with ways to successfully promote agroforestry within the communities. (IHG)

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Capitalising on experience in Indo-Swiss cooperation in livestock development in India. *Capitalisation of Experiences in Livestock Production and Dairying (LPD) in India project (CAPEX), Intercooperation, PO Box 6724, CH-3001 Berne, Switzerland / intercooperation@intercoop.ch; Swiss Agency for Development and Cooperation (SDC)/IC NRM Programme, Chandragupta Marg, Chanakyapuri, New Delhi 110021, India. 2000. 50 p. free.*

This booklet presents the main findings of the project CAPEX, Capitalisation of Experiences in Livestock Production and Dairying (LPD) in India. The task of this project was to review the experiences of the Indo-Swiss Programme LPD in India, since its inception in 1963 to date, and to formulate future priorities based on its findings. LPD involved 8 projects spread throughout India and included support to developing a national livestock policy. From this wealth of experiences gained after such a lengthy and large programme, the CAPEX-team chose 2 topics to focus on: 1) the evolution of a comprehensive LPD programme out of single projects and 2) selected technical issues in livestock breeding. The project is a nice example of the value of reflecting on experiences! This booklet is a summary of a full version, also available at Intercooperation, as technical report no. 15. (IHG)

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Developing forage technologies with smallholder farmers : how to select the best varieties to offer farmers in southeast Asia *by Horne P and Stuer W. 1999. 80 p. ISBN 1 86320 271 4. Australian Centre for International Agricultural Research (ACIAR), GPO Box 1571, Canberra, ACT 2601, Australia / aciar@aciar.gov.au; Australian Agency for International Development (AusAID); CIAT Forages for Smallholders Project. (ACIAR Monograph ; 62).*

This booklet is based on the experiences of researchers and farmers working with the Forages for Smallholders Project in Southeast Asia. The manual can be useful for development workers in selecting appropriate forage options for farmers. It contains a list of forage species and varieties that grow in a wide range of conditions, and are either being used successfully by smallholder farmers or

have significant potential in Southeast Asia. On many farms, feed resources for livestock are no longer plentiful, so farmers have to spend more time finding food for their animals. Planting forages can help to overcome this problem. (WR)

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Natural crop protection in the tropics : letting information come to life *by Stoll G (ed.). 2000. 376 p. ISBN 3 8236 1317 0 : EUR 55.-. Tropical Agroecology Series. Margraf Verlag,PO Box 105, 97985 Weikersheim, Germany.*

This completely revised, enlarged and updated new edition of one of our most consulted books has been recently published. The first edition of Natural Crop Protection was published in 1986; though there were several updates, this revised edition is very welcome. The book presents practical information on natural crop protection techniques, already presented in former editions, combined with a number of case studies. By presenting both technical information and case studies on farmer participatory research, the book links information on natural crop protection with approaches and methodologies. Valuable suggestions are made for research to further improve engagement in developing natural crop protection practices for resource-poor and organic farmers. (WR)

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The emerging alternative rice marketing system: selling high volume excellent quality rice : a preliminary study of an emerging alternative rice marketing system in Manila and Luzon provinces *by Miclat-Teves AG (ed). 1999. 100 p. Project development Institute, 3-B Mayumi St., U.P.Village, Diliman, Quezon City, Philippines; Center for Research and Information on Low External Input and Sustainable Agriculture (ILEIA).*

This study on alternative rice marketing has been prepared for the ILEIA Collaborative research program in the Philippines. Although it focuses on Luzon, its conclusions and recommendations are important for the development of alternative rice production and marketing in the whole country. Marketing of rice produced by small farmers' organizations, based on the principle of "fair trading" is studied. The low volume of the commodity is compensated by its high quality, and the marketing activity seeks to promote sustainable agriculture as well as to provide higher incomes for farmers. This alternative rice marketing system in which NGO's play an important role is compared to the mainstream rice marketing system. The book ends with a summary of problems, potentials and recommendations. (WR)

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Agricultural Information Resource Centers - A World Directory 2000 *Edited by Johnson J.S., Fisher R.C. and Robertson C.B., 2000.752p. ISBN 0 9624052 2 1:US$105.00. IAALD World Directory, The Samuel Roberts Noble Foundation, 2510 Sam Noble Parkway, Ardmore, Oklahoma 73401, USA. pbrennen@noble.org*

Updated over the past five years, this third edition of the directory provides the most complete, up-to-date, single source of access to the world's agricultural information centres. Contains 3,940 entries from 189 countries, including contact details. The information is organised alphabetically first by country, then by city and parent institution. The key to acronyms and abbreviations that appear in the directory for databases, database vendors, institutions, institutions, and networks is an extremely valuable tool.

