# ILEIA NEWSLETTER 1&2|91

FOR LOW EXTERNAL INPUT AND SUSTAINABLE AGRICULTURE

SPECIAL ISSUE


# ASSESSING FARMING TECHNIQUES

**Proceedings of ILEIA workshop 1990**

**Can quality be quantified? Let the farmers judge!**

**No sustainability without local economies?**

# ILEIA 1&2 | 91

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**TYPING**
Ellen Radstake

**LANGUAGE CORRECTIONS**
Carine Alders

**ADMINISTRATION**
Carine Alders, Marika van den Brom

**DESIGN & LAY-OUT**
Annemieke de Haan

**PRINTING**
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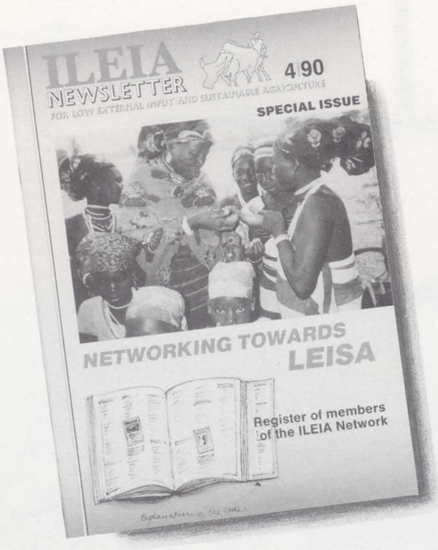


**BACK COPIES** of the ILEIA Newsletter are available. See page 72.

## Dear Readers,

### Whose criteria count?

*In December 1990, ILEIA organized a workshop on "Assessing low-external-input farming techniques". In this issue of the ILEIA Newsletter the proceedings of this workshop are presented. We have tried to do that in such a way that the main findings and recommendations are illustrated by evidence from practical experiences from many places in the tropics. With this publication we hope to stimulate critical reflection on technology assessment and the limits of market economies. We want to acknowledge and thank all those who have contributed (see page 71). Without them, the workshop would not have been possible.*

*The Editors*

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**Cover photo: Mrs. Balometsi Ngongorego assessing crop development and seed quality of a local sorghum variety (Segaolane) in her field, Sekgweng, Palapye district, Botswana. Mrs. Ngongorego is working with fellow female farmers on sustainable dryland farming in Botswana within the Field Improvement Programme of Palapye Development Trust. Good seed quality determines ultimate selection before harvest. Photo: Kees Manintveld.**

# Assessing low-external-input farming techniques

**To respond to the need for evidence on the sustainability of low-external-input farming techniques, ILEIA organised a workshop on ways to assess this. Critical reflexion on context and the criteria applied is seen as a precondition for assessing technology.**

The need for sustainability of farming systems is generally accepted. Low-external-input and traditional techniques such as agroforestry, multiple cropping, crop-livestock integration, integrated pest management, organic matter management, and water and nutrient harvesting are being given greater attention in agricultural development. They are seen as technology options that could help create sustainable systems and decrease the need for expensive, imported inputs. However, nongovernmental organisations (NGOs), policy makers and project planners are increasingly demanding documented evidence of technical feasibility and economical and environmental viability.

Many farmers who have left their traditional context have lost their feeling for traditional farming. Those who have adopted chemical farming are now confronted with an increasing threat of nonsustainability. How could they reorient their farming? Which techniques should be used? There are no ''sustainable techniques'' as such, but there are techniques that can contribute to making farm systems sustainable, if used in the right context and in the right way.

### What does sustainability mean?

Many different definitions have been coined. Is sustainability ''successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources'' (TAC/CGIAR 1988)? Or is it more than that? What about poverty issues, quality of life, North-South relations, food quality, interhuman relations, human relations with nature, and cultural and spiritual identity? What about the timespan to be considered: our tomorrow or also that of future generations? Do we consider only local effects or also global aspects? Do we accept only scientifically proven facts, or also aspects which are still being debated by scientists or are not measurable, e.g. greenhouse effects, spiritual relations?

Can we speak of ''sustainable agriculture'' alone? Agriculture is an integrated part of societies. Production cannot be separated from consumption, nor the production system from the cultural system. As farm households often have non-farm sources of income, must not we look at complete livelihood systems instead of only farm systems? Obviously, sustainable agriculture (if we want to use this term) is extremely complex and cannot be simply approached by a scientific formula. Nevertheless, we have to orient our livelihood systems to sustainability, for us and our children to survive in a ''human'' way, if at all possible.

### Which criteria do we need?

Sustainability can be achieved and maintained only if it is deliberately and continuously sought, and if the whole farm system is constantly monitored for its sustainability. To be able to do this and to choose the best techniques to achieve sustainability, criteria are necessary. But, which criteria and according to what priority? Who decides which criteria to use? The policy maker or researcher, interested primarily in technical performance, yields, profit, foreign currency balance etc? Or the farm household, certainly interested in cash income but often also in products for their own use such as food, fodder, manure, fuel, construction materials, medicines and functions such as risk minimisation, management flexibility, and the health of the soil, crops, animals and themselves?

What biases do policy makers, researchers and farmers have? Which criteria does each leave out or give lower priority, that may have impact on sustainability?

Farmers in Burkina Faso are assessing seeds for experimentation. In many traditional societies, men were also nursing children. We have to orient our livelihood systems to sustainability, for us and our children to survive in a human way, if at all possible. Photo: Peter Gubbels.

### The ILEIA workshop

Being an information centre for Low-External-Input and Sustainable Agriculture (LEISA), ILEIA was confronted with the need to gain greater clarity about how low-external-input farming techniques could be assessed with a view to sustainability. For this reason, ILEIA organised a workshop to find relevant and acceptable methodologies. What alternative methodologies have been developed, and are improvements possible? What conclusions can be drawn about the viability of low-external-input techniques, based on the quantitative or qualitative data available?

For practical and strategical reasons, ILEIA limited its search to data on soil fertility management techniques which have been quantified in some way. Three students from the Agricultural University of Wageningen and Utrecht – Nico Barning, Lies Joosten and Bart van Kats – searched the literature to find relevant data and analyse them. Members of the ILEIA network offered their experiences and gave comments on a basic paper. Publications on technology assessment and alternative or environmental economics were studied. Twenty-eight persons from different backgrounds (policy, research, development, practical farming) were invited to share their experiences and deepen insights at the workshop held 11-13 December 1990 in the ILEIA office. This newsletter has grown out of that meeting. ■

# The Bontoc rice terraces: high and stable yields

**How can the ancient Bontoc terraces continue to produce high and stable rice yields after so many centuries? Hilario Padilla tries to explain this classic example of ecological farming and to assess whether the indigenous LEISA techniques used in this mountainous area could find wider application.**

**Hilario Padilla**

The sophisticated Bontoc terraces, like a stairway to sky, were terraced with river stones using only simple tools. The synergy between the forest as water source and the rice terraces indicates the intricate agro-ecosystem relationship. Photo: Hilario Padilla.

The famous rice terraces of Northern Luzon are one of the wonders of the world. Many are astonished to see how the steep rocky mountains have been transformed into ricefields, like stairways to the sky, using only simple tools. The centuries-old terraces are believed to have been carved by "Indonesians" who came from Southern China sailing to Luzon in dugout boats. These migrants arrived with copper and bronze tools and the knowledge of building rice terraces (Scott 1975).

It is a wonder, too, that one of these terrace systems – Bontoc, at an altitude of over 1500 m – has maintained high yields through time under very difficult conditions. Omengan (1981) reported that the Bontoc rice paddies yield 6.2 t/ha without the use of modern cultivars, chemical fertilisers and pesticides. My sampling gave an average rice yield of 6.1 t/ha. Both measurements excluded the terrace borders, which produce more tillers, more filled grains and, hence, higher yields. In comparison, IRRI's long-term experiments with NPK fertiliser applications of 140-30-30 in the dry season yielded 7.3 t/ha (Chang 1975). The Philippine national average yield is about 2.5 t/ha. There is obviously much to be learned from the Bontoc farmers.

Unfortunately, their rice-growing system is now beginning to disappear without having been thoroughly investigated and documented. How do the Bontoc maintain their high yields without the use of "modern" techniques? Does it have anything to do with their cultural traditions? What makes this traditional system ecologically viable? Why has it not spread to other parts of the Cordillera with almost the same cultural traditions?

### The importance of tradition

Rice is central to the social, economic and religious life of the Bontoc people. It is the main dish on all festive occasions and is also made into wine, which is highly valued for rituals. Rice production therefore demands utmost care, and the people live very close to the rice terraces. Rice is much more valued than the other main staple food, sweet potatoes. To have an abundant supply of rice is a status symbol.

The Bontoc have developed a very complicated sociopolitical system or Ato, centered on the council of elders who act as priests (mumba'i) during rituals. The Ato is the seat of all major decisions in the community. Without the Ato, the age-old rice production technology would have long been abandoned.

### Water as a tool in terracing

Terraces are built by the men, mainly for soil and water conservation. Areas are chosen where there is an ample water, regardless of slope, and a nearby source of construction materials. Slopes prone to landslides are avoided.

Terraces are usually built at times when water is particularly abundant, as water is an essential tool in construction. When terracing, the Bontoc never lift what water can move. Impounded water is used to transport tons of rocks, granules, debris and soil fill. Topsoil is carefully saved as the last filling material. Water is conveyed from its source by gravity flow and is sometimes diverted 1-4 km upstream. This hydraulic technology and the Bantoc's stone-walling skills are incredible feats of engineering. Terrace construction requires high labour input and is usually done through mutual assistance (ob-ob-fo).

Paddy dikes and walls are religiously maintained. Seepage and weak points are immediately repaired, requiring constant field visits. A unique feature of the Bontoc terraces is their long curved walls of smooth stones (other terraces use angular broken rocks). The river-stone linings are said to conserve heat, and may indirectly influence nutrient cycling by crop uptake (Omengan 1981) or the activity of soil micro-organisms.

The long perimeters of the terraces are a Bontoc adaptation to increase yield, based on observations that the borders (paddy edges) produce more tillers and filled grains. This may be due to the effect of solar radiation.

### Soil puddling by foot

The women then clear and weed the terrace walls and immediate surroundings. Farmers are very particular about the cleanliness of terrace dikes and walls for fear of rat infestation. The weeds are not burned, but dumped in heaps for partial decomposition.

The women then puddle the soil with their feet. In some cases, if the terrain permits, animals are used to trample the mud. During puddling the partially decaying weeds cut from the surroundings and the weeds in the pond (especially the floating azollas and blue green algae) are treaded deep into the mud. The value of azollas had long been recognised in the area even before scientists started investigating its potential as fertiliser. Nitrogen-fixing algae are thought to be a major source of N in the paddies.

In some parts of the pond where the water is shallow, weed vegetation is mixed with mud and formed into mounds that protrude above the watertable. They are used later to grow onions, garlic, legumes and other greens. As the women move forward, working the organic matter into the mud, they also gather fish, especially "yoyo", an eel-like fish the size of a pencil.

### Sowing with whole panicles

Two to five traditional varieties, usually long-season ones, are planted in a medium to large field. Seeding starts with the appearance of the "kiling" (*Erythruru hyperythra brunneiventris*), a migratory bird. Whole, unthreshed rice panicles are laid parallel to each other in the seedbed.

Little is known of the scientific significance of this practice. A new approach to raise the yield potential of rice is manipulating the weight of single grains. Increasing the number of high density (HD) grains increases yield, milling recovery and head rice recovery. Varieties differ in the number of HD grains. Within a panicle, certain spikelets invariably develop into HD grains. Most spikelets on the primary branches are HD grains. Leaves near the panicle are more important in grain filling. Removal of the 4th leaf from the top increased grain weight and number of HD grains (Vergara 1987). It is possible that the Bontoc's careful selection of panicles as seed source contributes to their high yields.

Seeding is done simultaneously in every community. This is related to a traditional holiday (tengao) which is declared before sowing. During this holiday, when it is taboo to go to the fields, seed is selected. Simultaneous sowing also helps prevent build-up of pests, especially rats (Valentin 1986), and allows re-utilisation of irrigation water and whatever nutrients it carries for other paddies.

### Dense transplanting and little weeding

Rice seedlings are transplanted singly and randomly at a spacing which depends on variety, elevation and season. Generally, planting density is high, with a hill spacing of 8-12 cm. Seedlings are already very large when transplanted. The village agricultural priest (Tomona) declares when to transplant. The large seedlings and close spacing could be ways of controlling weeds. Plant are spaced more closely in poorer soils and during the rains, because tillering is slower in these conditions.

**An old woman incorporating weeds, compost and azolla during land preparation. Simultaneously, she gathers yo-yo (an eel-like fish with the size of a pencil) and snails for food. Almost all farm work is done by women. Photo: Hilario Padilla.**

**Terraces are now being converted to vegetable gardens and farmers are drawn into the market system, leaving the delicate balance of the agro-ecosystem. This poses one of the great threats to the sustainability of the Bontoc rice terraces. Photo: Hilario Padilla.**

In many areas, transplanting is exclusively done by women. They also gather shell and mudfish at this time, and some transfer small mudfish to less-stocked terraces. At this stage of rice growing, the women work in many fields and become familiar with the soil conditions of each parcel and the agronomic response of the different varieties grown. After transplanting, no one enters a field for almost 4 days, another tengao.

Weeds are not a major problem. Often, only one weeding is enough, and the time is used again for collecting snails and weeds as food supplements. It is also a time for replacing missing hills.

### Communally managed irrigation

Irrigation water is maintained at 5-10 cm throughout the growing period. Farmers are very particular about water depth. After transplanting, a ritual is held to regulate the headwater source gate to avoid excess flow and thus lessen the nutrient loss due to water overflow. Irrigation water is usually stopped a week before harvest.

During dry periods, irrigation water is a common source of conflict. The role of the elders in settling such conflict is highly significant in the local management of the communal irrigation systems.

Omengan (1981) studied the nutrient content of water coming in and out of the fields and found that irrigation water contributes to the nutrient content of the paddies. She also found that significant quantities of P and N accumulate within the paddies. She inferred that the compost was the P source and probably nitrogen fixation from blue-green algae and azolla in the paddy was the N source.

Water quality differs from place to place. The occurrence of the disease "Lisao", the wilting and drying of seedlings 2-3 weeks after transplanting, could be related to water quality, as the disease occurs close to where the irrigation water enters the fields (Valentin 1986).

### Few pests and diseases

No major pests and diseases occur in the rice terraces, only minor ones like Lisao, which could be due to a zinc deficiency brought about by continuous flooding. This physiological disorder is manifested by red tops and rotten roots. In some areas, used batteries are ground and applied to the affected fields, as people claim it helps prevent Lisao. The Bontoc claimed that draining the fields also helps prevent this disease. This would correspond with experience at IRRI, where paddies were dried up to prevent zinc deficiency resulting from oxidation.

Rats are prevented by keeping the paddies clean. Birds are driven away by scaring and the ritual "felew". A large worm (tuwing) that causes paddy seepage is controlled using sunflower (*Thitania* sp.) and "paswek" (family *Sapindaceae*).

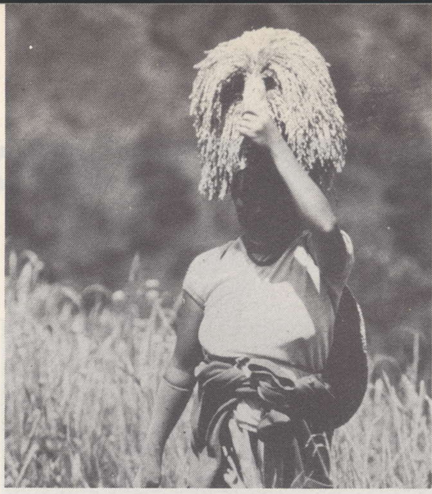
Another characteristic of the rice paddy system is the practice of "bangkag" or soil drying to prevent the occurrence of Lisao, to make the soil easier to manage during land preparation and to enhance the rooting of seedlings. Moreover, various scientific reports suggest that soil drying could enhance soil fertility by releasing some nutrients tied up in the soil organic complex.

## A classical integrated system

The Bontoc rice terraces give a classic example of a traditional farming system that is highly productive with proven sustainability. Elsewhere in the region, the cultural rites concerning rice and the terracing systems are quite similar, but the Bontoc have more advanced techniques to enhance soil fertility, make narrower terraces and use rounded river-stones for terrace walling.

They make maximal use of local resources and conserve water and soil. Soil life is maintained through nutrient recycling and the use of biomass like weeds and sunflower. The pig, already part of their tradition as a ritual animal, is an important part of the system's nutrient flow pattern, as it consumes byproducts like rice bran, and its dung, together with the bedding material cut from the grasslands, produces excellent compost. The Bontoc composting technique is worth emulating in other parts of the Cordillera, where pigs are free-roaming, but labour and cultural differences seem to constrain its diffusion. Other groups like the Kalinga regard the use of manure as a taboo.

The sociopolitical structure of the Bontoc and the careful work of the women are very important aspects in the perpetuation of this traditional rice-growing system. However, the increasing influence of ''modern'' culture and technology may push it into oblivion. The attraction of cash income from growing temperate vegetables is a major reason for the conversion of terraces into gardens. Some observers may regard diversification into vegetable growing as sound, because the farmers then have both rice and cash. But how long can they stand the pressure that characterises the economy of commercial vegetable production, which is highly dependent on external inputs with unpredictable pricing and cash flow?



Harvesting is done by panicle. My sampling gave an average rice yield of 6.1 tons per ha. The measurements excluded the terrace borders which produce more tillers, more filled grains and, hence, higher yields. Photo: Hilario Padilla.

## Still room for improvement

As commendable as the Bontoc rice system is, it could be improved in certain aspects. For example, the women's task of using their feet to puddle the soil is very laborious. Some recommendations made by the Agricultural Sector Committee (in which I serve) for the Cordillera Comprehensive Development Plan on rice terraces are:

– Appropriate farm mechanisation, for example hand-operated puddler or carabao-drawn plough, should be encouraged wherever possible to replace soil puddling with the feet. Weeding tools like the rotary weeder could also be introduced to free women's labour time for other tasks and help reduce labour bottlenecks.

Sunflowers lying on the paddy. A large worm (tuwing) that causes paddy seepage is controlled using sunflower (Thitania sp.) and ''paswek'' (family Sapindaceae). Photo: Hilario Padilla.

– Crop rotation with legumes should be encouraged. Planting of ''legume banks'' in unused spaces near rice terraces should be promoted as a source of green manure. This could be an alternative source of fertiliser in parts of the Cordillera where there is cultural resistance to using manure.

– Modern rice-growing technology like that being promoted by the government, particularly the use of modern varieties, should be carefully studied in the light of existing cultural traditions, e.g. since harvesting is done by panicle, varietal characteristics such as resistance to panicle shattering should be considered.

– The Bontoc rice-growing technology, particularly the nutrient cycling practices, should be promoted in other areas. Building pig pens could be encouraged to facilitate manure collection.

– To permit self-sufficiency in rice, construction of more terraces should be encouraged.

– The irrigation system could be improved. The use of concrete channels to convey water from its sources up to 5 km away would greatly reduce current seepage problems.

The rice terraces, a national heritage, embody invaluable knowledge which is in danger of being lost under the pressure of ''modernisation''. Gaining insights into the wisdom of this traditional system could help us rethink current agricultural policies and learn about ecologically-oriented and productive farming. ■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**Hilario J. Padilla**
Agtalon, Nalsian, Manaoag
Pangasinan 2428, Philippines

**Precise knowledge of the yields in peasant farming and an understanding of how these relate to environmental conditions, techniques used and household economics are needed to direct research and extension. Pierre Morlon reveals how highland peasants' ways of dealing with climatic risks and market conditions lead to a huge variation in yields.**

The soil cultivation achieved with the 'chaquitaclla' (andean footplough) permits control of water runoff. Huancho (Puno), Peru, 3850 meters above sea level. Photo: Pierre Morlon.

# Peasant strategies to deal with risk

Pierre Morlon

In the Andes of Peru and Bolivia, observations and measurements in the field reveal that yields are sometimes far higher than given in official statistics or obtained by quick surveys (Hibon 1981, Horton 1984, Morlon 1990). Above all, they show the extreme variability in the yields of all crops, firstly, between years; secondly, between different categories of producers and even between producers within each category; and thirdly, between the different plots cultivated by one and the same family in different "production zones" (Mayer 1985). Some plots are cultivated "intensively" with chemical fertilizers, pesticides and modern plant varieties, and others "in the traditional way" without purchased inputs.

Therefore, when very low yields are observed, they must not be taken at face value and in isolation (leading to the all too frequently drawn wrong conclusions), but as the lower end of a vast range of variations.

Accurate assessment of yields raises several methodological or conceptual questions (Morlon 1990):

- survey versus direct measurement in the field;
- sampling versus exhaustive verification of all fields;
- evaluation of the associated crops;
- the "byproducts" to be used for animal feed may be just as important to the peasant as the "product" which alone interests the technician;
- choice of the productivity criterion in the light of the factor perceived as a constraint: return per unit area, labour productivity, return compared to the amount of seed used, irrigation water efficiency, etc.

However, it is not enough to know the yields, they must also be explained.

### Commercialisation as limiting factor

It has often been observed that peasants voluntarily limit production for market, either because of the low prices received from greedy middlemen or because there is an apparent lack of outlets, given that big business and the food processing industries prefer to buy uniform cargos of imported (often subsidised) foodstuffs, rather than collect many assorted (and never subsidised) batches produced by smallholders. The emphasis on farm consumption therefore emerges not as a hangover from the past, but as a response to current conditions.

In addition to the natural risks of bad harvests, marketing problems induce the peasants to buy the lowest possible quantity of inputs or services, the cost of which they cannot be sure of recovering by selling the increased production which might result. This is the case when the crops are for farm consumption, when the ratio between market prices and production costs are unfavourable, and in the production zones at highest ecological risk. On the other hand, peasants at the very bottom of the economic scale and in the most precarious circumstances have been seen to adopt unhesitatingly new, more productive techniques when these are adapted to their situation and are deemed more reliable – in their particular context – than the other economic activities of the family. This explains why, in certain production zones, the same peasants apply traditional practices without purchased inputs and, in other zones, turn to "modern" techniques with high inputs.

### Competing factors in peasant economy

Within the peasant family economy, there are several competing factors. Returns per unit area depend on the choice of priorities made by the family between agricultural and non-agricultural activities.

For example, agronomic recommendations and input supply were part of a 1978-79 study of several peasant families in the Altiplano (Montoya et al 1986). Two families seemed very similar with respect to size, economic level and land ownership (just over 0.5 ha). Yet, in the fields of the first family, potato yields that year were between 15 and 40 t/ha, whereas the second family harvested an average of 5.5 t/ha, with a maximum of 9 t/ha. The difference could not be explained by natural environmental factors. However, it turned out that the head of the first family had decided not to migrate temporarily that year, in order to watch over the crops and ensure the harvest. In contrast, the other family had concentrated on artisanal activities and had not carried out (or did so too late) certain cultural operations such as weeding. The difference in priorities was perhaps due to the difference in the ownership of livestock which guarantees cash income.

### Multiplying the combinations

Brunschwig (1986; pers.comm.) calculated that, in the Laraos community on irrigated terraces at an altitude of 3200-3400 m, the average maize yield of the 5 families studied was 5100 kg/ha during a favourable year, using traditional varieties and no purchased chemical inputs. This was the average of all fields of the five families studied. In fact, the average return includes and masks extremes ranging from 1600 to 12,000 kg/ha (Fig. 1).

A yield of 12 t/ha of maize is probably exceptional, but we are interested in precisely such exceptions because they illustrate the high potential of a highly developed production zone and give a quite surprising answer to the question: What yields can be obtained from traditional farming? This question must be replaced by another: Why are these high yields not obtained everywhere?

Risks, especially climatic ones, inevitably cause marked variations between years and, in the same year, between fields exposed to these risks to a greater or lesser extent. Faced with these risks, the peasants have long adopted two main complementary strategies:

1) Reducing the risk level

- by developing the environment: irrigation, terraces, ridged fields, (although this does not completely suppress variability, cf Fig. 1);
- by choosing ways of tilling and working the soil that retain the water, or remove it, depending on the type of soil, land relief, and precipitation in that year (Bourliaud et al 1988);
- by adapting the morphology of the canopy to prevailing microclimatic characteristics (high-altitude frosts in particular).

2) Spreading the risks as much as possible

- in time, by staggering sowing dates; dehydrating tubers so that the results of good years can be carried over to bad ones;
- in space, by exploiting the maximum number of ecological zones on the mountain (Murra 1975) and by cropping a large number of dispersed (''salpicadas'') plots (Morlon et al 1982).

The result of this risk-spreading strategy is the multiplication of the number of farming combinations: cultivated sites (soil, climate, topography) multiplied by ways of working the soil, multiplied by species and varieties, multiplied by sowing dates etc, so that at least some of these combinations will be productive.

Thus, the divergent yields (their dispersal in statistical terms) of the various fields cultivated by the same family result from the peasant strategy of risk spreading and from complementary use of different ecological environments. As the climate is unpredictable, the peasant cannot foresee which of the combinations will prove best (except in very favourable zones such as the ''campiñas'', irrigated fields with hedges and groves in valley bottoms at about 3000 m) and, in fact, in any one year only a small proportion of these combinations prove to be ''optimal'' and produce high yields. Return from the other cultivated plots can be very low, and therefore the average yield, too.

### Averages are of no use

Thus, if we merely look at average data, official statistics are not necessarily far from reality, but knowing only averages is of no use for improving production and the lot of the peasant farmer. To begin to work efficiently, the production obtained from many fields must first be measured. Next, one must analyse the factors which intervened in each case and the causes of the differences observed – not forgetting that, while the yields obtained affect the producers' standard of living, the organisation of the economic system of the peasant family is one of the principal determinants of these yields. ■


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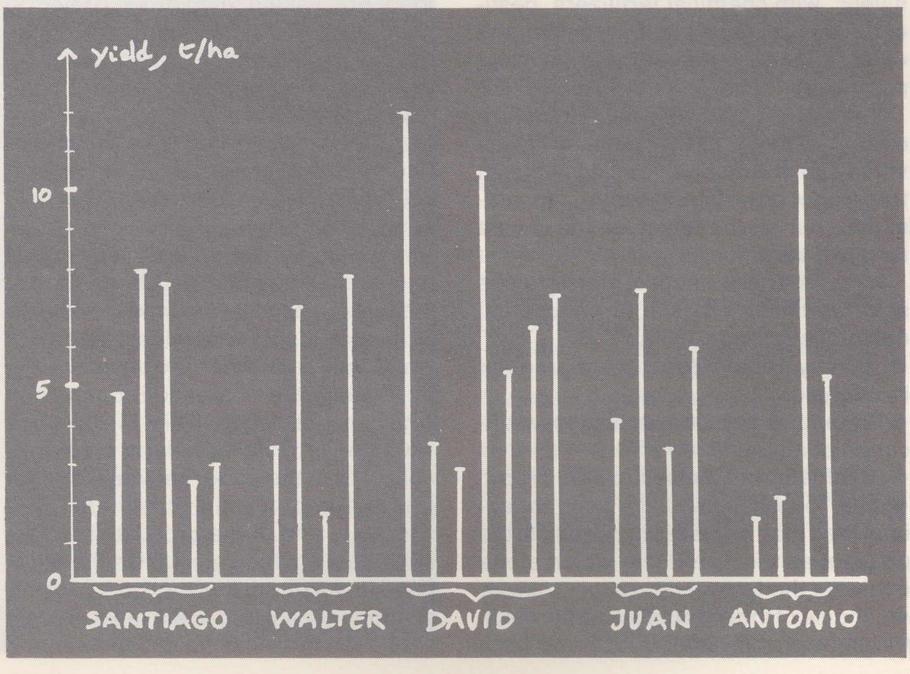
**Pierre Morlon**
INRA
26, bd du Docteur Petitjean
21100 Dijon, France


**Yield variations from different irrigated maize fields of 5 peasant farmers, Laraos, in the same year. (Brunschwig, personal communication).**



# Africa's soils are being mined

**Loss of macro- as well as micronutrients in tropical soils is leading to a quiet crisis, threatening food security and sustainable agricultural development. The author reports on a FAO study.**


## Eric Smaling


Sub-Saharan Africa is the only part of the world where per capita food production has declined over the past two decades. This has largely been attributed to rather abrupt catastrophes such as droughts and locust pests. A more gradually developing problem in the region, less readily linked to the food shortages of the recent past, is declining soil fertility. Recently, the UN Food and Agriculture Organization (FAO) initiated a study on the assessment of soil fertility loss under 35 crops in sub-Saharan Africa. In this study the net removal of the macronutrients nitrogen, phosphorus and potassium from the rootable soil layer was calculated for 1982-84 and for 2000.

### Calculating the nutrient balance

To calculate nutrient balances, the arable land of 38 countries was partitioned into units of similar production potential, i.e. agro-ecological zones and land-use systems, characterized by rainfall, current soil fertility level, cropping systems, fertilizer and manure application, crop residue management and erosion control. The flow of nutrients into and out of the soil was assumed to be governed by five input and five output factors.

Input from mineral fertilizers (IN 1) was calculated, taking into account that farmers in densely populated areas with favourable rainfall have better access to fertilizers than their colleagues in semi-arid areas, who may also be less inclined to use fertilizers due to the drought risk. Animal manure (IN 2) is added to the soil upon collection from stalled cattle, or through droppings of livestock that feeds on crop residues while in the arable field. Considerable amounts of nutrients can be supplied to soils by the processes of wet and dry deposition (IN 3). Biological nitrogen fixation (IN 4) is mainly important to leguminous crops and wetland rice, whereas input from sedimentation (IN 5) is important for flooded and irrigated areas. Harvesting a crop means that nutrients are removed from the field. Nutrients in the harvested product (OUT 1) are mostly removed completely and forever, but removal of crop residues (OUT 2) varies according to farmers' residue management, which differs greatly among and within countries. Other loss mechanisms are leaching (OUT 3) of nitrogen and potassium, the anaerobic process of denitrification (OUT 4) and erosion (OUT 5).

**Loss of nutrients occurs among others from from erosion. Continuous monoculture, like here in Kisii, Kenya, poses erosion control problems, but also pest constraints. Photo: Eric Smaling.**

For fallow land, a modest net nutrient import was accounted for. It should be borne in mind that the fertility restoring capacity of fallows is mainly a result of increased availability of nutrients that are already inside the soil (weathering, mineralization, burning of fallow biomass).

### Nutrient mining in all countries

Nutrient balances for some countries are shown in Table 1. The countries with a high rate of nutrient depletion are in densely populated and erosion-prone east and southern Africa, where many soils are still relatively rich, whereas countries with low or zero depletion are in semi-arid environments, characterized by poor soils that have little left to lose.

The main conclusions of the study were that sum of inputs minus sum of outputs of nutrients is negative in all countries, and that the net removal of nutrients in 2000 will be even higher than in 1982-84. The difference between inputs and outputs is paid by the soil nutrient pool: with depletion progressing, the soil can make less nutrients available, and crop production will decline.

What could be the implications of this quiet crisis, assuming two future scenarios?

### Continued mining

The bad scenario is one of soil mining, without much improvement in land management between 1982-84 and 2000. As demographic pressure increases, fallow cycles become shorter, enhancing processes of soil degradation and nutrient depletion. Gradually, the nutrient reservoir of the soil drops to levels which can no longer sustain the desired yield levels. This must have happened in Sierra Leone, where 67% of the farmers in the country, interviewed during a rural survey, considered present yields of upland crops to be much lower than those of the past. In north-west Tanzania, unfertilized maize yields of 4 tons/ha were recorded during the first four years of cultivation. Over the next four years, however, yields were 40% lower. Organic matter, phosphorus and potassium contents deteriorated accordingly. In central Kenya and southern Nigeria, similar drops in unfertilized maize yields were recorded. These trends are in line with the data in Table 1, where Tanzania, Nigeria and Kenya experience increasingly severe nutrient depletion problems.

### Conservation of soil fertility

The better scenario assumes improved land management between 1982-84 and 2000, including conservation of soil fertility by farmers.

To reach that goal, they should preferably apply modest amounts of the proper type of fertilizer, based on area-specific recommendations. This would increase the uptake efficiency by crops and alleviate the need for both country and farmer to buy fertilizers haphazardly. Continuous application of acidifying fertilizers should be avoided. In this respect, calcium ammonium nitrate is less harmful than urea, which is still preferred to sulphate of ammonia. On phosphorus, the superphosphates are less harmful than the popular diammonium phosphate. The latter also contains some nitrogen, thus saving labour on soils that are low in both elements. In western Kenya, farmers recently started to notice decreasing yield increments by using this initially highly appreciated fertilizer. African countries could introduce farmer-friendly fertilizer pricing policies, taking adverse environmental implications of different types of fertilizer into account.

Efficient use of animal manure and household waste is not only a source of (recycled) nutrients, but it also brings about relatively lasting benefits of increased water storage and nutrient retention. The general complaint is that farmers' quantities are not sufficient, but there seems to be scope for returning town waste to arable fields. Vigorous maize growth was observed on the garbage fields of Cote d'Ivoire's second largest city Bouake.

There is scope for increased adoption of leguminous species in cropping systems. Green manures (for example Kudzu, *Pueraria phaseoloides*), grain legumes (particularly when single-cropped) and many woody species can render 40-100 kg N/ha for a subsequent non-leguminous crop.

Farmers' crop residue management is governed by the presence of livestock, sources of firewood, thatching materials, etc. Having animals feed on residues in the arable field is to be preferred to feeding them outside. Leaving residues as a surface mulch has advantages of nutrient and water conservation and weed suppression, but in monocultures it enhances pests (for example stalkborer in maize). Ploughing residues back into the soil is labour-intensive but still best for the soil.

Properly timed, if needed split application of mineral fertilizers may also be labour-intensive, but it certainly brings down nutrient losses through leaching and denitrification.

Appropriate tillage and soil conservation measures are of paramount importance. Construction of terraces will stop erosion, but simpler farming techniques such as strip cropping, mulching, intercropping, and agro-forestry practices are effective too; zero-grazing seems promising in densely populated areas, feeding contour-planted napier grass to stalled livestock.

### Integrated systems of soil fertility management

There is an obvious need for integrated systems of soil fertility management, where all input and output factors are manipulated in a judicious way. Only then will crop yields stay in line with the desired levels and will environmental degradation stand a chance of being halted. Integrated systems can reduce

## Where rice devours the land

The soils of Asia are under tremendous pressure to produce more with every passing year. The increasing population, heavy nutrient withdrawals by harvested crops, resource-poor small landholders, nutrient losses through erosion and leaching which defy calculations and unbalanced nutrient application are all taking their toll. The result? Today, deficiencies of at least five of 13 mineral nutrients of crucial importance to Asian agriculture – nitrogen, phosphate, potassium, sulphur and zinc – are widespread. Deficiencies in calcium, magnesium, iron, boron, copper and chlorine, although of more regional character, are reported too. Studies show that in rice growing areas (rice is a rather heavy consumer of nutrients) nutrient deficiencies are widely spread.

### Nitrogen fertilizer

On the whole, nitrogen deficiency is almost universal in Asia and its application as a fertilizer is a must for growing a good crop. Ironically, however, farmers trying to offset its loss by using only nitrogen fertilizer are in fact letting the crop use nitrogen as a shovel to mine the soil of other nutrients.

### Possible solutions and limitations

To correct nutrient deficiencies integrated use of mineral, organic and biological sources is the best course. Fertilizers, organic manures and crop residues can and should be team-mates of a deficiency correcting programme. Each country must work out the right combinations for its own conditions, taking into account its resources, customs, logistics and alternate competing uses for organic materials and residues. The need now is to practise "fertilizer rotations" in the same way as farmers follow up crop rotations. In a fertilizer rotation, the sources of sulphur and needed micronutrients should be integrated into fertility management programmes. It will be increasingly necessary to bring micronutrient production, promotion and marketing into the mainstream of fertilizer use. Other solutions lie in prevention of nutrient imbalances and cultivation of crop varieties which are tolerant to nutrient stresses.

### Fertilizer logistics

It is not enough to produce and procure nutrients at the national level. Their timely positioning in villages when needed, assurance of product quality, correct price, user-friendly credit facilities and attractive crop prices are all prerequisites for a healthy soil environment.

From: Tandon, H.L.S. 1990. **Where rice devours the land**. Ceres 126:25-29.

the requirement, and at the same time increase the efficiency of added inputs. In the example of central Kenya, yields of maize that received either a crop residue mulch or animal manure or mineral fertilizer still decreased in the second four year period, but when all was combined, a sustained increase of 12% was realized. Egger, in ILEIA 6(2), described sustained production in Rwanda as long as ecologically-based aspects of traditional and modern farming techniques are brought together. In many cases, a shift of labour input may be required to achieve sustainable systems. In-depth farming systems analysis should reveal to what extent changes are feasible and desirable in order to preserve, or even improve precious soil.

| Country | Nutrient balance (kg/ha) N | | $P_2O_5$ | | $K_2O$ | |
|---|---|---|---|---|---|---|
| | 1983 | 2000 | 1983 | 2000 | 1983 | 2000 |
| Botswana | 0 | - 2 | 2 | 1 | 0 | - 2 |
| Ethiopia | -41 | -47 | -13 | -15 | -31 | -38 |
| Kenya | -42 | -46 | - 8 | - 3 | -35 | -43 |
| Malawi | -68 | -67 | -23 | -23 | -53 | -57 |
| Mali | - 8 | -11 | - 2 | - 4 | - 8 | -12 |
| Nigeria | -34 | -37 | -10 | - 9 | -29 | -37 |
| Rwanda | -54 | -60 | -20 | -25 | -56 | -73 |
| Tanzania | -27 | -32 | - 9 | -12 | -21 | -25 |

Table 1. Nutrient balances for some countries.

**Research and extension needed**

Research is needed to come to recommendations for integrated nutrient management systems that are specific for well-defined agro-environments. There is, however, no need to purchase less current blends of NPK fertilizers, as presently practised by a number of West African countries. This is quite costly as the fertilizers have to be manufactured according to the desired specifications. An effective extension service that can give support to farmers to adapt the recommendations to their specific needs and resources is a prerequisite in making farmers adopt integrated nutrient management systems. ■

**Eric Smaling**
Winand Staring Centre for Integrated Land, Soil and Water Research
P.O. Box 125
6700 AC Wageningen
The Netherlands

**Reference**

– Stoorvogel, J.J. and Smaling, E.M.A. 1990. **Assessment of the soil nutrient depletion in Sub-Saharan Africa**. Report 28. Wageningen: Winand Staring Centre, 137 pp.

## Integrated Plant Nutrient Systems

Many initiatives to raise crop productivity in developing countries have been centred on the substitution of mineral fertilizers and other off-farm inputs by fallow and the recycling of organic materials. Some now argue that mono-crop systems based on off-farm inputs cannot be sustained and that there should be a shift to low-external-input systems which would be more appropriate for resource poor farmers. The reality is that there are limitations to both low-input and high-input systems. Solutions will most probably have to be tailored to individual agro-ecological and socio-economic situations and are likely to involve elements of both low-input and high-input systems. Nonetheless, minimizing external inputs through an economic combination of available sources of organic and mineral fertilizers is likely to be a central objective for most countries.

**FAO and organic fertilizers**

FAO is paying increasing attention to organic materials as fertilizers and the development of integrated plant nutrient systems (IPNS). Several studies were organized on the use of organic materials as fertilizers (FAO 1975; FAO 1977; FAO 1980; FAO 1983) and the Asian Network on Bio and Organic Fertilizers was founded in 1988 (FAO 1988; FAO 1989). Recently, as an answer to the serious problem of nutrient mining, the "Integrated Plant Nutrient Systems" programme was launched to bring together the available information on IPNS and to enhance further research.

**Integrated Plant Nutrient Systems**

The basic concept underlying IPNS is the maintenance and possibly increase of soil fertility for sustaining enhanced crop productivity through optimizing all possible sources, organic and inorganic, of plant nutrients required for crop production in an integrated manner, and as appropriate to each cropping system and farming conditions within ecological, social and economic situations. The cropping system rather than an individual crop is the focus of attention in this approach. It is envisaged that locally available materials of plant and animal origin be used or, where such materials are not abundantly available, in situ production of organics could be attempted.

Attempts made in several countries to complement the use of mineral with organic sources of plant nutrients have generated useful – though limited – information on the complementary and synergistic effects of these materials on the yield of crops. Examples of this are published in Roy (1991).

**Research on IPNS**

After the identification of potential organic/biological resources, some simple models of nutrient scheduling underlying the concepts and application of IPNS for some selected cropping systems have been developed. To generate information on combined application of organic/biological sources with mineral fertilizers in different agro-ecological situations and dominant cropping systems, research institutions have been sub-contracted to initiate long-term experiments in Bangladesh, India, Indonesia, Laos, Nepal, Pakistan, Rwanda, Tanzania and Thailand. Other countries may follow in a later stage.

**Establishment of a data bank**

To facilitate transfer of IPNS technology it is intended to establish a data bank on available results and develop computer models for prescribing location specific recommendations. To foster applications, FAO will continue to publish publications and training materials on IPNS.

As a follow up, an International Programme for Sustainable Development of Soil Productivity providing a framework for national strategies to conserve and regenerate soil productivity is recommended.

From: Roy, R.N. 1991. Integrated plant nutrition systems and sustainable development of soil productivity. Rome: FAO, 17 pp.

for references see page 60.

Photo: Hans Hurni.

# Local economies: framework for assessment

**To be acceptable to smallholders, techniques have to fit smallholder conditions and satisfy their aims and needs. However, this will not be enough if sustainability is the ultimate goal of development. Techniques must also follow the principles of the "economics of nature". This means that local economies need to be enhanced.**

How agricultural techniques are evaluated depends largely on the criteria used by the evaluators. The choice of criteria is greatly influenced by the perception evaluators have of how rural economies function or should function. As the perceptions of policy makers and researchers differ from those of farmers, there can be considerable disagreement on the viability of techniques and farming systems and on the direction development should take. Vandana Shiva has distinguished three different economies (see box): market economy, nature's economy and survival economy. Development policies are generally based on the market economy, whereas smallholders act primarily according to the survival economy (cf. the articles by Padilla and Morlon). Which kind of economy should we use as reference framework for assessing technology, if we strive for sustainable low-external-input farming?