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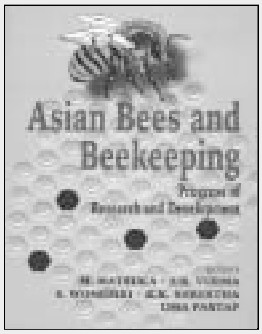
Asian bees and beekeeping : progress of research and development : proceedings of Fourth Asian Apicultural Association International Conference, Kathmandu, March 23-28, 1998 *by Matsuka M ... [et al.]. 2000. 274 p. ISBN 1 57808 084 3. International Centre for Integrated Mountain Development (ICIMOD), G.P.O. 3226, Kathmandu, Nepal / distri@icimod.org.np / www.icimod.org.sg . Science Publishers, PO Box 699, Enfield, N.H. 03748, USA / sales@scipub.net, www.scipub.net.*

This publication is an outcome of the knowledge and information shared during the conference and related workshops in Kathmandu, organised by the Asian Apicultural Association (AAA). The book presents an overview of indigenous bees and beekeeping



research and development in Asia, and highlights the issues related to conservation and management of the Asian hive bee, Apis cerana. In part one the authors advocate the need to conserve Apis cerana and suggest strategies for conservation of this indigenous bee species in the hindu Kush-Himalayan region. Part two explains new frontiers of bee biology research, especially of Apis cerana compared to the introduced species Apis mellifera (honey bee). There is a part on recent findings in bee diseases and pest control and on innovations in apiary management. A section on production, processing, properties, and marketing of different bee products- is also provided. In addition, new advances in crop pollination research through beekeeping and experiences in extension covering topics ranging from beekeeping needs and extension methodology in hills and mountain areas to the role of various institutions in promoting sustainable beekeeping are given in detail. The last part of the book provides information on traditional beekeeping methods and indigenous knowledge of beekeeping, and potential of beekeeping as a self-employment opportunity for women in hilly and mountain areas. (WR)

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Roots and tubers for the 21st century : trends, projections, and policy options *by Scott GJ, Rosegrant MW and Ringler C. 2000. 64 p. ISBN 0 89629 635 0. The 2020 Vision, International Food Policy Research Institute (IFPRI), 2033 K Street, N.W., Washington, DC 20006-1002, USA / ifpri-info@cgiar.org; Centro Internacional de la Papa (CIP), Apartado 1558, Lima 12, Peru. (Food, Agriculture and the Environment Discussion paper ; 31). To order via internet or to download the complete paper, go to: http://www.cgiar.org/ifpri/pubs/catalog.htm#dp.*

This paper gives an overview of the most recent data and information on potato, sweet potato, yam and cassava and gives trends and projections towards the future per region. Research activities and organizations are also provided, with the objective of providing a vision for research on roots and tubers in the CGIAR. This publication provides a clear insight of the importance of roots and tubers in the food systems of developing countries nowadays, the role of which will remain important, and diversify increasingly in the future. (IHG)

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Profit for the poor: cases in micro-finance *by Harper M. 1998. 188 p. ISBN 1 85339 438 6 : GBP 12.95. Intermediate Technology Publications, 103-105 Southampton Row, London WC1B 4HH, UK.*

This book shows that there are many different ways of banking possible, which are rooted in the traditional methods of money-lending, local saving and credit groups. Fifteen case studies are presented, varying from well-known cases to more obscure ones, but they are all successful. Although sympathetic and accessible, the tone in the book is unmistakably that of a banking viewpoint. This does not have to be a disadvantage, as is said in the introduction: "micro-finance can offer a unique opportunity to combine genuine humanitarian aid for the poorest with good opportunities for trade and investment". (IHG)

Studies on *desi* cotton based intercropping under dryland conditions

R. Naganagouda, V.S.Veeranna, M.B.Guled and S.M.Hiremath

Northern dry zone of Karnataka has mean rainfall of 583 mm with 38 rainy days indicating that cotton production is risky and not consistent. In recent years, decline in its area is observed both under irrigated and rainfed conditions.