### Market economics

The current, nonsustainable state of the world can be blamed on the market-economy perception of reality which is the basis of conventional development policies. The market is seen as the main instrument to regulate supply and demand and hence the flow of materials. Profit-making is the main driving force. The market economy is based on a linear concept: using huge quantities of energy and raw materials (mainly from the South) as inputs, processing and transporting them around the globe, and selling them (mainly in the North) to consumers. In the end, they are excreted as waste at "the other end of the pipe". The "free" market with its invisible hand cannot guarantee that social and ecological needs are met, as the market economy is a power-play ruled by those who can pay the best prices. As vulnerable social groups and the environment have no clout on the market, they can be exploited at low costs. Real costs are externalised, leaving the burden of social and environmental damage on vulnerable groups and future generations. There is some danger that this is occurring even in the global trade in organic produce.

### Market agriculture

This economic concept, translated to agriculture, has favoured:

- production for the market, leading to increased production of export crops (the external costs being loss of local food self-sufficiency and reinforcement of rural inequalities);
- intensified but often inefficient use of external inputs (leading to external costs like pollution, lower food quality, indebtedness and increasing use of nonrenewable energy);
- monocropping and simplification of the agroecosystem (leading to soil erosion and loss of diversity and indigenous knowledge);
- reliance on "modern" technologies and lifestyle (undermining the traditional social and cultural strengths of communities, and increasing the burden on women).

True, higher economic yields of commodity crops to feed the fast-growing urban populations at low prices have been achieved, but at what cost? Can these yields be sustained? The technology that was introduced during the "green revolution" has disrupted most rural communities and drawn them into the global market economy. In 1983, Punjab was still cited as the green revolution's most celebrated success story (Swaminathan 1983), but by 1989 the hidden externalised costs were becoming increasingly obvious. These include lowering of the watertable, deterioration of the soil (salinity, formation of an

**Local market economy in Dakar, Senegal. Conventional economics has favoured production of export crops for the international market often leading to a loss of local and national food self-sufficiency. Photo: KIT.** ◄

impervious layer which prevents nutrient uptake from deeper layers, deficiency in micronutrients, water pollution) and multiplication of pests and diseases (e.g. food contamination, health risks for humans and animals) (Jagjit Singh Hara 1989). If we want to assess the technology options for sustainable agriculture, these hidden effects of "green revolution" technology have to be analysed and accounted for.

## Low-external-input agriculture

In large parts of the tropics, the "green revolution" did not occur because, for various economic, ecological or cultural reasons, the techniques did not apply. Nevertheless, the market economy has profoundly changed rural life in most areas, also where low-external-input farming is practised, because it has led to:

– cultural disorientation and erosion of traditional knowledge and practices of natural resource management;
– population increase without adequate increase in livelihood opportunities which, in turn, forces people to:
– overuse of natural resources, resulting in deforestation, soil erosion, nutrient depletion etc, and
– marginalisation of rural societies and exodus of poor, rural labour force.

These negative impacts are often ascribed to the "backward" techniques that low-external-input farmers are still using, without taking into account the changed economic and cultural context with which they have to cope. Is not the perception of economics pushed by (international) trade, policy makers and researchers to blame? It is thus clear that technology assessment touches on a hot political issue: Whose sustainability counts? Is it the sustainability of the market economy and its vested interest groups? Is it the urban wealthy, a great part of them living in the North and profiting most from international trade? Or is it the sustainability of local economies and the rural masses, mainly in the South but also in the North, who heavily depend for their livelihoods on the opportunities offered by the natural environment?

## Assessing LEISA technology

Assessment of techniques for Low-External-Input and Sustainable Agriculture (LEISA) needs to include an analysis of the evolution of agriculture and the root causes of its current problems. Development toward sustainable agriculture should counteract the present negative tendencies of development as well as build on the opportunities created by positive interactions between nature's economy and survival economy. Difficult compromises will have to be found between the interests of poor urban and rural people, before human society as a whole can regain some degree of balance with nature. But what do we know of the economics of nature and survival?

## Nature's economy

Ecologists are often regarded as estranged from "reality" or as a danger to the market economy. Much effort is being put into developing technology of war and space exploration. But the way our own spaceship, Mother Earth, is functioning is still far from understood. Nature's economy seems to be aimed at the continuity and evolution of life itself in all its diversity, but how exactly nature pursues this is not very clear. Much is known about the physical processes in nature and the functioning and habits of many organisms and their interactions, but many details and major links are still obscure. Nevertheless, millennia of experience with survival in the natural environment permit certain important principles to be derived:

– survival is based on needs, availability of resources and incidence of mortality;
– some key relationships in the environment are cyclical (e.g. nutrient cycle, water cycle, energy cycle);
– limits exist within the environment which, if not respected, result in its degradation;
– over time, ecosystems tend to increase in complexity, resilience and the functional diversity of their species;
– although competition, strife, conflict and parasitism exist in nature, evolution usually depends more on cooperation and symbiotic relationships;
– natural ecosystems exhibit numerous benign self-maintaining and self-regulating processes that, if interfered with, result in degeneration and dramatic population fluctuations (MacRae et al 1990).

## Survival economy

Peasant communities are generally finely tuned to the physical, economic and social environments in which they operate. The building blocks of these communities are the farm households and their economies, which are organised in such a way that both the production and consumption aims of the family can be met. The overarching goal which motivates their behaviour is maximisation of welfare, which includes more than food, shelter and profit maximisation (cf. articles by Padilla and Morlon). It is culturally defined and often incorporates such objectives as status, security, prestige, comfort, stability and leisure. The household uses an integrated system of strategies to reach its objectives, e.g. crop and livestock production for both subsistence and sale, as well as off-farm labour and trade enterprises.

Smallholders are typically constrained by certain characteristics of their specific ecological and economic systems. In low-external-input agriculture, the inputs used (labour, genetic resources, nutrients etc) are mainly of local origin. Important limiting factors are ecological complexity, risk proneness and relative isolation. Limited availability of resources such as land, nutrients, labour or capital are major factors which shape farming systems. The social organisation of the household is a major determinant of production and management in smallholder farming (Sands 1986).

## Objectives for sustainable agriculture

In mature farming systems, where considerable experience has been built up in managing natural resources, a dynamic balance has been found between the principles of nature's economy and survival economy. The different objectives of the community are balanced in such a way that optimal welfare and sustainable use of natural resources are obtained. The objectives within such smallholder farming systems can be seen as:

– productivity. The interest of the farm household is to produce a combination of products to use and products to exchange, so that maximum returns to the limiting factor of production are obtained and family needs are met.
– security. In marginal, risk-prone areas, the most basic household objective is to secure subsistence. Several strategies can be pursued such as producing for home consumption, maintaining reciprocal social bonds with other households, using resistant varieties, diversifying, maintaining management flexibility, remaining independent of unreliable outsiders (self-reliance), protecting family health (also by avoiding too strenuous work), but also social customs such as dowry or brideprice requirements. As the ecological and socioeconomic environment

and the farm household itself are subject to change, another important aspect of security is adaptability: the local capacity to innovate, to develop new technology and new options for survival.
– continuity. The short-term as well as the long-term interest of the household is to conserve or, if possible, enhance the available resources: natural, human and capital. Different strategies can be used such as keeping as much biomass as possible in and on the soil (e.g. by fallowing, agroforestry, intercropping, recycling organic matter), applying fertiliser, conserving water and soil, keeping trees and livestock as savings, transferring experience from generation to generation, observing rules of inheritance and maximising returns to cash.
– identity. Most farming systems are also shaped by social and cultural objectives such as status, prestige, ideology (farming should be, e.g., natural, organic, scientific), leisure, nature conservation, social relations, and division of labour between men and women.

These different objectives interact and some overlap. Together, they can be seen as the objectives for achieving sustainable agriculture, which have to be kept in balance with each other. From these objectives, important criteria can be derived for assessing LEISA techniques.

**Strengthening local economies**

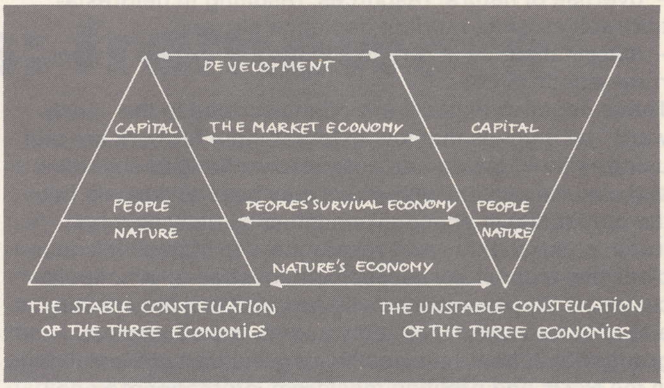
If these objectives are to be sought in a balanced way, it means that:

- local food self-sufficiency should be enhanced;
- resources should be better distributed;
- natural resource management should be the responsibility of the local community, for which a high level of local autonomy is needed;
- renewable resources should be used as much as possible;
- diversification and recycling, especially of nutrients, should be key strategies;
- indigenous knowledge and culture should be reinforced to enable rural communities to determine their own development path.

These important features of sustainable farming and livelihoods are best guaranteed in local economies. If following the principles of nature's economy and survival economy is seen as necessary to counter current nonsustainability in agriculture, this means that local economies should be strengthened.

Larger economic units can exist only if they enable the self-sufficiency of smaller units. A new and sustainable economy should be systematically enabling for people, and it should conserve resources and environment. Moreover, it should treat the world's economy as a multilevel one-world system, with autonomous but interdependent parts at all levels (Robertson 1990). LEISA is a central feature of local economies, and the question may be raised if sustainable agriculture is at all possible without enhancing local economies. In view of this, ILEIA is of the opinion that the needs and objectives of sustainable local economies should provide the reference framework for technology assessment. ■

**The ecological approach to conservation.**




## Three economies

Development has been based on the growth of the market economy. The invisible costs of this development have been the ignorance, neglect or destruction of two other economies, namely the economies of nature's processes and of people's survival. This has been the reason why development has posed a threat of ecological destruction and a threat to human survival. The organizing principle of economic development based on capital accumulation and economic growth renders valueless all properties and processes of nature and society that are not priced in the market and are not inputs to commodity production.

Preserving the sanctity of development and economic growth through sustainable development is based on a false interpretation of sustainability. Economic growth takes place through over-exploitation of natural resources and people's survival economy. Further economic growth cannot help in the regeneration of the very spheres which must be destroyed for economic growth to take place. Nature shrinks as capital grows. Natural resources can be turned into cash, cash cannot be turned into nature's ecological processes. Those who offer market solutions to the ecological crisis limit themselves to the market and look for substitutes to the commercial function of natural resources as commodities and raw material. However, in nature's economy, the currency is not money, it's life! Real sustainability therefore demands that market and production processes be reshaped on the nature's law of return, not on the laws of financial profit.

**Redressing the balance**

Today, in addition to the industry-oriented agricultural policies of the past three decades, sustainable agriculture faces a new threat from the trade liberalization regime being pushed through the General Agreement for Trade and Tariff (GATT). The free market for transnational agribusiness translates into a total lack of freedom for local farmers to adopt sustainable agriculture practices. While big business depends entirely on public subsidies of all kinds for its profits and markets, there is much din and noise in GATT on removal of subsidies.

Given that an earlier era of subsidies destroyed the vibrancy of sustainable systems of agriculture, a reversing of subsidies and incentives is needed to redress the balance. This is especially true in those aspects of agriculture where externalization of the ecological costs of HEIA has undermined the ecological base for LEISA politically and economically. The context for LEISA has to be directly and explicitly addressed if we are serious about sustainability. And that is as much a political challenge as a technological one.

From: Vandana Shiva, 1990, **The real meaning of sustainability**, AT Source 18 (2): 7-8; and Vandana Shiva, 1991, **The political and economic context of sustainable agriculture**, Paper for ILEIA Workshop.

**Vandana Shiva**, 105 Rajpur Road, Dehra Dun 248 001, India.

# Farmers' assessment of techniques

Anne Floquet

**According to what criteria do farmers choose how to intensify land use? Anne Floquet found that farmers rejected many recommended techniques not because they don't match with farmers' objectives and constraints, but rather because they are not effective in agronomic terms.**

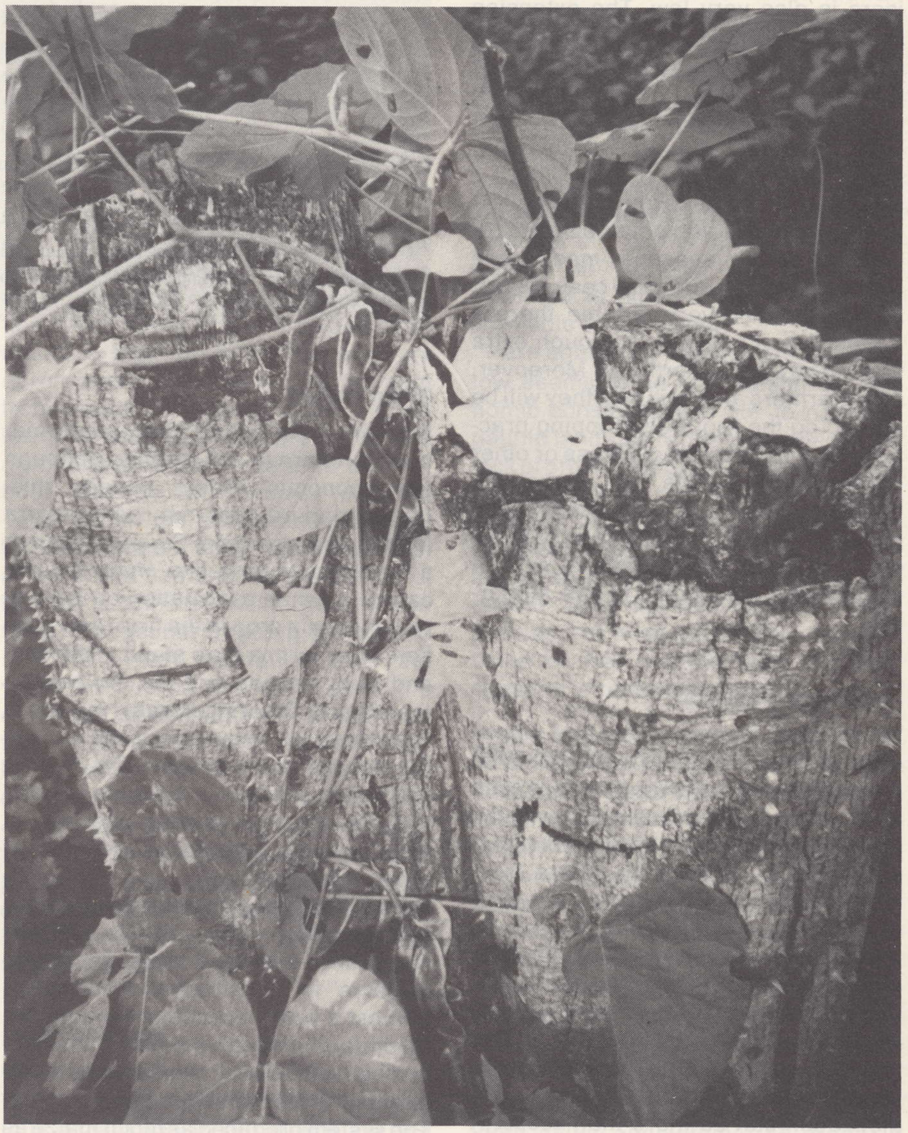
How do farmers in southern Benin cope with problems of land scarcity and degradation? Our research team explored why farmers chose their current farming practices and economic activities and what factors limited their choices. We spoke with farmers who had tried but abandoned using fertilisers to restore soil nutrients. We brought farmer groups to researchers' field trials with sown fallow and to farmers' field trials where green manure, sown fallow and alley cropping were being tested. The sample of farmers was stratified so that their assessment of the techniques, which differ in resource requirements, could be related to their economic situation.

### The "terres de barre" area

Crop yields in this area depend mainly on the organic matter content of the soil. As long as a dense bush fallow could grow before the land was cropped again, fertility could be restored. Where land has become scarce (more than 150 people/km2), the fallow is shortened, its composition degenerates and the soil becomes acidic and poor in N, K, P and S. The maize (the main crop) then has only shallow roots and is more sensitive to dry spells. The yields fall until, eventually, maize can no longer be grown and is replaced by groundnut, cowpea and cassava.

In the face of land scarcity, the farmers have tried different strategies such as:

- cultivating all available (even marginal) land and integrating oil palms into the rotation;
- including cassava as intermediate fallow, growing more legumes in rotation with maize, ridging and incorporating residues into the soil, in order to extend the cropping period;
- intensive compound farming using household refuse, in some densely populated areas with very impoverished soils;
- part-time farming purely for home consumption, and seasonal migration, off-farm work, processing activities etc to earn cash;



Farmers have not adopted green manure to improve soil fertility. Some farmers, however, adopted Mucuna utilis to control Imperata. Photo: Wim Hiemstra.

- collecting and selling tree products from fallow land;
- resettling on vacant land in the north.

As soil degradation is a gradual process, most farmers are not aware of it. This ecological deterioration is occurring in a very unfavourable economic context of general recession, characterised by a tight local market due to rising unemployment and low salaries and by a diminishing standard of living in rural areas. This affects nutrition, health and education and, thus, the productivity of labour.

Various research institutes have long been working in the ''terres de barre'' area, studying fertiliser use, green manure, improving fallow with fast-growing trees, and alley cropping. However, thus far, few farmers have integrated these practices into their cropping systems.

### Fertiliser to replace lost nutrients

Fertilisers have long been advocated but farmers adopt them only in cotton-growing areas. This has both agronomic and economic reasons.

The extra yield gained from applying fertiliser on local varieties in not high enough to justify the costs. Improved varieties (IITA composites), which would profit more from fertiliser, are not acceptable to farmers, as they do not store well and have a long cycle (120 days). Farmers have been replacing their 120-day varieties by 105- or even 90-day varieties because the risk of flowering during a dry spell has become too high.

On degraded land, applying fertiliser without sufficient organic matter accelerates soil impoverishment. On newly cleared land, where the crop can still profit from the ashes of the burnt vegetation, the extra yield brought by fertilisers is also very low. The extension services have not yet adjusted their recommendations to the fertility status of the soil, and few experiments have been conducted on the synergy between organic and non-organic manure.

Even when some farmers tested fertilisers on maize and obtained good results for a few seasons, many were eventually discouraged by cash losses. As the climate is very variable, there is a high risk of not having enough extra yield to pay for the fertiliser. Moreover, some farmers are not sure if they will be able to do the required cropping practices in time because of illness or other unpredictable events. The probability that these occur and yield losses result is particularly high in the case of farmers with small families and of women with insufficient income to hire labourers.

### Investing in fertilisers?

Where cash income is low and unpredictable, it is difficult to save money to invest in farming. Farmers regard cash as the most limiting factor. If they make an investment, it must be profitable. Assessment of profitability differs from farmer to farmer, depending on their objectives.

Those farmers who are sure of having a marketable surplus and could invest money in hiring labour or renting more land compare the cash returns of this with other activities, especially distilling palm wine. Returns to investment in distillation can be more than 100%. A development project in a neighbouring province chose this as a threshold to evaluate the profitability of fertiliser use by farmers and found in on-farm trials that this threshhold was reached by less than 50% of the farmers.

Farmers who are not sure of having enough maize for family needs will try to secure this first. They do strive for extra yield but with minimal extra costs. In cases where no family labour can be mobilised, these extra costs must include labourers' wages. Comparison of costs revealed that extending the normal cropping period (3-4 years) by applying fertiliser is not as profitable as renting and clearing fallow land, as long as the farmer cannot be sure of getting an average yield higher than 975 kg (using family labour) or 1000 kg (using paid labour) with fertiliser. As long as fallow land is available to rent or borrow, farmers will not invest in fertilisers.

**Rotation patterns with green manure**

| First year | | | Second year | |
|---|---|---|---|---|
| first rainy season | second rainy season | dry season | first rainy season | second rainy season |
| M<br>Caj | | | M | M |
| M<br>Mu | | | M | M |
| M | M | Fallow | M | M |

M = Maize; Caj = Cajanus cajan; Mu = Mucuna utilis; Fallow = Bush regrowth between the weeding of the second season and the hoeing of the next first season.

### Green manure

Farmers have not adopted green manure to improve soil fertility, although few economic factors impede this. Green manure does not require extra labour, as a shrub like *Cajanus cajan* or a herbaceous vine like *Mucuna utilis* can be sown in association or in relay with the main crop in the first rainy season. They form a pure stand in the second rainy season and the dry season (see Fig. 1). Clearing is easy, the soil is weed-free and no work must be done in the second rainy season. Thus, over two years, the labour balance is positive. So, the next obvious question is: what are the agronomic benefits of green manuring?

Results of green manuring trials are contradictory. On IRAT's 6-year researcher-managed trials on ''terres de barre'' in Togo, the loss of one maize harvest a year because green manure (*Crotalaria juncea*) is sown in the second season was compensated by a better yield in the subsequent maize crop. The system produced as much maize as maize monocropping in both wet seasons. These plots were fertilised. In trials conducted by CARDER Atlantique on farmers' fields with a rotation of maize + Cajanus / Cajanus / maize / maize (see Fig. 1) on non-degraded land, the additional maize yield in Year 2 did not compensate for the loss of a maize harvest in Year 1. In similar trials conducted by farmers on degraded land, the maize yields were equal in both alternatives.

A rough comparison between incorporating green manure and incorporating crop biomass (cassava, maize, groundnut) as mulch indicated that *Cajanus cajan* brings more biomass than crops at sites where it grows well, but it requires fairly fertile soils. Still, on farmers' fields where the fallow was still vigorous, the biomass of bush regrowth during the second rainy season and the following dry season, added to the biomass of the crop residues, appeared to be just as high as the biomass produced by sown Cajanus. On degraded ''terres de barre'', Cajanus does not grow well and probably does not produce as much biomass as cassava.

Palm trees have a good market value and are the farmer's best savings. Photo: Wim Hiemstra.

Some farmers are, however, adopting *Mucuna utilis* to control Imperata. If this weed invades a field, they have to invest much labour to reclaim it, or even have to abandon it. Farmers are therefore prepared to invest work in establishing a green manure crop, if it helps control the weed.

### Planted vs natural fallow

Researchers regard fallow merely as a way to enhance soil fertility; farmers also see it as a way of generating cash. Marketable products can be collected from fallows and – especially firewood in periurban areas – are in high demand.

Natural fallow was – and, on some areas, still is – the most efficient way to ''wake up'' the soil (the local expression for land regeneration). The optimal length of fallow is 7-9 years, but when the cropping period is short enough (5-7 years) that many roots of fallow shrubs survive, a fallow of 3-4 years is still sufficient to produce firewood and bring acceptable yields after clearing.

Sown fallows with fast-growing species (*Cassia siamea, Acacia auriculiformis*) produce firewood and stakes within 2-3 years. They may be more productive than natural fallow, but relevant measurements have not yet been made.

An interesting case is the indigenous palm agroforestry system: as land becomes scarce, palms are integrated into the seasonal cropping system. They are planted together with maize, which ensures their weeding during the first years. Later, they grow as a pure crop together with bush regrowth, which is sometimes cleared yearly. As soon as the trees mature, they are sold and/or felled for wine extraction and distillation. Palm trees have a good market value and are the farmer's best savings. Some of these systems also restore soil fertility. For these reasons, farmers with access to enough land will plant palms on it.

The profitability of fallowing must therefore be assessed in terms of the cash income it brings and the capital accumulation it permits. For farmers who can save and invest in productive activities, the return to investment is higher in agroforestry than seasonal cropping, especially if labour is employed. Larger farmers and urban dwellers were interested in planting teak in the 1980s and, after the market for stakes collapsed, they started planting palms.

Participatory evaluation could help farmers to define their own objectives and criteria for assessment. Photo: Wim Hiemstra.

### Return on investment

For farmers with little land and insufficient maize production to secure family needs, any reduction in cropped area for sown fallow must be offset by higher subsequent maize yields. Even so, this happens only after 2-4 years and these farmers cannot wait so long. One partial solution is to mulch the cropped area with litter taken each year from the growing sown fallow.

Farmers who have more land and a secure food supply but not enough income for investment try to maximise their income and compare what they can gain from different systems: sown or natural fallow or seasonal crop rotation. Near towns where firewood commands a high price, the income from agroforestry is sometimes higher than from seasonal cropping, especially for farmers who hire labourers, as the agroforestry system requires less labour. But the two incomes differ in "quality". In the agroforestry system, farmers obtain a fairly high income all at once and can choose the period of harvest to coincide with large expenditures. In seasonal cropping, the income is more evenly distributed over the years and, if the market is poor, the crops can be consumed. Therefore, although an agroforestry system may bring a higher total income than a food cropping system, it can be established on only part of the farm. Nevertheless, the agroforestry system may be more profitable than natural fallow, especially on degraded land in overcropped areas, on account of its favourable effect on the soil.

### Land ownership

Not all farmers are free to choose how to use the land. Less than half the arable land is cultivated by its owners; the rest is rented or borrowed. Women do not inherit land and cannot buy large plots. Tree planting symbolises ownership. Where there is enough land, farmers rent fallow to use it for 3-4 years. If the owner needs money urgently, tenants rent fields "in advance" when the fallow is still young, and wait a few years before clearing. Any measure which restores the soil and produces wood more quickly than natural fallow could be advantageous to both parties.

Another form of tenancy is planting palms for the field's owner in return for the right to grow annual crops for as long as the palms are sensitive to weeds. This "taungya" system could be extended to other trees, if these are profitable to the owner.

Here again, non-adoption of sown fallow seems to be due neither to economic considerations nor to noncompatible land-use rights but rather to the lack of proven agronomic benefits. Data on the effect of sown fallow on the productivity and sustainability of local cropping systems are scarce, and the fallow species being researched are exotics. Little has been done with local species, not even those which farmers value for their multiple uses and their capacity to restore soil fertility.

### Alley cropping

This is an elegant system of integrating fallow shrubs within cropped fields to reduce leaching and runoff losses and to continuously produce and recycle biomass. However, agronomic results of alley cropping with *Leucaena leucocephala* and *Gliricidia sepium* on "terres de barre" have been disappointing.

Competition between crops and shrubs can be so great that less maize is produced in the alley system than in open fields. Competition for water is particularly high in the second rainy season, and any delay in pruning the shrubs causes high crop losses. To improve the water balance, trials have been made with shrub species with slower regrowth and litter which decays more slowly. Researchers are also trying to reduce the crop/shrub interfaces (e.g. wider alleys, double rows of shrubs).

But the fact remains: alley cropping is time-consuming. For small-scale part-time farmers who cultivate for subsistence and gain cash income from off-farm activities, alley cropping must produce an extra yield which pays for the extra labour at a higher rate than the off-farm activities. Similarly, farmers who invest savings expect a cash return at least as high as their alternative investment possibilities. The higher the labour costs, the lower the probability of gaining such a high return with the surplus produced. ▶

Farmers with large families might be interested in adopting alley cropping to "employ" their dependents, if the system brings them more maize to consume or sell. These farmers also run less risk of not being able to prune the shrubs in time. They can gain extra income by selling some of the shrubs for acadjas (branches planted in water to attract fish). For these farmers, the system might be profitable if it can be modified to reduce crop-shrub competition. Good farmers might be better able to optimise the management of this system than researchers, who tend to stick to a trial plan. But, even then, this system will probably interest only a small group of farmers.

### Individual techniques?

The major criteria on which the farmers in southern Benin based their decisions were food supply, cash income and return on investment. For farmers without a secure food supply, a land-consuming innovation such as green manuring or sown fallow has to increase maize yields on a smaller area. In the case of labour-consuming practices (alley cropping), if the extra work obliges the farmer to reduce off-farm activities, this work has to be renumerated as well as the abandoned activities. For farmers with secure food supply but insufficient income for investment, an innovation must raise income either after payment for inputs and wages or on a smaller cropped area. Farmers who invest regularly in productive activities try to maximise not the income but rather their cash returns on investment.

Each of the techniques might become profitable for some category of farmer: nutrient-restoring fertilisers as soon as fallow land becomes scarce, if the risk of losses is reduced (appropriate varieties, better water balance with mulching etc). Green manuring and sown fallow to replace degraded natural fallow could be profitable to small and medium-scale farmers, there being no risk of cash losses as in the case of fertilisers. Cash-saving activities are likely to be profitable to large farmers, as cash returns will be improved.

### Combining systems

However, none of these techniques would, on its own, fulfil all the objectives of the farmers, e.g. well-distributed income vs secure savings. Therefore, each farmer has to combine several systems. Assessment of the techniques has to take the specific situation of each farmer into account. Ideally, the evaluation process would help the farmers define their own objectives and criteria for assessment.

Researchers should verify that the techniques they propose fulfil certain minimum criteria. Farmer testing of innovations is meaningful only when the problem they are meant to solve actually arises. As long as land is still available, farmers will look for natural fallow to clear rather than investing labour and cash to intensify land use. But if a problem is critical, e.g. invasion of Imperata, an innovation such as *Mucuna utilis* will spread very quickly among farmers as soon as they see it works.

Above all, new practices must perform well in agronomic terms. Species for green manure and improved fallow have to be screened for different locations, and the productivity and stability of the new system must be compared with that of the existing cropping system(s). Too little relevant research has been done in such a way that results from different stations can be compared. Nor can the results be compared with farmers' systems. Detailed research is conducted on very specific topics before the system as a whole has been assessed. Such assessments have to be done by researchers before truly sustainable farming practices can be adapted, improved and assessed by farmers. ■

**Anne Floquet**
Project UNIHO-DRA
B.P. 06-2523
Cotonou, Benin

## More to life than money

Agricultural experimentation has usually been judged in purely physical terms – especially by the criterion of maximum gross yield. One of the first agricultural research organisations explicitly to recognise that farmers might have considerations and priorities other than yield maximisation was CIMMYT. They produced a training manual in 1976 which recently has been revised completely (CIMMYT 1988). Nevertheless the economic analysis has hitherto had the limitation of considering "the farm" as a business more than is properly justified by the reality of many societies for which subsistence is at least as important an objective as earning some cash.

### Wider set of criteria

The Adaptive Research Planning Team (ARPT) looked at a wider set of criteria more likely to reflect farmers own criteria than cash return only. In Luapula Province, Zambia, ARPT carried out trials on sunflower with the aim of improving nutrition, and secondarily, on labour reducing technologies in women's activities. The trial derived from a perceived need for cooking oil. Sunflower is already grown in the area as a cash crop. Comparisons were made between the local seed and an improved variety; between no use of fertiliser and the application of both basal and top dressings; and between the cultivation on small ridges and the traditional practice of incorporation of weeds under large mounds.

### Energy as measure of food value

A problem with taking food as an important criterion is how to measure food value. According to nutritionists energy deficiency in general is the most serious problem in third world countries. ARPT therefore decided to use energy to represent food value as a whole. This has the nice advantage in subsistence farming that the main input is in the form of human or animal labour, fueled by food energy. So there is a very direct relationship between output and input. In addition, it is the only measure which describes the effort involved in work as compared to the time taken. There are even calculated values for the energy values for various fertilisers.

### Results depend on objectives and constraints

These experiments are showing that the results very much depend on objectives and constraints of farmers. In short, where cash is a constraining factor and the major objective, local seed planted on ridges will give the best cash return to cash invested. Where labour is constraining, mounding is less laborious than ridging and the application of fertiliser to local seed gives the best returns. Where the output is to be consumed at home, as expelled oil, the improved variety, which gives a higher food energy output than local seed, and mounding without the use of fertiliser, give the most efficient combination. In all cases, the next best option is current farmers' practice.

### Technologies more appropriate

Measures of energy expenditure in various types of agricultural work are difficult to calculate. But as long as there are only a handful of esoteric scientists who are collecting this information this situation is likely to remain unchanged. The more economists seek such information the more accurate will be the rules of thumb, and the more appropriate the technologies.

From: Allen, J.M.S. 1987. More to life than money: trial analysis for subsistence economies. Paper presented at the 7th Annual Farming Systems Research and Extension Symposium, Fayetteville, Arkansas, October 1987.

**Sustainable farming systems can improve the living conditions and stabilize the ecological balance in the highlands of Northern Thailand. Concept development, training and extension activities in agriculture, soil and water conservation and agroforestry are the major tasks of a regional rural development programme there. Christoph Backhaus describes experiences with yield surveys in the highlands and gives outlines for a new approach.**

**The farmer is presented with the data measured in his fields and is asked to state reasons for the differences between the traditional and the sustainable farming plot. Photo: John Connell.**

# From data collection to farmer assessment

Christoph Backhaus

As the activities of our programme are implemented by agencies of the Royal Thai Government, any concept or approach applied must be feasible in this context and must be agreeable to the staff concerned on all levels. Monitoring of adoption and impact has always been an important topic for the programme, with varying acceptance by the extension staff. Recently, extensionists have shown increasing interest to participate in this process as part of everyday extension work. This hopefully provides a good starting point for the project to adjust its approach to monitoring.

Assessing yields in farmers' fields and analysing reasons for yield differences are necessary and important means of evaluating the impact of project recommendations. However, in diverse environments and with diversified farmers' practices, the meaningfulness of conventional yield measurement surveys is rather limited. In a 3-year survey of a large sample of farmers, no significant correlation could be found between the so-called "adoption performance" as monitored in farmers' fields and the yields measured in the same plots (Robert et al. 1989). The major problems encountered in the yield measurement surveys are listed below.

## Bias in data collection

The necessary data could be collected with a relatively high degree of accuracy by a team of enumerators who lived in the area for almost six months. If possible, the data were collected by observation or measurement, but some crucial information had to be asked from farmers, because it could not be directly observed in the field. However, a farmer who thinks he is expected to have followed a particular recommendation of the project would not always frankly tell an interviewer that he has not. This not only restricts the accuracy of the data collected about farmer adoption, but also biases the farmers' statements why certain recommendations or systems will not work. A farmer who knows that his rice yield is low because he could not weed as early as recommended due to labour constraints, will most likely give the interviewer another reason. Thus, farmers' perception of fixed recommendations causes an inevitable bias in adoption surveys. However, yield measurements which cannot be related to the farmers' actual practice and/or adoption of recommendations are of rather limited use.

## Diversity of conditions

The diversity in the natural conditions such as soils and climate in mountain areas means that numerous factors determine crop performance. A huge sample is required if significant correlations are to be found by statistical analysis (assuming that the information describing the relevant yield-determining factors can be collected at all). More important: if diversity in farmers' conditions is very high, but the results can only describe an average situation, the meaningfulness of the results is more than doubtful.

Thus, the main result of the survey was that, under highly diverse conditions, the usefulness of fixed, generally applicable recommendations is very restricted.

In such a diverse environment and under varying socioeconomic conditions, each farmer has to apply a different set of recommendations, considering the particular situation of his farm. However, where is the extension system which can provide the tailor-made advice to thousands of small-scale farmers, especially in highland areas with their communication and transport problems?

As a consequence, in 1989 TG-HDP interrupted its yield measurements for one season and has subsequently changed its approach to measuring impact. In the coming season, yields will be measured again, with farmers instead of from them. The yield measurements will become part of the extension process, rather than merely a data collection activity. Here, we can only outline the survey approach as it is planned at present, based on our previous experience, but we cannot yet report about the pros and cons of the new approach.

## Introduction and sample selection

The sample selection starts with a meeting with the group of villagers participating in the programme. The concept and purpose of the survey is outlined, as well as the cooperation expected from a farmer whose yield is measured. Farmers who have been in the sample of previous yield measurement surveys are especially encouraged to participate, as their yields can then be compared over time. If more than one third of the participating farmers (the desired sample size) want to join the survey, randomization is done by drawing lots in the meeting, so that farmers understand why they are in the sample or not.

## Yield measurements

Although most farmers grow a large variety of crops, only the yields of upland rice are measured, because this crop is by far the most important for the majority of families. Because upland rice reacts very sensitively to land degradation, it can be regarded as an indicator for ecological sustainability.

In the fields of the farmers in the sample, farmers and small teams of trained enumerators measure the yields in the "traditional" plot and in the "sustainable farming" (SF) plot, where farmers are supposed to have applied some of the project recommendations. Two methods of measurements are applied: replicated crop cuts in three 20 m2 plots per field, and measurements of the total volume (in traditional units) of the crop from the whole plot. The latter is conducted by farmers on their own, in order to compute the measurements in yield per unit area.

## Evaluation

The yield measurements will be evaluated in two steps:

– interviews with individual farmers, during which the farmer is presented with the data measured in his fields and is asked to state reasons for the differences between the traditional and the SF-plot and (if available) for the differences over time.

– group meetings held in the village, to which all farmers participating in the programme are invited, regardless of whether their yields have been measured or not. The discussion in the meeting will be based on the measured differences between yields. Charts will be used in which each line represents a farmer and the yields measured in his fields. The remaining columns show the reasons for yield differences as suggested by farmers and whether or not these reasons apply for each farmer (see figure).

| Farmer name | Yield (Trad.) | Yield (SF) | Reasons for differences |
|---|---|---|---|
| A | | | |
| B | | | |
| C | | | |
| D | | | |
| E | | | |
| etc. | | | |

Evaluation of yield measurements during group meetings in the village (Trad. = traditional; SF = sustainable farming).

## Farmer assessment

Another method will be to group farmers according to their yields and to ask them to find out the most important yield-determining factors which can be identified as the common differences between the groups, related either to the field characteristics or the management techniques applied. The extension worker as moderator can – if necessary – raise additional topics and ask farmers to find out whether they are also yield-determining factors.

The results of the meeting will be noted in the chart and presented to farmers in a summarized form after the meeting. (Even if most farmers cannot read and write, it was found that visualization of meeting results increases their understanding, if a combination of text and pictures is used on charts and if the charts are well explained to them. In addition, the use of writing in village meetings provides a stimulus for participation in literacy programmes.) The chart will be kept and made available as an entry point for further group meetings.

The results from each group meeting will also be presented in the monthly meetings of the area extension staff, when the results from about 20 such group meetings are summarized and evaluated by the extensionists. As the outcome of this evaluation, the extensionists will suggest to the project and their agencies how technical recommendations for the crops concerned could be adjusted and how the concept for next year's yield measurement surveys could be improved.

Thus, the purpose of yield measurements is a learning activity for farmers and extensionists and shall also provide the necessary information for concept adjustments. ■

**Christoph Backhaus**
c/o Thai-German Highland Development Programme
PO Box 67
Chiang Mai 50000
Thailand

## Production risk and soil management

It appears that through environmental degradation, poor management, and inadequate stewardship, the capacity of the soil to buffer against yield variance is being eroded. Consequently knowledge of the nature and causes of yield variability and how this relates to risk becomes very important.

Soil management minimizes risk through applications of the following principles and techniques:

- **Increasing the soil rooting depth.** This is fundamental because it increases the volume and in many cases the reliability of supply of moisture and nutrients to the plant. Rooting depth can be increased using techniques such as deep tillage, land forming (broad beds, ridges, etc), soil drainage, and sometimes lime application to neutralize the effect of aluminum toxicity at depth. (Crops or varieties with relative deep rooting systems often have better drought resistance (ed.)).
- **Increasing the organic matter content.** This applies particularly in situations where organic matter levels are naturally low, or where levels have been reduced through degradation. Techniques may involve zero tillage, improved surface mulch management, additions through composting, organic fertilizers or green manures, or stimulation of underground biomass production.
- **Better soil moisture management.** This is perhaps the soil factor which is the most critical for ameliorating production risk. In areas with excessive periods or amounts of precipitation, land drainage and land forming may be necessary. in semiarid and arid areas various techniques of moisture harvesting, coupled with improved soil physical conditions to enhance storage (by way of the above mentioned techniques), can be used. In either case, the aim is to improve the supply of moisture available to the plant, thereby reducing the risk of crop failure.

From: Dumanski, J. 1989. Understanding and evaluating crop production risk. IBSRAM Newsfletter, No. 13, September 1989.

# Criteria for assessment

**Assessing technology for sustainable agriculture requires a set of criteria that covers all aspects of sustainability. The ILEIA Workshop looked at possible criteria and their indicators so as to develop a checklist.**

New farming techniques have to fit into the specific and complex agroecological, socioeconomic, cultural and political setting of the farm. They have to contribute to satisfying the needs and objectives of the farm household. A technique may be multifunctional and may have a positive, negative or no impact on any of these needs or objectives, but the impact of the complete system of techniques used should achieve all of them. If sustainability is sought, the new technique should also contribute to meeting the objectives for sustainable agriculture (see "Local economies – framework for assessment").

### Criteria and indicators

To be able to analyse if a technique fits the local setting and to what extent it contributes to meeting the objectives for sustainable agriculture, criteria are needed as a framework for assessment. To be able to measure the performance of a technique according to each criterion, quantitative or qualitative indicators are needed.

When different techniques are being compared, only those criteria need to be examined on which the alternative techniques have different impacts. Where complex, multifunctional techniques such as agroforestry are being assessed, the exercise can be rather complicated. Techniques function in combination with other techniques and can influence each other's performance in a positive (synergy) or negative (competition) way. It may therefore be necessary to compare sets of techniques, e.g. chemical fertiliser + improved seeds + pesticides vs organic manure + stress-resistant indigenous seeds. This makes the exercise even more complicated.

On account of differences in, e.g., agroecological and household settings or differences in needs and objectives, farm systems are highly diverse. Therefore, techniques that suit one farm will not necessarily suit another. Also within one farm, differences between fields with respect to, e.g., soil condition or distance to the farmhouse may demand different techniques to meet the same objective.

When choosing techniques, farmers may not always be aware of the implications with respect to sustainability. Often, there may be no alternative, if farmers do not have access to the necessary resources (e.g. land, nutrients, labour, cash, skills) and/or viable techniques are not available.

### Supporting farmers

Outsiders such as fieldworkers, researchers and policy makers can support farmers in their decision-making. For example, researchers can increase the understanding of the ecological processes involved in farming and sharpen the criteria that could be used. They can also provide farmers with useful indicators, or support them in monitoring the performance of techniques and farm systems. Fieldworkers can strengthen farmers' capacity to assess technology with a view to sustainability.

Policy makers have a responsibility to add the interests of the nation as a whole to farmers' decision-making, introducing criteria such as "food security for the nation",

Culture may provide criteria that have high priority in farmers' assessment. Photo: Wim Hiemstra.

"affordable level of imported inputs" and "favourable balance between food and cash production". The needs of the farmers to keep their systems sustainable and of the society to be nonpolluting must be kept in mind. Ensuring that farmers have access to the necessary resources (e.g. land, inputs, infrastructure, credit) and bringing in legislation to enhance sustainability are also tasks of the policy makers. But these support activities will be effective only if outsiders understand the economic complexity of LEISA. This is possible only when farmers and outsiders work together in mutual support of decision-making processes at farm and community level as well as at research and policy level.