Intercropping of cotton with short duration legumes, cereals and oilseeds was found more remunerative than growing cotton alone. Intercropping offers a great promise particularly under rainfed conditions and the farmers are adopting this system since many years to overcome risk due to failure of single crop and also with the aim of obtaining different agricultural produces for their household consumption.

Experiments were carried out under dryland conditions at Regional Research Station, Bijapur during kharif 1998 to study the effect of intercropping of oilseeds in desi cotton on growth, yield and economics. Experiments included intercropping with castor and sunflower.

- Three sole cropping and 8 intercropping systems were designed.
- Cotton(cv DB-3-12), Sunflower (KBSH-1) and Castor (cv n0.48-1) were the varieties used.
- The row ratios for intercropping treatments were 1:1 and 2:1 (cotton & other crop).
- Uniform row spacing (60cm) and variable intra row spacing.
- The population level of cotton:other crop tried were: 100:75 and 100:50.

Sole crop of cotton, sunflower and castor recorded higher yields. However, cotton equivalent yields, net returns (rupees per hectare) and cost benefit ratios were higher in intercropping systems.2:1 intercropping ratio facilitated better growth than 1:1 ratio. 100: 75 plant population levels gave better results.

Though the cotton equivalent yield recorded was highest in cotton: castor intercropping system (935kg/ha), the next highest yield was recorded in cotton:sunflower intercropping system (905kg/ha). The net returns were highest in cotton:sunflower system.

Sunflower being short duration, shallow rooted and narrow canopy crop in comparison to castor (exuberant growth) has resulted in lesser competition when intercropped with cotton. Higher kapas yield and better intercrop yield were recorded because of lesser competition between main and intercrops for growth resources as a result of better geometry and optimum plant population levels.

Intercropping of sunflower or castor in cotton increased the net returns as compared to that with sole crops and the maximum increase was to the extent of 23 and 22 percent respectively. It was due to greater productivity in terms of cotton equivalent yields and higher gross returns as a result of higher market price.

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Themes for the LEISA-India

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Going to scale

How do the benefits of innovations in agriculture and natural resource management spread to more people? What type of innovations do people prefer - when, where and why? How and when does spontaneous diffusion take place? What conditions can be created and what methodologies can be used to enhance or plan going to scale? What are the obstacles of going to scale, can they be overcome and how? What can we learn from case studies that analyse more or less successful experiences with going to scale? Going to scale has multiple dimensions, methodologies, players and contexts – spatial, temporal, technological, economic, ecological, social, gender, cultural, institutional, empowerment, capacity building, partnerships, communication, negotiation, financial incentives, etc. What role do these dimensions play in going to scale?

This issue will include and build on the results of earlier workshops on this theme. With some extra pages to spare and considering the complexity of the theme, some longer articles (up to 3600 words) may be accepted as well. ***Deadline for contribution 15 February 2002.***

December 2001 Vol. 3,4

Alternatives to Biotechnology

'Terminator Technology', 'Golden Rice', 'Bt Cotton or Maize', herbicide resistant 'Roundup Ready Soya' are the products of modern biotechnology. Some claim that such developments will solve the problem of world hunger and that we need Genetically Modified (GM) crops to meet the demands of a rapidly growing world population. But do we really need these technologies? Do they deliver what they promise? Are large companies investing in these technologies interested in the specific needs and requirements of smallholders in the tropics? Will low-cost and low-risk oriented farmers benefit from these technologies? And are there other biotechnologies not based on genetic modification that provide affordable and complementary tools for improving genetic resources?

In this issue on 'Alternatives to Biotechnology', we would like to focus on the specific claims made in favour of the introduction of the Genetic Revolution in tropical farming, the risks involved and the alternatives that exist around the world. For example, do natural pest control mechanisms in ecological maize or cotton production systems provide good alternatives to high external-input based Bt-Maize or Bt-Cotton? Do people who depend on integrated rice-based systems really need Golden Rice for their daily Vitamin A supply? Are herbicide resistant crops really needed in zero tillage systems? ***Deadline for contribution 15 March 2002.***

You are invited to contribute to these issues with articles (about 1800 words + 2 illustrations), suggest possible authors, and send us information about interesting issues, publications, training courses, meetings and websites.