### Participatory Technology Development

For this reason, the ILEIA workshop placed technology assessment in the wider context of Participatory Technology Development (PTD), which consists of collaboration of farmers and outsiders in:

*1* analysing the local farming system, including the dynamic aspects, farmers' objectives related to sustainability, felt needs and limiting factors;

*2* collecting and selecting technology options that could address the felt needs and/or constraints;

*3* trying out these techniques with continuous evaluation and monitoring of their performance;

*4* spreading promising techniques more widely, and finding out under which conditions they can be used.

In this process, techniques are examined for their viability and compared with alternatives. It is not expected that the selected techniques provide permanent solutions, as conditions will change over time. PTD therefore aims not only at finding better techniques but also at strengthening local capacity to develop technology. It is meant to motivate farmers to become involved in further technology development to sustain their farm systems.

In Activities 2, 3, and 4 in a technology development process as outlined above, a criteria checklist is indispensable as a reference framework for assessing the relative performance of techniques.

**Checklist for sustainability**

The need to use a consistent set of criteria to cover all aspects of sustainability is not yet generally recognised or applied. Therefore, the ILEIA workshop saw as its task to propose a holistic, sustainability-oriented checklist of criteria. This checklist (see box) will need further improvement and should be adapted after field testing.

**The farm system**

If achieving sustainability of a farm system is a deliberate objective, the performance of techniques must be related to all aspects of sustainability: productivity, security, continuity, identity. The performance of each individual technique should be related to that of the system as a whole. For this, profound knowledge of the farm system, including its history and processes of change, is needed. Although the workshop focused mainly on the checklist for technology assessment, a list of key words was compiled to analyse farm and livelihood systems.

HISTORY
- origin of the settlement
- outside impact: influence, market incorporation, exposure to ideas and methods from outside (extension)
- population growth
- social and ethnic struggle

ECOLOGY (''carrying capacity'')
- resource base of present farming systems
- which local resources are underexploited, in balance or overexploited?
- level of pollution
- ecological diversity

SOCIAL/POLITICAL
- ownership of and access to essential resources
- division and organisation of labour (quantity and quality)
- gender/class/age/ethnic/caste social relations, as affecting resource use
- inheritance patterns
- institutional power and control within village and at state level

CULTURAL
- consciousness of ecological situation, including pollution
- values and attitudes, affecting resource use and labour
- norms and sanctions
- religion and spiritual motivation
- gender, age and class issues
- experimenting capacity and learning habits (hierarchy, formal education)
- food habits

ECONOMIC
- degree of market orientation
- household survival strategies (on- and off-farm activities)
- food sufficiency and access to food
- credit and indebtedness
- nonmonetary exchange systems
- infrastructure: roads, access to markets, government services
- availability and affordability of external inputs.

These factors are all thought to influence farmers' motivation for change and hence the techniques chosen. The motivation can lead to spontaneous change (''autonomous technology development'') or may need outside support (''participatory technology development'').

**Complementarity of criteria**

Different actors are involved in technology development: farmers (women and men), development workers, researchers, policy makers. These actors use different criteria to assess technology and/or give different priorities to them. There is overlap, tension and complementarity between these criteria. To make a checklist that contains the criteria of all actors, ILEIA invited persons from these different groups to take part in the workshop. In small working groups, the participants gave their opinion as to which criteria should be included and what importance should be given to each criterion with a view to sustainability. Also indicators were discussed, but to a lesser extent.

The farmers in the workshop were especially interested in criteria concerning the farm level, whereas the policy makers were more interested in those concerning the entire nation, e.g. general food security, foreign currency balance. Development workers had the most holistic vision.

**Complementarity of indicators**

The farmers' group proposed mainly visual indicators. For example, for soil quality, they proposed soil life, colour, structure, temperature and depth; organic matter content; yield as indicator of fertility; amount and type of vegetation; presence or absence of certain weeds; and incidence of certain plant pests and diseases. The researchers preferred measurable indicators such as yield (in kg), cost/benefit ratio, gross margin, marginal rate of return (in monetary units), nutrient levels and balance, organic manure needed per ecozone/soil type/year/crop/ha, soil erosion (t/ha). These indicators often complement each other.

The relative importance given to the different criteria depends on the personal vision of the person applying them and the specific farm situation, which will change over time. Technology choice will therefore be very farmer-specific. Only in a continuous process of conscious adaptation toward sustainability can the right balance between the different objectives be found.

**Rapid appraisal needed**

As low-external-input farming systems are often complex, diverse and risk-prone, a holistic assessment of farm systems and techniques is not easy. Farming Systems Research (FSR) is being criticised for its time- and cost-consuming analysis process which, however, is still far from holistic. For example, many environmental impacts are left out as they are difficult to measure in their complexity (Worman et al 1990). It can even be questioned whether outsiders can make a holistic assessment of farm systems and techniques in a time- and cost-efficient way. Often, the assessment is limited to a minimum data set (TSBF 1990, Scherr & Muller 1991). This means, however, that only indications can be obtained of the performance of the techniques and of the system.

The users of the farm systems are the persons who know them best. To improve system analysis, Rapid Rural Appraisal (RRA) methods are being developed based on participation and self-evaluation of the farm community (e.g. McCracken et al 1988, Lightfoot et al 1990). With these methods it is possible to make cost- and time-efficient agroecosystem analyses which provides ecology-based frameworks for understanding farming systems and identifying problems perceived by the farm communities.

Recently some first attempts have been made to use such RRA techniques in technology evaluation and monitoring (Buck 1990). These attempts should be encouraged, as they provide useful instruments for technology assessment by farmers. ■

# Criteria checklist for assessing farming techniques

**Productivity**

1 Does the technique meet farmer/household needs for kind?
- does it improve food availability, quality and security?
- does it sustain or improve the availability of secondary products (fuelwood, building material, medicines, gifts etc)?

2 Does it meet farmer/household needs for exchangeable products/cash?
- is there a market for the products?
- are prices high enough?

3 Is enough land available to produce farmer/household needs?
- quantity
- quality

4 Do labour requirements fit farmers' labour resources and needs for labour productivity?
- by gender
- by season

5 Do farmers have access to the necessary inputs?
- available
- affordable

6 Do financial requirements fit farmers' monetary resources and needs for cost efficiency?
- by different costs (nutrients, pesticides, hired labour, transport, provisions, bribes, etc.)
- by season

**Security**

7 Does the technique minimise the risk of
- crop failure (pests, diseases, climate)
- financial failure
- health hazards
- non-availability of external input
- inappropriateness of exotic species

8 Does it leave sufficient management flexibility?

9 Is it based on the use of local resources (e.g. land, water, genetic resources, knowledge, experience, skill) and locally produced inputs?
- are these resources under the control of the farmers?

10 Does it reduce dependency on information, inputs, subsidies, credit and markets?

11 Does it avoid conflicts of interest?

**Continuity**

12 Does it maintain/enhance soil quality?
- soil life
- soil fertility (macro-, micro-nutrients)
- nutrient balance (macro-, micro-nutrients)
- structure
- water-holding capacity

13 Does it recycle nutrients?

14 Does it prevent/reduce soil/nutrient loss?
- soil cover
- complementary root structure
- water conservation

15 Does it enhance/maintain perennial biomass (grasses, shrubs, trees, animals)?

16 Does it use water in a safe and efficient way?
- water-use efficiency of crops
- overpumping
- drainage

17 Does it enhance diversity (genetic diversity and mixed farming)?

18 Does it reduce toxic effects on people and resources?

19 Does it enhance human health?

20 Are maintenance costs of ecological and economic infrastructure affordable?

21 Does it recycle capital?

22 Does it have neutral or positive effects on systems beyond the farm (watershed, village, downstream areas, nation etc)?
- use of nonrenewable resources
- pollution of air, water, soil
- production of "greenhouse gases"

**Identity**

23 Does the technique integrate well within the existing farming system?
- agroecological
- socioeconomic
- household conditions
- gender
- evolution

24 Is it feasible to introduce the technique given the existing infrastructure (credit, roads, transportation, support by extension service etc)?

25 Does it fit/strengthen the culture of the farming population?
- social organisation
- religion or values
- preferences
- perceptions of social justice

26 Can it be easily understood by farmers?

27 Is it consistent with government policy?
- does it generate employment opportunities with adequate returns (on-farm, off-farm)?
- does it contribute to regional/national food security
- does it enhance the foreign currency balance?

28 Does it benefit poorer/powerless farmers (men, women)?

**Adaptability**

29 Has it been practised already by small farmers or has it spread spontaneously?

30 Does it bring rapid, recognisable success?

31 Does it stimulate or allow experimentation/adaptation by farmers?

32 Can it easily be communicated to other farmers?

33 Can knowledge, skill easily be transferred to farmers by training?

**Guidelines for use**

This is a checklist and not a should-list. People working with this list should feel free to give high or low value to the different criteria, modify and/or skip or add new criteria.

# Soil erosion? That's not how we see the problem!

**As a result of increasing pressures on upland and highland areas in Southeast Asia in recent decades, the soils are eroding. Christine Pahlman indicates however, that farmers hold a different perception of soil erosion and conservation. Only one out of 240 farmers spontaneously mentioned soil erosion as a major problem! Farmers regard (fruit) tree integration as the most important conservation measure for their fields, as it gives the highest economic returns.**

**Christine Pahlman**

The reasons for increased pressure on upland and highland areas in Southeast Asia are complex, but it is at least partly a response to the demands of a growing population and the transformation of subsistence communities to market economies. This has led to more intensive cultivation of marginal sloping lands, and the breakdown of the stability of traditional swidden systems of agriculture. Fallow periods have shortened and lands are being increasingly cultivated before soil recovery is complete.

In Thailand, one of the most devastating consequences of intensified farming of the uplands is soil degradation. Upland soils tend to be of moderate to low fertility and highly susceptible to soil erosion. Srikhajon et al. (1980) estimated that 33% of the Kingdom's total land area was moderately to severely eroded, particularly on upland slopes. Indications are that the extent and degree of erosion has increased since then.

### Dependance on land for survival

Although it can be argued that a significant proportion of the sloping lands of northern Thailand are too steep and poorly structured to be suitable for any form of agriculture, it is probably neither realistic nor accpetable to ban farming in these areas – the land which hundreds of thousands of people depend on for their survival. For this reason there is an urgent need to develop sustainable agricultural systems appropriate for upland communities, capable of supporting the inhabitants whilst conserving the soil resources upon which they depend.

Much work has been and is being directed toward developing more sustainable farming practices for sloping land. Promising and potentially appropriate methods including various agroforestry systems such as alley cropping have been developed. Nevertheless, the rate of farmer adoption of these practices remains notably low and, in northern Thailand, is still insufficient to have any real impact on the situtation. This suggests a disparity between the perceptions of researchers and development workers on one hand and those of farmes on the other. While researchers may perceive soil erosion as a major problem, the low adoption rate of soil conservation practices suggests that farmers perceive their problems quite differently, or perhaps cannot adopt these innovations for reasons not well understood by others.


**The headman of Ban Giw Muang standing next to a sign erected to honour the community forestry project recently initiated in the village. The sign is a quote from the King of Thailand, HRH Bhumibol Adulyadej and reads: "The Department of Forestry does not have sufficient capacity to protect the forests. It should be the people who plant forests and derive the benefits from the forests, adn the people should be guardians and the caretakers of the forests". Photo: Christine Pahlman.**

### Farmer perception of sustainability

As part of a Masters thesis to develop an understanding of how upland farmers perceive their farming problems and the sustainability of their farming systems, a group of 240 ethnic Thai farmers from eight villages of Non Province, northern Thailand were interviewed. Farmers were selected on the basis that they were farming mostly rainfed upland areas and derived most of their food and income from these activities. Questions were answered mostly by the household heads, usually males, although other family members often contributed.

It was found that a typical farmer has little if any formal education, is farming an area of less than 1.8 ha located more than 2 km from the house and has an annual household income of less than USD 400. The main crops grown are glutinous upland rice, corn and groundnuts in the wet season and mungbeans in the dry season. Cultivating fields in rows going up and down the slope and burning crop residues is standard practice. The dry season is characterized by widespread burning of fields by fires that are lit and then left largely uncontrolled to run their own course. Fields lay bare and vulnerable to the impacts of the hot tropical sun during the dry season and the highly erosive monsoonal rains at the onset of the wet season.

Most farmers were unaware of soil erosion, or thought that soil erosion was not serious enough to require action, or were unaware of what they could do about soil erosion and/or were unable to adopt soil conservation strategies due to economic and resource constraints.

Interestingly, despite general recognition among the research and extension community that soil erosion is a critical problem in northern Thailand, only one farmer (out of 240 questioned) spontaneously mentioned soil erosion when asked generally about major farming problems. Instead, the primary concerns of farmers were centred around weeds, insect pests and a shortage of water. When specifically questioned on the incidence of soil erosion on their fields, 43% said there was none, 34% acknowledged a moderate degree of erosion and only 23% said there was substantial erosion on their fields.

### Lack of new land

However, despite the seemingly low awareness and concern about soil erosion, declining soil quality/fertility was recognised as a problem by most of those questioned. According to the farmers, the major reason for this decline in soil quality is the lack of new land to clear, making it necessary to practise more continuous farming of fields and reduce the length and frequency of fallow periods. It became clear that farmers are well aware of the soil degradation that results from continuous slash-and-burn cycles on a single piece of land. To them, it is like a law of nature: "Fallows are necessary to rest the soil; without fallows, the soil eventually dies ...." Many farmers therefore do not see the problem so much in terms of farming practices, but rather as lack of land (making fallowing and soil regeneration impossible).

Farmers' views on the suitability and effectiveness of five potential soil conservation measures (integration of trees, contour farming, bench terraces, alley cropping and rock/log barriers) were sought. Farmers clearly regarded the integration of tree crops, e.g. fruit trees, to be both the most effective and the most suitable conservation measure for their fields.

Neverthless, although tree crops are already widely used in some form and the majority of farmers are aware of the benefits of tree crops on soil quality, soil conservation as such does not seem to be a major incentive to plant trees. For example, 141 of the 200 farmers growing or interested in growing fruit trees said it was for economic returns, whereas only 10 farmers said it was for soil erosion control. This is an important consideration given the low level of concern about soil erosion.

### Food and income needs

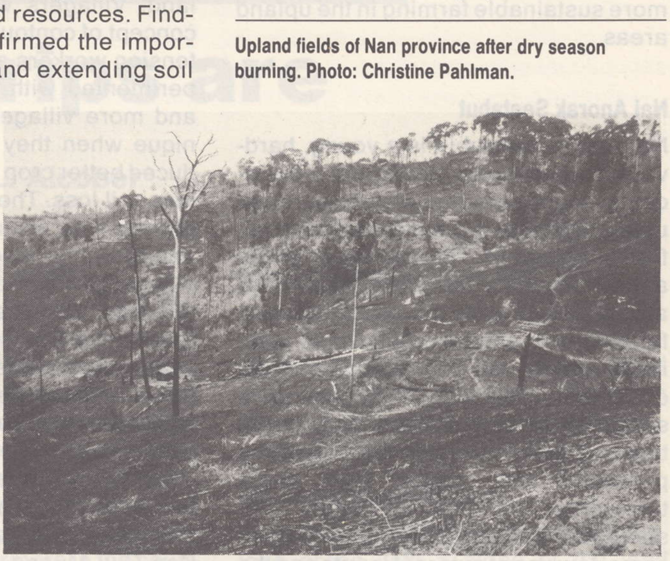
Farmers also spoke of the value of growing tree crops to suppress weed growth (their major farming concern) and to mitigate against the effects of deforestation including declining infiltration of water and dwindling supplies of timber and forest food resources. Findings of the study confirmed the importance of developing and extending soil conservation techniques that have a direct and clear relevance to food and income needs of farmers, and do not just address environmental sustainability.

In the view of the farmers interviewed, the main constraints to using tree crops (in order of importance) are lack of resources/funds, lack of water, the possible reduction in yields of their field crops that would arise from growing trees, and security problems associated with protecting trees and their produce from uncontrolled fires and theft and damage from people and villagers.

### Land tenure makes no difference

Of the fields being farmed by the surveyed farmers, 50% were without any form of legal title, and only a few were covered by what is considered to be highly secure legal tenure. Conservation literature has generally argued that secure land tenure is a necessary precondition to the adoption of long-term sustainable farming practices. It is

**Upland fields of Nan province after dry season burning. Photo: Christine Pahlman.**



**Nai Anorak and his wife at their farm, looking over their fish pond above which they raise pigs. Photo: Christine Pahlman.**

therefore highly interesting that 69% of farmers interviewed thought that land tenure made no difference to farming practices and did not limit the establishment of permanent tree crops. Of the farmers who had already planted fruit trees, 40% did not have any form of legal land tenure and only 6% had highly secure tenure. In fact, some farmers even went so far as to say that planting fruit trees was a way for them to make a more secure and permanent claim to the land they were farming.

### Conservation farming approaches

In the sample group, there were two examples, one of an individual farmer (Nai Anorak Seetabut) and one of a village community (Ban Giw Muang), who have actively sought and developed ways to farm more sustainably and, in this regard, were not typical of the interviewed farmers. Their success provides some insights into the technologies and processes that may be appropriate for more sustainable farming in the upland areas.

### Nai Anorak Seetabut

Nai Anorak Seetabut is a young, hardworking and thoughtful farmer who recently acquired a 2-ha plot of degraded upland through a government land reform programme. His own experiences and observations led him to believe that a continuous cycle of slash-and-burn farming with annual crops would inevitably lead to soil degradation and decreased productivity. He therefore sought to develop a diversified and integrated farming system incorporating perennial tree crops, food crops throughout the year for family consumption, cash crops for monetary income, low use of external inputs and the recycling rather than the burning of crop residues. Having witnessed many fellow villagers fall into a downward spiral of debt and hardship, Nai Anorak wanted to develop his farm without borrowing money.

With training and advice from local extension personnel, Nai Anorak started experimenting with different cover crops and began propagating fruit trees and planting them inbetween various field crops. In recognition of his committment and interest in conservation farming, Nai Anorak was selected as a ''model farmer'' by a local agricultural project. This meant that he received modest technical and material support to develop his farm in return for trying out new and untried crops and technologies on his farm and helping to extend successful ones to other farmers. So far, he has experimented and attained moderate success with alley cropping, growing wheat as a supplementary dry-season crop, digging fish ponds and raising fish and pigs.

Within four years, Nai Anorak and his family have transformed 2 ha of relatively unproductive deforested and degraded sloping land into a diversified and integrated farming system incorporating tree crops, field crops, animals and conservation structures. This has been done with a lot of hard work, few external inputs and little capital investment. It is a system which Nai Anorak believes will produce enough food and income to support his family throughout the year.

### Ban Giw Muang

The farming approach of villagers in Ban Giw Muang could be described as unique for the uplands of northern Thailand. The majority of farmers in the village have not only been integrating fruit trees into their fields for several years, but have also been contour farming as opposed to cultivating up and down the slope as is the norm in northern Thailand. Villagers were exposed to the concept of contour farming by local extension workers and a few farmers experimented with the technique. More and more villagers adopted the technique when they realized that it produced better crop yields and resulted in less soil loss. The village headman explained that, when maize is planted up and down the steep slopes around the village, the field can be cropped for only one year and then the soil is so degraded that it must be fallowed for three years. Contour farming, on the other hand, enabled fields to be farmed for two successive years before it was necessary to fallow.

Farmer-to-farmer extension was also the method by which the integration of fruit trees has become so popular in Ban Giw Muang. One of the villagers had thought out the economic and conservation benefits of growing trees amidst field crops and, with the resource assistance of a local conservation-minded monk, he began experimenting with tree species. Interest amongst villagers quickly spread.

### Protecting existing forest

Planting fruit trees on their fields presents many challenges to these farmers. So far, villagers have been restricted to growing trees on fields close to the village to afford greater protection from uncontrolled fires, damage from animals and theft from other farmers. The farmers have had to cut grass and dig around the trees in the hope of creating a firebreak from dry-season burns. The village headman envisages that the threat from fires will reduce in future years as more and more farmers start to grow trees in their fields.

Recently, becoming increasingly concerned about the effects of deforestation in their area, Ban Giw Muang villagers joined together to protect remaining forest close to the village. A community forestry area was proclaimed and a blessing ceremony was held and a small shrine erected by local Budhist monks to bless and sanctify the area.

In addition to protecting existing forest, the villagers are also planting tree seedlings in the school and temple grounds, along roads and in other public areas. Although a local development worker supported and was involved in these activities, the main initiative came from the villagers themselves.

### "Selling" conservation?

The move toward more sustainable farming practices involves both appropriate practices and a process of developing and extending these practices. This study provided some useful insights into the characteristics of appropriate farming practices for sustainable farming and the process of developing and extending these practices.

Farming practices which are developed for, and extended to, upland farming communities of northern Thailand need to:

- address immediate and short-term needs for food and income;
- be based on existing practices, i.e. modify rather than replace;
- diversify farming practices;
- minimize capital/resource requirements and external inputs;
- provide economic returns;
- meet labour availability.

In the process of developing and extending farming practices, involvement of the whole community, farmer experimentation and farmer-to-farmer extension are necessary. It favours a process of developing and extending farming practices which are appropriate in the perception of the local people. With a view to sustainable land use in the upland farming areas, emphasis should be placed on practices which meet the needs perceived by the local farmers (e.g. for food and income). Simultaneously, these practices should contribute to resource protection, e.g. the planting of economic trees. There is no point in trying to ''sell'' conservation-farming practices to farmers for the sake primarily of conservation, if they see their problems differently. ■

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**Christine Pahlman**
c/o CUSO Thailand
17 Phaholyothin Golf Village
Phaholyothin Road
Bangkhen, Bangkok 10900, Thailand

# Natural grass strips are preferred

Ly Tung and D.L. Alcober

**Indigenous technology may be more in line with farmers' criteria than technologies introduced by researchers and extension workers. This case shows how a technology was poorly adopted because researchers thought of different criteria (nutrient recycling) than farmers (labour, availability of planting material).**

Some 10 million hectares of upland in the Philippines are characterized by sloping land and high soil erosivity. Tens of thousands of small scale farm families have settled in these once forested areas to practice shifting cultivation on crop/fallow rotation (Mercado et al. 1989). Upland farmers have a distinct preference for clean cultivation of their fields. This is manifested in numerous tillage operations per year in animal-powered systems. This practice is applied on slopes from 8 to 60 percent. Soil erosion losses are enormous, often being reported in excess of 1 cm topsoil per year (Garrity and Sajise, 1990).

As farm density has increased, the fallow cycles are reduced to a few years at most. And as it continues to increase, farm sizes further decline, and fallow cycles are replaced by continuous cropping. Therefore, many of the resulting cereal-based farming systems in such areas are unsustainable because of soil erosion and soil nutrient depletion.

### Contour hedgerows not adopted

One of the technical possibilities to address the problem is the development of contour hedgerow farming systems. These farming systems include the growing of food/cash crops in the alley bounded by leguminous trees or shrubs planted as a hedgerow. Although scientists perceived many benefits of this hedgerow system technology, its adoption rate by upland farmers in the country is disappointing.

A close study of the production system in the upland region learned that farmers have developed their own technique to fight soil erosion.

### The Matalom area

The terrain of this region ranges from rolling to hilly. With a high rainfall (about 2000 mm/year) concentrating from the months of June to November, the soils are highly erodible unless soil conservation measures are applied. Upland rice planted during the rainy season is commonly observed on strongly acidic soils, whereas corn is the dominant crop on calcareous soils. Coconuts are sparsely populated. Other annual crops such as sweet potato and peanut are much less important. Cereals (upland rice, corn) relayed with sweet potato appears to be a popular production system. The crop-fallow rotation is still practiced by the majority of farmers. The fallow period may range from just one off-season (November to April) to several years.

General view of upland, Villaba. Photo: Ly Tung.

### The indigenous technology

The simple technique is applied in upland areas with a slope of the land mostly ranging from 10 to 30 percent. At the end of the fallow period (several years), the land is observed to be covered with natural low-growing grasses or with cogon *(Imperata cylindrica)*. The farmer comes in and plows it using the carabao. The direction of plowing is along the contour, not up-down the slope. And, for every plowed strip of which the width (surface run) may range from 4m to 10m, a strip of about 0.5m-1m wide is left unplowed. In some fields, the unplowed strips look more or less straight across the slope, whereas in other fields, the unplowed strips appear to approximately follow the contour lines. The plowed area is, of course, prepared until ready for planting crops, while the unplowed strips being covered with either natural low-growing grasses or cogon serve as the soil trap. As time goes by, terrace formation takes place. We observe that in a matter of one or two years time, the form of natural terraces is already apparent. Thus, the vegetative hedgerow on the resulting bunds is simply either natural low-growing grasses or cogon. As the technology is effective in checking soil erosion, fallowing the land for a number of years is no longer necessary.

### The story behind it

When asked about the origin of this technique, farmers told us some interesting stories.

One farmer got the idea from the farms which he observed in Surigao when he stayed with his uncle, who taught the members of his farmers' association the contour hedgerow system using kakawate (*Gliricidia sepium*) and ipil-ipil (*Leucaena leucocephala*). The land to which the technology was applied formed terraces. Back in Esperanza, the farmer applied the technology with the help of his wife on the piece of land (about one hectare) which they are now tenanting. He did not use kakawate nor ipil-ipil because there were no planting materials. He just left strips of about 3-feet wide unplowed.

### The use of cogon

When asked why the farmers started to apply this technique, they mentioned lessening soil erosion and avoiding fallow periods as the main reasons. An advantage is that the proportion of the alley area which can give good growth to corn is increasing. The uses for cogon grown on the strips/bunds are manifold: to hold the soil, to feed the livestock, to provide mulching material and roofing material. Cogon also affects the crops planted on the alleys. According to one farmer, rows of peanut adjacent to cogon strips have poorer growth (after having applied the technology for a year), but another farmer claims that rows of corn adjacent to cogon strips have better growth (after having applied the technology for seven years). The farmers are not afraid cogon will spread as a weed as the alley area on both sides of the strips/bunds is cultivated. Besides, the cogon on the bunds cannot produce flowers since the part above ground is cut regularly for various purposes. On the possibility of cogon hosting rats, insect pests, and diseases that may affect crops, no experience has been gained sofar. The advantage of cogon above mura (Vetiver grass), which has the same function and is planted to maintain the dikes of the lowland rice fields, is that cogon is already there whereas mura needs to be planted.

**In some fields, the unplowed strips look more or less straight accorss the slope. In other fields, the unplowed strips appear to approximately follow the contour lines.**

### Grasses versus trees

The technology seems very simple, but the farmers who had that original idea deserve admiration.

Experiments done by some upland farmers in Claveria, Cagayan de Oro, where there are similarities in physical conditions with Matalom, indicate that grass strips are an effective soil trap. They found that grasses provide more effective and faster terracing compared to trees (Fujisaka and Garrity 1989). The technology does not require additional labour for hedgerow establishment. Cogon strips may require maintenance by regular cutting but the cut cogon provides various uses as cited by the farmer.

Some reasons why the hedgerow tree legumes technology, which is very much advocated, is still poorly adopted:

- Trees are not as effective as grass in checking soil erosion.
- The researcher's perceived benefit of hedgerow tree legumes in nutrient recycling is a lower farmer priority.
- Tree legumes commonly recommended are kakawate and ipil-ipil, but planting materials, especially seeds, are difficult to secure.
- Labour is required for establishment and management. It takes about 30 person-days to establish a hectare of hedgerows using tree legumes (labour 1000m of hedgerows) (Fujisaka and Garrity 1989).
- Trees may be in competition with crops planted on the alley for light, soil nutrients and water. To minimize light competition, timely pruning is required which entails labour too. Furthermore, Basri et al (1990) reported an adverse nutrient competition between *Cassia spectabilis* and upland rice under Claveria conditions.
- All of the aspects mentioned above are of course considered by the farmer in conjunction with his security (or insecurity) of land tenure.

### Possibilities for improvement

The technology is not without problems, however. Sometimes the low-growing grassbunds may be broken, perhaps by heavy rain or by animals.

With a good understanding of the technology, researchers in collaboration with farmers can start looking for new innovations to solve these problems and further accomodate farmers' other priorities such as cash crop along hedgerows, feed for livestock, nutrient recycling and fuelwood. ■


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**Ly Tung and D.L. Alcober**
Farm and Resource Management Institute
8 Lourdes Street
Pasay City 3129
Philippines

# Researchers assess soil fertility techniques

**As one case, research on soil fertility techniques was evaluated by the ILEIA Workshop. Research methods as well as results were examined.**

The loss of soil fertility in large parts of developing countries due to nutrient mining by crop production, soil erosion, leaching and volatisation poses an immediate threat to the sustainability of farming, especially of low-external-input farming. Although the use of mineral fertilisers is often regarded as the quickest and surest way of counteracting nutrient depletion and boosting crop production (Roy 1991), availability, effectivity, cost and other constraints frequently deter farmers from using them at all or in recommended quantities. Cost escalation resulting from reduction in or withdrawal of subsidies from fertilisers without correspondingly increasing produce prices, is making the use of mineral fertilisers even less attractive in many countries.

Traditionally, farmers use one or more of the locally available sources of plant nutrients such as fallow vegetation, manure, crop residues and silt, but the quantities in which these traditional sources of nutrients are available to them are often no longer enough to keep soil fertility at an acceptable level. Being aware of declining soil fertility, farmers and organisations supporting them, are looking for appropriate techniques to improve and sustain soil fertility. Most of them know from experience or have heard about mineral fertilisers and their positive effects but, often, also their negative effects.

Policy makers want to know if these traditional techniques can be used to replace mineral fertilisers, so that expensive imports can be decreased and soil degradation prevented. But how to know about their viability?

Information on viability of traditional soil fertility management techniques and on complementary use of mineral fertilisers (combining organic and mineral fertilisers to enhance their effectivity) is not readily available. This is because, since "green revolution" techniques became popular, conventional research and extension have not been particularly interested in these techniques. Comparable information on the viability of soil fertility management techniques is therefore urgently needed. ILEIA therefore decided to look especially at what data – both quantitative and qualitative – are available about them.

### Comparing soil management techniques

Some techniques are deliberately aimed at improving soil fertility, e.g. applying chemical fertiliser, manure, compost or green manure. Other techniques affect soil fertility by capturing nutrients, e.g. nitrogen fixation, nutrient harvesting; by preventing nutrient losses, e.g. erosion control measures, prevention of leaching (by increasing the water- and nutrient-holding capacity of the soil), recycling nutrients (deep-rooting trees and shrubs, composting organic waste from processing farm products, etc); or by activating nutrients to make them available to plant growth, e.g. association with mycorrhiza, using different crops. Other techniques aimed at controlling weeds (e.g. cover crops) or controlling pests (e.g. rotation) also affect soil fertility.

Ecological soil fertility techniques are very variable in how they function and should therefore be well analysed as to their effect on nutrient content, organic matter content, composition of organic components, time of decomposition, growth habit etc. They also have many management variants and are multifunctional: they not only influence productivity (yield) but may also have positive or negative impacts on security (risk) and continuity (soil conservation).

Soil fertility techniques are used together with other techniques, e.g. of water management or pest control, with which they interact in a positive or negative way. Therefore, also other indicators should be examined, e.g. the effect of the technique on organic matter content, soil structure, sensitivity to soil erosion, water-holding capacity, cation-exchange capacity, soil microclimate, soil biological activity, nutrient adequacies and balances, surface charge characteristics, soil acidity, crop removal of nutrients, crop health, weed growth, pest incidence.

Full comparison of techniques therefore requires an extensive checklist of criteria and indicators.

In view of the long-term effects of biological processes and the variability in, e.g., climatic conditions, long-term observations are needed to obtain reliable results. As there are many variables involved in soil systems, experiments can be compared only if they are conducted under similar conditions.

### The ILEIA workshop

During the ILEIA workshop, an attempt was made to assess the viability of soil fertility management techniques to enhance LEISA. Based on publications available at ILEIA, quantitative and qualitative data were collected and evaluated. Although, due to time limitations, only a beginning could be made in this exercise, an impression could be gained of the amount and value of the available data and about how such techniques are generally assessed. Here, some selected cases are presented in which soil fertility management techniques are compared.

### Farmyard manure vs chemical fertilisers

Xi S, Yong-song Z, Qi-zhao Y & Cai-xian T (undated). **Effects of organic manure on soil fertility and crop production.** Current Progress in Soil Research in People's Republic of China, Zhejiang Agricultural University, pp 197-206.

Field experiments were carried out from 1981 to 1984 to study the effect of organic manure on soil fertility and crop production on red earth paddy soil in Dongyang country with barley as the test plant, and on silty paddy soil at Zhejiang Agricultural University with rice as the test plant. The results indicated that the plot treated with animal manure combined with chemical fertiliser gave nearly the same rice grain yield as the one treated with chemical fertiliser alone, using the same amount of NPK on each plot (N 97.5 kg, P 60.8 kg, K 55.5 kg). The grain yield of barley from the plot treated with combined fertiliser was higher than from the plots which were treated with a comparable amount of chemical fertiliser (N 153 kg, P 34.5 kg, K 150 kg). The organic manure can improve soil fertility and supply organic and inorganic nutrients, but the amount of nutrients liberated in the soil is comparatively small and cannot meet the demand of the crop at various stages of its growth. Therefore, the application of organic manure combined with chemical fertiliser has been found to be suitable for Chinese farming. ►

Augstburger F. 1982. **Agronomic and economic potential of manure in Bolivian valleys and highlands.** Paper presented at 4th International Conference on Resource-Conserving, Environmentally Sound Agricultural Alternatives, Massachusetts Institute of Technology, Cambridge, 18-20 August 1982. AGRUCO, Casilla 1836, Cochabamba, Bolivia.
Experiments were carried out with fresh and composted organic manures and chemical fertilisers in two potato producing regions with different climatic and soil characteristics. At high altitudes with acid soils, fresh manure and chemical fertiliser gave good results. In the valley of Cochabamba (Pairumani) with neutral soils, higher yields were obtained with composted manures. In the Pairumani experiment, the same level of nitrogen was used in all applications. Of the crops used in the rotation (potato, grain corn, potato, silage corn) only the potato crops were fertilised. Nitrogen was applied at 80 kg/ha in 1980 and at 140 kg/ha in 1981. As for chemical fertiliser, 120 kg/ha (1980) and 140 kg/ha P2O5 (1981) were added to the nitrogen. There were no adjustments in the amount of each organic manure applied according to their respective concentrations of P, K, Ca and Mg.

Earnings per peso invested in fertiliser were calculated. In 1982 farmers needed to produce more than double the amount of potatoes as in the previous year in order to buy the same quantity of imported fertilisers.

Bolivian soils contain sufficient K, Ca, Mg and microelements. However, a lack of N and P, as well as a deficient soil structure, impede efficient production. As organic manures are deficient in phosphorus, it is recommended to complement them with rock phosphate or bone meal, as these can be obtained from national resources. With the locally available renewable resources, it should be possible to increase agricultural production in Bolivia, especially of potatoes.

### Organic residues vs chemical fertilisers

Bonsu M. 1985. **Organic residues for less erosion and more grain in Ghana.** In: Soil erosion and conservation, Soil Conservation Society of America, Iowa, pp 615-621.
The soil-conserving potential of cow dung and surface straw mulch in the savanna region in North Ghana, and cow dung, poultry manure and wood shavings in the rainforest zone in South Ghana were investigated, based on the ratio of soil loss to grain yield of maize.

On the forest soil (site: Kwadaso), treatments were established on six runoff plots on a 7.5% slope. The six treatments were bare fallow; 5 t/ha cow dung; 5 t/ha wood shavings plus commercial fertiliser (100 kg/ha sulfate of ammonia, 100 kg/ha triple superphosphate and 60 kg/ha muriate of potash); 5 t/ha poultry manure; 5 t/ha cow dung + poultry manure mixture (ratio 1:1); commercial fertiliser (200 kg/ha sulfate of ammonia, 200 kg/ha triple superphosphate, 120 kg/ha muriate of potash). The initial tillage was done by rotovator, and weeds were controlled by hand-hoeing. Maize, the test crop, was planted up and down the slope.

On the forest soil, mean annual runoff increased in the order of wood shavings, poultry manure, cow dung + poultry manure mixture, cow dung, commercial fertiliser and bare fallow. Average yield of maize was highest in the cow dung treatment, followed by wood shavings, poultry manure, cow dung + poultry manure mixture, and commercial fertilizer.

In Ghana, wood shavings (normally burned as waste materials) and poultry manure could be better used in erosion control and soil fertility maintenance. In the hot savanna region, straw mulch improves the effectiveness of manures in minimising erosion and increasing crop yields. Therefore, a combination of manure and straw mulching may have a promising future in soil management for the dry and humid tropics. During the dry season, however, termites generally attack the straw mulch, so mulch and manure must be applied every year. Cow dung has the greatest soil-conserving potential in the forest soil, although its effect is not very different from that of the other organic residues.

### Improved fallow systems

Singh R, Helgaker K & Holden ST. 1987. **Improved fallow systems**. In: Africaland – Land development and management of acid soils in Africa II, IBSRAM Proceedings 7, Bangkok, pp 133-47.
The paper summarises the results of multidisciplinary research on soils, agronomy and agroforestry carried out by the Soil Productivity Research Programme of Zambia in 1982-86. The high rainfall areas are characterised by unimodal rainfall from mid-November to April. Average annual rainfall is about 1200 mm. The dominant soil types are Ultisols and Oxisols. The basic aim of the research was to study soil acidity and its amelioration, phosphorus and organic matter management, as these factors had been identified as the most limiting ones in soil fertility management.

When maize was grown on Kasama sandy loam soil using fertiliser and lime together with residues applied through mulch and compost, no response to liming was found, but the mulch/compost/fertiliser interaction was found to be significant. Soil analysis after maize harvest showed that crop residues applied through mulch and compost had an effect similar to liming in decreasing $Al^{3+}$ saturation.

Sanchez PA & Benites JR. 1987. **Low-input cropping for acid soils of the humid tropics: a transition technology between shifting and continuous cultivation**. In: Africaland – Land development and management of acid soils in Africa II, IBSRAM Proceedings 7, Bangkok, pp 85-106. TropSoils, Box 7113, North Carolina State University, Raleigh, NC 27695-7113, USA.
A low-input cropping system was developed in Yurimaguas, Peru, on an Ultisol. Its principal components are: i) traditional slash-and-burn clearing of forest fallow; ii) selection of acid-tolerant cultivars capable of high yields without liming; iii) rotation of upland rice and cowpea cultivars (no tillage) and removing only the grain: about 30% of the P, half the N and more than 89% of K, Ca and Mg are recycled through the soil via crop residues; iv) no fertilisers, lime or organic inputs are brought in: soil pH remains at about 4.5; v) purchased chemical inputs (herbicides and pesticides) constitute less than 10% of production costs; vi) continuous rotation for 3 years, but increasing weed pressure and decreases in available P and K cause the system to collapse in agronomic and economic terms; vii) growing a kudzu (*Pueraria phaseoloides*) fallow for one year smothers weeds, the kudzu is slashed and burned, and a second crop cycle can start; viii) other alternatives at that point are shifting to intensively fertilised continuous cropping, grass-legume pastures, or agroforestry.
These results contrasted sharply with local intensive cropping systems of which crop yields approached zero without fertilisation or liming within one year.

### Food legumes vs chemical fertilizers

Suwanarit A, Suwannarat C & Chotechaungmairat S. 1984. **Effects of long-term applications of chemical fertilizers and cropping systems on productivity of a reddish**

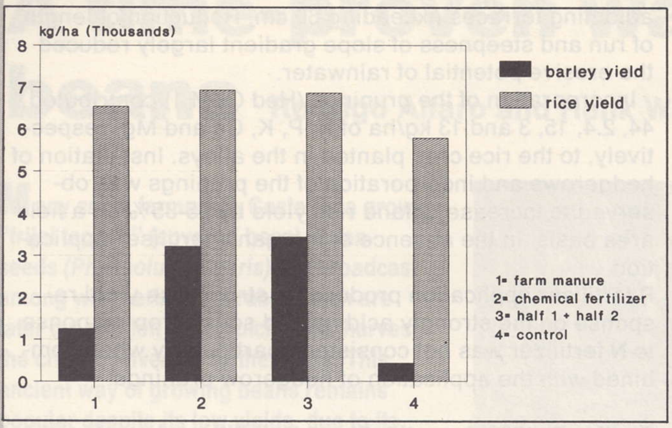



**Table 1. Effect of organic manure combined with chemical fertilizer.**

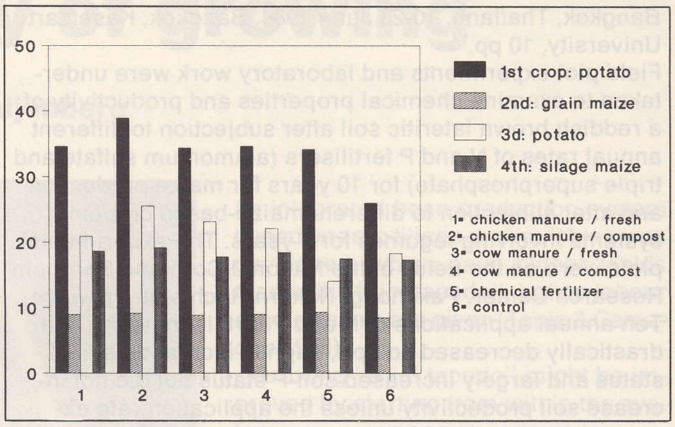



**Table 2. Yields obtained with different manures and fertilizer in Pairumani, 1980-1982.**

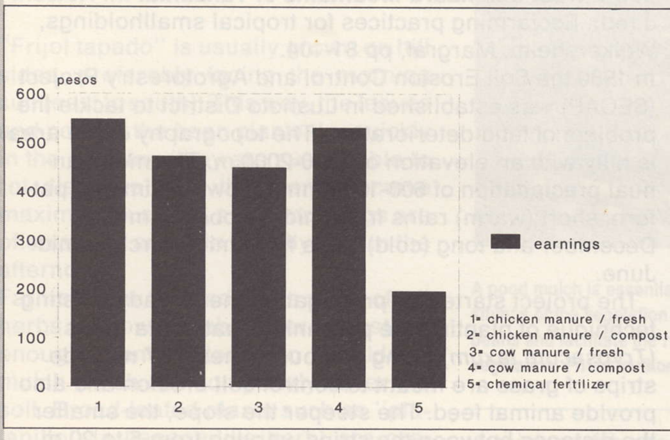



**Table 3. Earnings obtained with the application of different manures and fertilizer in Pairumani.**

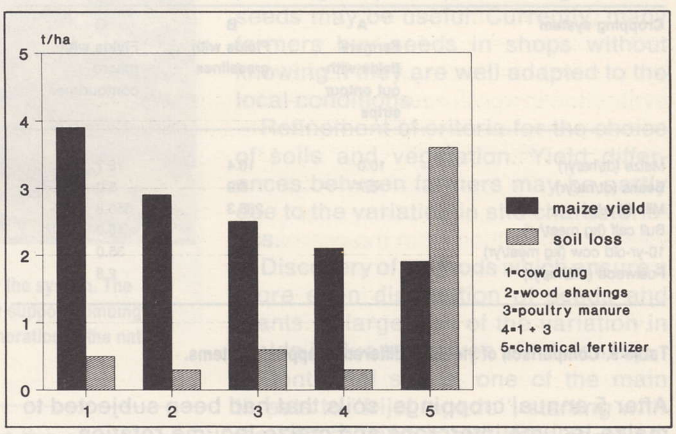



**Table 4. Average grain yield and soil loss at Kwadaso.**

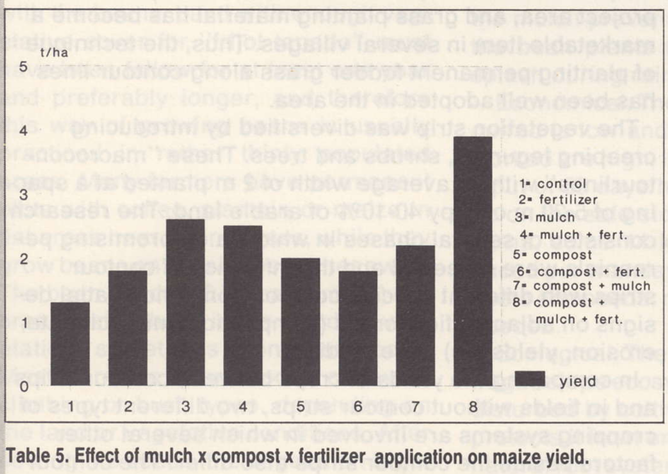



**Table 5. Effect of mulch x compost x fertilizer application on maize yield.**

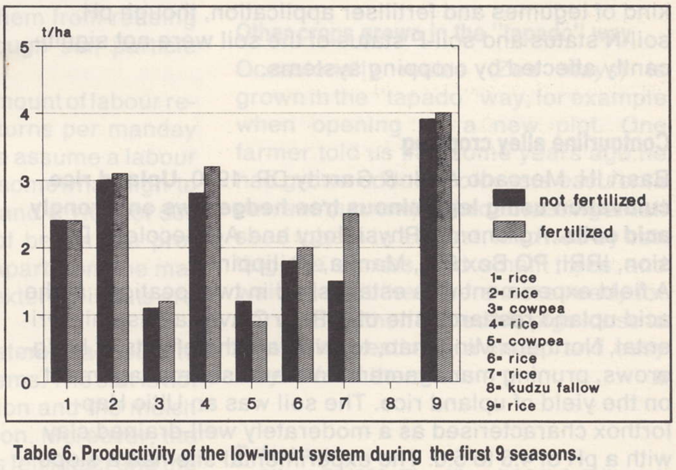



**Table 6. Productivity of the low-input system during the first 9 seasons.**

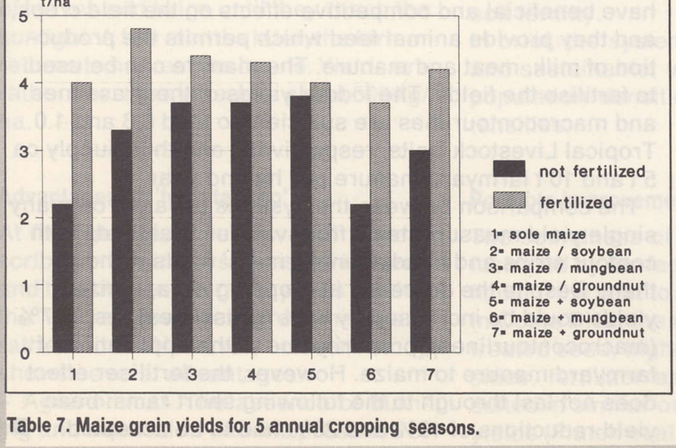



**Table 7. Maize grain yields for 5 annual cropping seasons.**

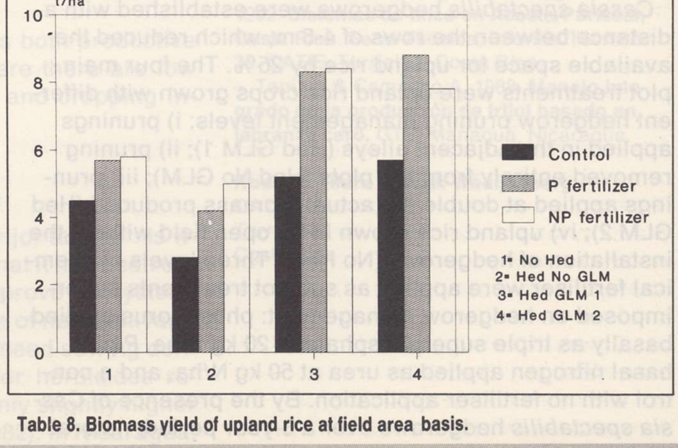



**Table 8. Biomass yield of upland rice at field area basis.**

**brown lateritic soil.** Fifth ASEAN Soil Conference, Bangkok, Thailand, 10-23 June 1984. Bangkok, Kasetsart University, 10 pp.

Field plot experiments and laboratory work were undertaken to examine chemical properties and productivity of a reddish brown lateritic soil after subjection to different annual rates of N and P fertilisers (ammonium sulfate and triple superphosphate) for 10 years for maize production and after subjection to different maize-based cropping systems involving legumes for 5 years. The experimental plots were on the fields of the National Corn and Sorghum Research Center, Pakchong, Nakorn Rachisma Province. Ten annual applications of N and P fertilisers to the soil drastically decreased soil pH, slightly increased soil-N status and largely increased soil-P status but did not increase soil productivity unless the application rate exceeded 90-90 kg N-P2O5/ha/yr.

| Cropping system | A<br>Farmers' fields without ontour strips | B<br>Fields with grasslines | C<br>Fields with macro-contourlines |
|---|---|---|---|
| Maize (dt/ha/yr) | 10.0 | 16.4 | 18.7 |
| Beans (dt/ha/yr) | 6.7 | 5.9 | 5.0 |
| Milk (l/ha/yr) | | 288.3 | 355.8 |
| Bull calf (kg meat/yr) | | 15.0 | 15.0 |
| 10-yr-old cow (kg meat/yr) | | 35.0 | 35.0 |
| Fuelwood (m3/ha/yr) | | | 2.8 |

**Table 9. Comparison of yields of different cropping systems.**

After 5 annual croppings, soils that had been subjected to maize-legume intercrops and maize-legume rotation were either as productive as or more productive than soil that had been subjected to constant maize, depending on kind of legumes and fertiliser application, though pH, soil-N status and soil-P status of the soil were not significantly affected by cropping systems.

## Contourline alley cropping

Basri IH, Mercado ARJr & Garrity DP. 1990. **Upland rice cultivation using leguminous tree hedgerows on strongly acid soils.** Agronomy, Physiology and Agroecology Division, IRRI, PO Box 933, Manila, Philippines.

A field experiment was established in two locations at the acid upland research site of IRRI in Claveria Misamis Oriental, Northern Mindanao, to evaluate the effects of hedgerows, pruning management and fertiliser management on the yield of upland rice. The soil was an Ultic Haplorthox characterised as a moderately well-drained clay with a pH of 4.6 to 5.0. The experimental site had a slope ranging from 25-30%. Rainfall in 1989 was 1830 mm in the period May-October.

*Cassia spectabilis* hedgerows were established with a distance between the rows of 4-5 m, which reduced the available space for upland rice by 25%. The four main plot treatments were upland rice crops grown with different hedgerow pruning management levels: i) prunings applied in the adjacent alleys (Hed GLM 1); ii) pruning removed entirely from the plots (Hed No GLM); iii) prunings applied at double the actual biomass produced (Hed GLM 2); iv) upland rice grown in an open field without the installation of hedgerows (No Hed). Three levels of chemical fertiliser were applied as subplot treatments superimposed on hedgerow management: phosphorus applied basally as triple superphosphate at 20 kg P/ha, P plus basal nitrogen applied as urea at 50 kg N/ha, and a control with no fertiliser application. By the presence of *Cassia spectabilis* hedgerows over a 3-year period, natural terraces were formed with elevation differences between adjoining terraces exceeding 60 cm. Reduction of length of run and steepness of slope gradient largely reduced the erosive potential of rainwater.

Incorporation of the prunings (Hed GLM 1) contributed 44, 2.4, 15, 3 and 13 kg/ha of N, P, K, Ca and Mg, respectively, to the rice crop planted in the alleys. Installation of hedgerows and incorporation of the prunings was observed to increase upland rice yield by 25-35% on a field area basis, in the absence of inorganic fertiliser application.

P fertiliser application produced a strong rice yield response on the strongly acid upland soils. Crop response to N fertilizer was not consistent, particularly when combined with the application of hedgerow prunings.

Pfeiffer R. 1990. **Investigating possibilities of combining fodder production with erosion control and agroforestry in the West Usambara Mountains of Tanzania.** In: Kotschi J (ed), Ecofarming practices for tropical smallholdings, Weikersheim, Margraf, pp 81-104.

In 1980 the Soil Erosion Control and Agroforestry Project (SECAP) was established in Lushoto District to tackle the problem of land deterioration. The topography of the area is hilly with an elevation of 1280-2000 m. The mean annual precipitation of 600-1200 mm follows a bimodal pattern: short (warm) rains from mid-October to mid-December and long (cold) rains from mid-March to mid-June.

The project started by propagating the already existing technique of planting the perennial Guatemala grass (*Trypsacum laxum*) along contours. These 0.7 m. wide strips of grass are meant to control soil erosion and also provide animal feed. The steeper the slope, the smaller the distance between the strips, varying from 5 to 20 m. The strips thus occupy 14-4% of arable land. More than 1200 km of these strips have been established in the project area, and grass planting material has become a marketable item in several villages. Thus, the technique of planting permanent fodder grass along contour lines has been well adopted in the area.

The vegetation strip was diversified by introducing creeping legumes, shrubs and trees. These "macrocontourlines" with an average width of 2 m planted at a spacing of 5-20 m occupy 40-10% of arable land. The research consisted of several phases in which, a.o., promising perennials were screened and the influence of contour strips with different species compositions and spatial designs on adjacent field crops (competition, microclimate, erosion, yields etc) were studied.

In comparing the yields of crops between contour strips and in fields without contour strips, two different types of cropping systems are involved in which several other factors beside the contour strips also differ. The contour strips not only reduce the cropping area by an average 18% (grasslines) or 25% (macrocontourlines). They also have beneficial and competitive effects on the field crops, and they provide animal feed which permits the production of milk, meat and manure. The manure can be used to fertilise the fields. The fodder yields of the grasslines and macrocontourlines are sufficient to feed 0.3 and 1.0 Tropical Livestock Units, respectively, and thus supply ca 5 t and 10 t farmyard manure per ha and year.

The comparison between the systems is based on many single yield measurements from various trial fields with contour strips and in adjacent farmers' fields without them. Despite the decrease in cropping area, maize yields could be increased by 64% (grasslines) resp. 87% (macrocontourlines), primarily due to the application of farmyard manure to maize. However, the fertiliser effect does not last through to the following short rains: bean yield reductions of 18% and 25% had to be accepted. ■

# A time-proven way of growing beans

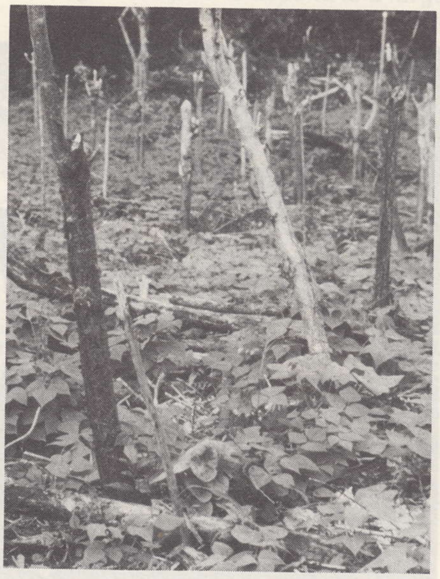
Rodrigo Alfaro and Henk Waaijenberg

**Many small farmers in Costa Rica grow "frijol tapado" (covered bean). Bean seeds *(Phaseolus vulgaris)* are broadcast among wild herbs or shrubs, which are later cut and left as a mulch. Until harvest, the crop receives no further work. This ancient way of growing beans remains popular despite its low yields, due to its high labour productivity and ecological stability.**

"Frijol tapado" is usually grown on hill sides, preferably facing the morning sun (east to south). This way, the leaves and pods of the bean plants dry quickly in the morning (they are susceptible to rot diseases) and the plants receive maximum sunlight, since mornings are often sunny and rain usually falls in the afternoon.

Farmers look for land with a cover of tall herbs or low shrubs; there must be enough plant material to provide a mulch which can completely cover the soil. Broad-leafed plants such as "platanillo" (a banana-like herb) are preferred. Grasses are avoided since they regrow quickly and compete strongly with the beans. Land with enough vegetative cover for "frijol tapado" must have been fallow for at least one year and preferably longer, and therefore this way of growing beans is usually practiced in rather thinly populated areas. Many farmers have permanent plots with coffee, plantain or maize in flat areas near their houses, while they grow beans on hill slopes further away.

The bean seeds (40 kg/ha or more) are broadcast by hand in the standing vegetation, sometimes along cut tracks. Most farmers plant local cultivars, climbing or bush types, depending on the land or vegetative conditions. After sowing the seeds, the vegetation is cut and left as a mulch. After germination, the bean plants grow through the layers of leaves and twigs until they reach the sunlight. A few months later, the farmer returns to harvest the beans. Yields are rather low: the average is about 500 kg/ha.



A good mulch is essential for the system. The stumps of the vegetation may support climbing beans and facilitate the regeneration of the natural vegetation. Photo: authors.

## Advantages of "frijol tapado"

At first glance, it seems as if the described cropping system is "primitive" and has little to offer: the yields per ha, the "sacred cows" of agronomists, are rather low. However, closer study shows several advantages.

– Agronomical. The absence of burning and cultivation and the presence of a thick mulch prevent the germination and growth of weeds. The fallow period reduces the pathogens in the soil, and the mulch prevents them from reading the bean plants through soil particle splash during rains.

– Economical. The amount of labour required is low and returns per manday worked are high; if we assume a labour input of 35 days/ha (somewhat high to be on the safe side) and a yield of 500 kg/ha, some 14 kg of beans are produced per manday. Apart from the machete and seeds, no external inputs are needed.

– Ecological. The system is adapted to fragile slope ecosystems. The soil is not disturbed by cultivation and the mulch protects it from erosion. Moreover, the natural root system is left intact and the vegetation's fast regrowth further reduces the risk of erosion and restores soil fertility.

In brief, the system is both productive and sustainable, where there are low population densities and cropping intensities.

## Possible improvements

The soundness of "frijol tapado" is illustrated by the fact that it has been difficult in the past to improve the system. In Costa Rica, the use of new cultivars, treated seed, higher seed sowing densities, fertilizer and/or herbicides resulted in similar or only slightly higher yields (Platen et al 1982). In Nicaragua, an integrated bean production system based on zero tillage and mulching was developed, which gave higher yields than with "frijol tapado", but no labour requirements are given (Tapia & Camacho 1988).

Growing "frijol tapado" might be improved by starting from within the system:

– Local selection of the best bean plants (germplasm) and storage of their seeds may be useful. Currently, many farmers buy seeds in shops without knowing if they are well adapted to the local conditions.

– Refinement of criteria for the choice of soils and vegetation. Yield differences between farmers may be partly due to the variation in site characteristics.

– Discovery of methods which ensure a more even distribution of seeds and plants. A large part of the variation in yields is due to uneven plant density.

– Control of snails, one of the main threats to "frijol tapado", starting with the use of papaya leaf traps to determine their presence.

## Other crops grown in the "tapado" way

Occasionally maize (*Zea mays*) is grown in the "tapado" way, for example when opening up a new plot. One farmer told us that some years ago he had grown eddoe (*Colocasia esculenta var. antiquorum*) by broadcasting small seed tubers in a forest, followed by cutting the shrubs and small trees and waiting until the tubers were ready for harvest. He then turned his pigs loose to do the harvesting – a cheap and easy way to feed them. ■

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**Rodrigo Alfaro & Henk Waaijenberg**
CATIE
Turrialba
Costa Rica

# Evaluating technology performance in agroforestry

Sarah J. Scherr and Eva U. Muller

**To help develop suitable methodologies for technology monitoring and evaluation, ICRAF conducted in 1988/89 a worldwide state-of-the-art review of activities and methods currently employed by development projects involved in agroforestry. The article summarizes the results of the review and looks at methods of technology evaluation.**

**An agricultural extensionist discusses traditional agroforestry with farmers in central Kenya. Cropping includes potato, banana, citrus and indigenous trees. Photo: ICRAF/ A. Njenga.**

In general, technology performance evaluation in agroforestry includes the assessment of three different aspects of the technologies:

– the quantity and quality of products from technology components and of trade-offs resulting from the combined production of crops, trees and/or livestock.

– the quality of service functions of the technology, i.e. their effectiveness and efficiency. Such service functions may include soil fertility improvement, soil erosion control, provision of shade, aesthetic functions, marking of boundaries, fencing, improvement of microclimate, windbreaks, weed suppression, or live staking for climbing plants.

– socioeconomic costs and benefits of the technology (input/output relations, opportunity costs, risk, tenure effects, division of labour, etc).

The three aspects of technology performance need to be evaluated from the point of view of biological, as well as socioeconomic sustainability. Evaluation of the latter emphasizes the perspective of the farmer, taking into account their own assessment of technology performance in relation to other alternatives available to them.

## Evaluating agroforestry is complicated

The nature of agroforestry, i.e. the combination of several different components and multiple objectives, complicates monitoring and evaluation of technologies in a number of ways:

- Multiple products from different components require production trade-offs which may not be easy to evaluate.
- A wide variation in management practices exists, especially for trees. In addition, management objectives may change over time to favour certain products or services over others.
- A general lack of scientific information about multi-purpose trees, seed provenances and genetic variability introduces additional sources of error and levels of uncertainty when evaluating agroforestry technologies.
- Due to the introduction of a tree component, agroforestry is a long-term undertaking. As a result, conclusive results from technology evaluation may often be obtained only after several years. In addition, the tree component may have to be evaluated differently in juvenile and mature stages.
- Some of the service functions of agroforestry are difficult to assess, for example microclimatic changes, windbreak effects or soil fertility changes. External factors may introduce additional sources of error and changes may only occur after many years.
- In subsistence farming, inputs and outputs often have non-monetary values, which complicates the assessment of economic costs and benefits.
- The mechanisms for interactions between the different components, especially crops and trees, are currently poorly understood. For this reason, observations may be misinterpreted and inaccurately evaluated.

## Variables assessed

The potential problems related to evaluating agroforestry technologies are reflected in the types of information collected through the reviewed projects. In summary, it seems that technology evaluation is mostly limited to biological aspects and to indicators that are conventionally assessed in agriculture and forestry research. Those aspects of the technologies that are more specific to agroforestry, like for example tree/crop functions, were evaluated by relatively few projects. This may in part be due to the fact that assessment of these is not as straightforward as, for example, counting tree survival.

Service functions can in most cases only be evaluated through indirect and often subjective indicators, and relationships may not always be clear because of other intervening factors. There are currently no easy methods available to projects to assess the performance of most agroforestry-specific indicators.

In addition, there seemed to be a general bias toward emphasizing the tree component. While the majority (73%) of the projects that reported technology evaluation were monitoring MPT (Multiple-Purpose Trees) performance, crop or livestock components were mentioned by relatively few projects (29% and 6% respectively).

## Methods used

An overview of methods employed by reviewed projects and their frequency is provided in Table 1. It should be noted that most projects used a combination of different methods. The relatively large number of projects involved in technology field testing indicates the demand for more site specific, technical information in agroforestry, which is currently lacking. It is notable that 40% of the development and extension projects which reported technology evaluation activities are actually involved in field testing of new technologies. In many cases it was difficult to determine the exact types of technology testing because project information was not conclusive in this respect. Often, a clear understanding of the objectives, requirements and design criteria for different technology testing methods seemed to be lacking. The relatively low frequency of farmer surveys, field days and meetings suggests that the farmers' perspective on technology performance was not given high priority by many projects.

### Priority variables

Priority variables to be assessed in technology evaluation will change as technologies mature, but generally include biological, as well as socioeconomic variables. Important biological indicators of technology performance for use by extension projects might include tree survival, growth characteristics and condition of crops, trees and livestock; and yields of these components. Important socioeconomic parameters might include the assessment of farmer preferences for species and technologies, economic yields, changes in risk and access to resources and quality of the human environment. It is not necessary to monitor all the variables. Projects may select a few priority variables according to objectives and available resources. Service functions of agroforestry technologies are often difficult to assess directly and the use of indirect indicators is recommended.

**Table 1: Methods used for technology evaluation by 92 projects**

| Method | No | % |
|---|---|---|
| Formal farmer surveys | 12 | 13% |
| Informal farmer surveys | 5 | 5% |
| Informal field surveys | 17 | 18% |
| Informal field surveys and observational methods | 20 | 22% |
| Combined farmer and field surveys | 13 | 14% |
| Farmer meetings/field days | 14 | 15% |
| On-farm or demonstration plot monitoring | 25 | 27% |
| On-farm experiments or technology trials | 23 | 25% |
| Experiments or technology trials on research plots | 24 | 26% |

### Selection of methods

The types of methods to be used for evaluating agroforestry technologies for a given objective depend to a large extent on the level of resources available to the project. Resources which determine the level of evaluation activities include the number and skill level of field staff and access to expertise, either within the project, or from external sources such as research centres or expert consultants. Where staff time is a constraint, technology evaluation should be integrated as much as possible with extension activities. For example, a simple format may be provided to extension workers to routinely record observations on technology performance during extension visits to farms (Carlson 1989). Table 2 indicates the relative appropriateness of technology evaluation methods for different project resource levels.

### Future needs and priorities

Collaborative or collegial relationship between farmers and extension staff for technology evaluation in agroforestry projects requires specific kinds of staff skills. Extension workers need to be trained in effective communication with farmers, interviewing and group discussion techniques and observational and measurement skills. The general project approach needs to emphasize learning from farmers. Monitoring and evaluation activities can thus become a learning experience for extension workers, increasing their awareness and technical knowledge and ultimately helping them to be more effective in their extension work.

On the other hand, the review of technology monitoring and evaluation by projects has shown a lack of available methods for evaluating variables that are specific to agroforestry, particularly the effectiveness and quality of service functions. It is therefore suggested that projects and researchers work much more closely together in agroforestry research and development. Projects can play valuable roles in generating hypotheses to be tested by researchers and also in identifying needed methods which can be developed through research.

But in order for the potential of this approach for technology development to be achieved, national ministries, donors and project managers will need to support, encourage and direct resources to technology monitoring and evaluation activities. This may require a fundamental shift of thinking about the role of extension in agroforestry development. ■


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**Sara J. Scherr**
1915 Imperial Avenue
Davis, CA 95616
USA


**Table 2:** Appropriateness of technology evaluation methods for different project resource levels (l = most appropriate; 2 = appropriate for projects at the higher end of scale; 3 = less appropriate)

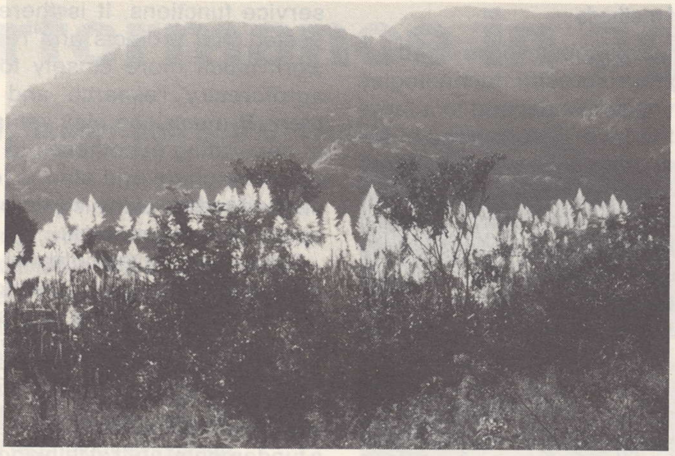
| Method | Resource constraints | | Staff skills | | Access to expertise | |
|---|---|---|---|---|---|---|
| | More | Less | Primary school or below | Secondary school or above | No | Yes |
| Informal farmer surveys | 1 | 1 | 2 | 1 | 1 | 1 |
| Formal farmer surveys | 3 | 1 | 2 | 1 | 2 | 1 |
| Farmer meetings/field visits | 1 | 1 | 1 | 1 | 1 | 1 |
| Informal field surveys | 1 | 1 | 2 | 1 | 1 | 1 |
| Formal field surveys | 3 | 2 | 2 | 1 | 2 | 1 |
| On-farm plot | 2 | 1 | 2 | 1 | 1 | 1 |

# Message from the

## The Kogi and

**The Kogi are the people living in communi**
**mountain jungle of Colombia. After centuries o**
**that the time has come to speak to us. They ca**
**race, and are convinced that the ignorance an**
**destroy the balance of life on Earth in the next**
**spiritual men. They believe that the only way i**
**set out to teach us what they know about the b**
**spiritual world. To send the message, Alan Er**
**is also described in a book: The heart of the w**

1



''In the beginning, there was blackness. Only the sea. In the beginning there was no sun, no moon, no people. In the beginning there were no animals, no plants. Only the sea. The sea was the Mother. The Mother was not people, she was not anything. Nothing at all. She was when she was, darkly. She was memory and potential. She was aluna. She was mind.'' 1

2

''When Columbus came, they took all our sacred things and they're still doing it to this day. We lost our sacred things. They took our soul. They took everything. The Mama says: I stayed without gold, I remained without anything, but with thought strong, profound, still esteemed. A system. Let us keep these customs. Keep the tradition. Let us keep it'. We respect the Mother Earth.'' 2

3

''The Mother told us that we should always be in agreement with women, that we should treat women well, because it was women, the Mama, who gave us all things... At first the Mama gave advice to men. She lectured them. That's why when women talk to us we have to look down at their feet. We shouldn't look at the Mama's face.''3

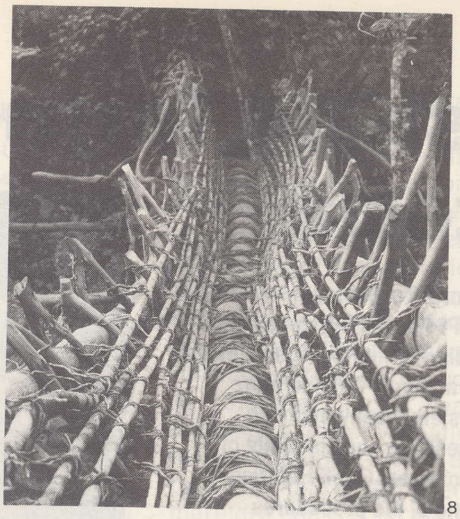
4

The Mamas would talk all night to discuss whether making a film was a truthful way of sending the message. In the morning they would go to the mountain top and divine. They decided to speak. ''We are the Elder Brothers. We have not forgotten the old ways. How could I say that I do not know how to dance? But now they are killing the Mother. The Younger Brother, all he thinks about is plunder. He is cutting into her flesh. He is cutting into her arms. He is cutting off her breasts. He takes out her heart. He is killing the heart of the world.'' 4

# heart of the world

d Alan Ereira

**ities, high on an isolated mountain, in a dense of deliberate isolation, the Kogi have decided all themselves The Elder Brothers of the human d greed of us, The Younger Brothers, will few years. The Mamas are the wise and s for us to change our ways, and so they have balance between nature, mankind and the eira was invited to make a film. Their warning orld.**


8

The bridge was closed again. The objectives of the Foundation for Tairona Heritage is to help to stabilise the frontier between the indigenous people of the Sierra and the outside world. I hope that this frontier can become a point of cultural exchange, for they have much to teach us, the Younger Brothers, if we are prepared to listen. They do not want us to enter their territory. Their isolation must be respected.

The Tairona Heritage Trust, 90 Summerlee Avenue, London N2 9QH, UK □

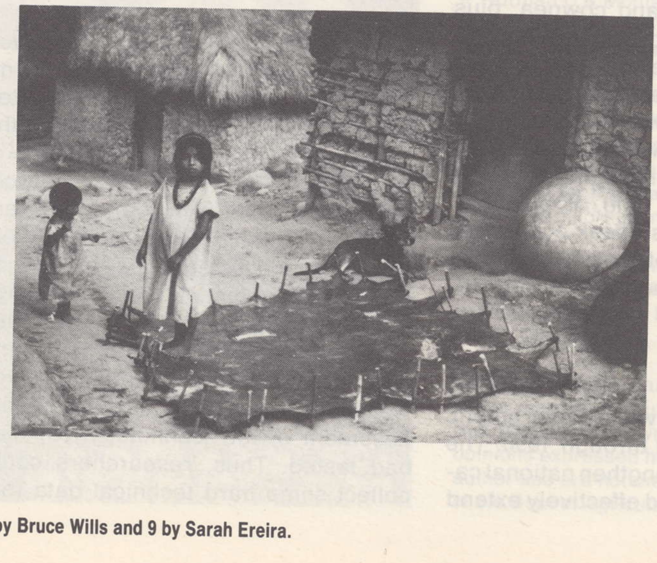

9


7

There had been many indications that the Kogi's fears were rooted in observed changes near the mountain peaks. This area is a great sponge. It holds the water of the snow-melt and the high rains. It is the fresh water supply of life below. But there was no water. The grass was dead. The earth was hard and dry, and covered in a mesh of fine cracks. "Younger Brother, stop doing it. You have already taken so much. We need water to live." 7


6

"The earth feels. They take out petrol, it feels the pain there. So the earth sends out sickness. There will be many medicines, drugs, but in the end the drugs will not be of any use. The Mamas say that this tale must be learnt by the Younger Brother. Father Serankua made this earth so that it would not end, so that we could all go on living here. Younger Brother, your water is drying up down below. Do not think that we are responsible, do not think that we have forgotten our work." 6


5

"I am an Older Brother. I look after the sun, I look after the mountains and the birds. I've done whatever I could, but before long I am probably going to die. I am suffering from a cough. Younger Brother could help me. He could save me. If all the Kogi die, do you, Younger Brother, think that you will also go on living?" 5

**Photos: 2,3,4,6,8 by Felicity Nock, 1 & 7 by Bill Broomfield, 5 by Bruce Wills and 9 by Sarah Ereira.**

Ereira, A. 1990 **The heart of the world**, Cape London 15.95 English Pounds

# Meshing farmer and researcher criteria

**The Agricultural Technology Improvement Project (ATIP) developed ways of including farmer perspectives in technology evaluation, but had more difficulty in systematically applying criteria to assess the sustainability of various technologies. Geoff Heinrich discusses some of the procedures developed and issues which arose.**

Geoff Heinrich

To assess the relative performance of technologies, researchers need measurable criteria. These have conventionally been variables such as productivity (kg/ha) or profit (return/ha). However, farmers have their own criteria for judging technologies: the "improved" technologies not only have to be better than ones they were using before, they also have to fit within the limits of the farmers' skills, resources, cultural values, tastes etc. Even if researchers could predict all the different criteria that farmers might apply to a specific technology, it would not be practical to measure all these variables. Instead, it is much easier to include farmers in the research process, let them make their own assessments and than tell researchers what they think. This is one reason why on-farm research with farmer participation is so important.

### The setting

Botswana is a large country with a relatively sparse population. Average annual rainfall in the cropping areas is ca 450 mm, the amount and distribution being very unpredictable both within and between years. Soils are generally shallow, somewhat sandy and low in fertility. The main crops are sorghum, millet, watermelon and cowpea, plus many other minor crops. Nationwide sorghum yields have averaged around 250 kg/ha over the last 30 years.

Like most areas where cropping is risky, farmers put few resources into arable farming and spread their risks by keeping smallstock and, if possible, cattle. They may also seek occasional wage labour and other ways of augmenting their income.

### The project approach

The ATIP project, jointly funded by USAID and the Botswana Government, operated from 1982 through 1990. The main aim was to strengthen national capacity to develop and effectively extend technologies to improve small-scale farming. The project, which started with a farming systems approach to research, fielded two interdisciplinary teams (working on-farm in two regions) and maintained a research-extension liaison office in the capital.

In monthly group meetings, farmers shared their observations with researchers and other farmers. Photo: David Norman.

The research programme in the Francistown Region eventually developed into a three-part system:

- a section where researchers controlled the agenda and either implemented or supervised the implementation of all experiments;
- a farmer participatory research section where farmers had a large degree of control over the research agenda and individual farmers implemented and managed their own trials; and
- a section for testing farmer participatory extension (see Heinrich et al 1990a for details).

The approach of Section 2 involved working with Research-Oriented Farmers Groups (ROFGs) of self-selected farmers. This provided a format for the joint design, testing and evaluation of technologies by farmer and researchers. In the ROFGs individual farmers selected technologies from a "basket" of options and tested them according to an agreed format. Monthly meetings were held with the farmers to discuss observations, progress and problems arising, and an end-of-season survey was made to quantify each farmers' assessment of the technology(ies) they had tested. Thus, researchers could collect some hard technical data (because of the standardised trial format) and farmer assessment was incorporated. To give an idea of the scale of the operation: in 1988-89 over 128 farmers in 3 groups implemented 140 valid trials including 8 technology options.

### Meshing farmer and researcher criteria

While technology assessment by farmers is vital to the process of developing extension recommendations, researchers often require very specific technical data to address other questions (e.g. ecological effects of technologies) or to provide information for other clients (e.g. station-based commodity researchers). To obtain these types of information, ATIP used a series of different trial formats: Researcher-Managed, Researcher-Implemented trials (RMRI), Researcher-Managed, Farmer-Implemented trials (RMFI) and Farmer-Managed, Farmer-Implemented trials (FMFI).

The mainly qualitative information provided by the FMFI trials (e.g. farmers' opinions) were sometime difficult for station-based researchers to appreciate, as they were used to dealing with technical, quantitative data. They could accept the qualitative data more easily when these were quantified, e.g. in a table showing that 76% of farmers who tested 3 cowpea varieties preferred variety A over B and C because of leaf quality. The end-of-season survey was the primary tool for quantifying farmer assessments.

### Farmers combine the components

In the project area, climatic variation between seasons was high and the community was very heterogeneous with respect to resources used for cropping. For example, for draught power, farmers used tractors, cattle or donkeys which were either owned, hired or shared in exchange for labour, making 9 possible traction categories. Rather than trying to develop technology packages for all farmers in all years, ATIP decided to develop technical options from which farmers could select according to their resources and the way the cropping season developed.

The ROFGs were primarily involved in testing components that could be combined into flexible packages. In the monthly group meetings, farmers shared their observations on these components with researchers and with the other farmers. A study on spontaneous technology adoption (Worman et al 1990b) indicated that many farmers had started combining the components into specific production packages which they were applying outside of the regular trial programme. This suggested that the farmers' views on technology options discussed in the ROFGs were useful to other farmers, and that presenting farmers with a "basket" of options could be an effective approach.

### Two types of sustainability

The "logistical sustainability" of a technology refers to whether a support system exists that will allow the technology to continue to function in an area. For example, using tractors would not be logistically sustainable, if the availability of fuel and spare parts is unreliable. "Environmental sustainability" refers to whether a technology degrades, improves or has no effect on the environment over time. For example, what effect does a certain tillage system have on soil erosion?

### Assessing logistical sustainability

Questions of logistical sustainability were handled mostly on a subjective basis, e.g. improved crop varieties were preferred to hybrids because the country clearly did not have the production capacity and marketing system to permit widespread use of hybrid seed. In some cases, problems were indicated by farm surveys, e.g. a plough condition survey (Koch & Matlho 1984) indicated that most ploughs were in disrepair and that farmers had difficulty in obtaining spare parts.

In general, the difficulty of the on-farm teams lay not in identifying problems of logistical sustainability but rather in addressing these problems. Ideally, on-farm teams would have links with national policy makers, but this was not the case in Botswana. Therefore, the teams chose to work with technologies that would fit the existing infrastructure and, later in the project, worked closely with extension and nongovernmental organisations (NGOs) in the region, mostly by holding coordinating meetings early in the season and conducting joint activities. For example, when farmers in a group in North East District identified lack of a supplies outlet as an obstacle to technology adoption, this was discussed in an annual meeting of research, extension and NGOs. An NGO in the region then decided to open a farm supplies store in the village where the group was operating.

### Assessing environmental sustainability

Although considerations of environmental sustainability were recognised as important, these were not a major focus of the research programme for two main reasons:

- studying environmental impact requires a long-term horizon. By the time ATIP started to focus on technology design and testing, only 3 years remained of the agreed project period. Later, the project was extended for 2 years and then one more year. The lack of a certain future for project activities inhibited initiation of long-term studies.
- the main focus was on tillage/planting systems. Virtually none of the new technologies involved chemical inputs. The main environmental concerns therefore centred on the effects of tillage on soil variables such as erosion level, soil bulk density, fertility and moisture infiltration. It was difficult to do all the careful monitoring needed without direct access to laboratory and other station facilities. The system that eventually developed included long-term on-farm RMRI trials (to ensure consistent treatments on specific plots over years) with basic monitoring of variables at farm level. The same trials were duplicated on or near the main research station, where detailed measurements of soil/water variables were made by station-based specialists.

Thus, both a clear, long-term research horizon and close collaboration between on-farm and on-station research teams is needed to study the environmental impacts of specific technologies. ■

**Women farmers were very clear on their criteria for technology assessment. Photo: David Norman.**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**Geoff M. Heinrich**, Farming Systems Advisor, Department of Agricultural Research, P.O. Box 10275Francistown, Botswana.

Note: The opinions expressed here are those of the author and are not meant to represent those of the Dept of Agricultural Research.

# Sustainability and entry points

Maha Yoo played an important role in the farmer-to-farmer extension of rice-fish culture which is the entry-point for the development of integrated farm systems.

Fruit trees become important elements in the integrated rice-fish farm. Photo: Media Center for Development.

**One change in a farm system that appears to lead to a large number of other beneficial changes and appears to enhance the evolution of the system, may be called an 'entry point'. Changes like this are usually made by farmers and are often unanticipated by researchers. Ken MacKay indicates how carefully chosen diversity may increase the sustainability of systems. Eventhough rice-fish culture in Northeast Thailand has recently become more difficult due to drought, the entry point concept may be an important methodological tool in assessing sustainability.**

**Ken MacKay**

What is important at a practical level is to determine indicators of sustainability of existing systems and to work with farmers to design new sustainable systems. One such indicator is systems diversity. One of the popular themes of ecosystem theory is the relationship between species diversity and system stability (Odum 1971; Woodwell and Smith 1969). In its simplest form, this theory suggested that simple systems with few species are less stable than more complex systems with a greater number of species. However, this theory has generated considerable arguments. The most recent consensus appears to be that increased diversity does not necessarily produce stability. It is, however, the connectances or linkages between species that are more important for system stability (Connell and Sousa 1983; King and Pimm 1983 and Margalef and Gutierrez 1983).

The relationship between stability and sustainability is much less tenuous, although Holling (1973) suggests the terms resistance and resilience both of which are properties of sustainability. Dover and Talbot (1987) give an excellent review of the ecological principles related to sustainability. They conclude that increasing diversity for its own sake will not necessarily improve sustainability. In fact poorly designed diversity may actually destabilize systems. They concur with the ecological consensus that it is the linkages between components that can increase sustainability. Agroecosystems will have to be carefully designed, considering ecosystem and community structure but also the characteristics of, and relationships among component populations including the humans that inhabit them.

### Entry points

Major changes to farming systems are seldom adopted, however, these systems can and do evolve. If you can not get there from here how do you get there? There are some examples in which a change in one component of a system leads to a large number of other changes which increase productivity and sustainability. These changes I call entry points: one change in the system appears to lead to a large number of other beneficial changes and enhance the evolution of the system. These changes are usually made by farmers and are often unanticipated by researchers. There are a number of examples where changing the resource base, for example terracing, water catchments or irrigation result in profound changes to the system. Irrigation is perhaps the clearest example in which a regular supply of water normally results in changes in cropping intensity, productivity, stability and probably sustainability (provided the water supply is renewable and salination does not occur).

### Rice-fish culture

There are other examples where the addition of only one component to a system results in considerable positive changes to the system. The introduction of fish into rice cultivation is an example in which increased diversity has increased productivity and sustainability (MacKay et al 1988). I will explore this system in more detail in search of more clues on entry points.

The integration of agriculture and aquaculture as practiced in the Chinese integrated pond systems has been shown to be highly productive and have a high ecological and energetic efficiency. Considerable effort has gone into trying to adapt this system to conditions in Southeast Asia. Attempts have been made to introduce it to Northeast Thailand with limited success. There appear to be considerable constraints related to the initial cash requirements, risk and operating capital and technical complexity. At the same time a much simpler farmer-to-farmer innovation of rice-fish culture has been spreading rapidly among poor farmers in Northeast Thailand with little or no research support or official extension.

**Farmer-to-farmer**

The practice of growing rice and fish together in one field at the same time is traditional in most of Asia. The practice decreased as the green revolution increased. The decrease in multiple cropping and increased use of agricultural chemicals were not conductive to the fish. However, in North-East Thailand rice-fish culture has expanded rapidly in the past ten years. This development is occurring spontaneously from farmer to farmer and it is only recently that government research and extension personnel have been involved. This expansion is occurring in the rainfed area among some of the poorest farmers. These farmers use very few pesticides in their rain fed rice production. A mixture of native and exotic fish species, usually common carp (*Cyprinus carpio*), tilapia (*Sarotherodon nilotica*), and silver barb (*Puntius gonionotus*) are stocked in the rice about ten days after transplanting. Usually a trench is dug in the field to offer a deeper refuge for the fish and make it easier to harvest them. The fish are harvested whenever needed but often after the rice harvest and some are maintained in small ponds during the dry season for food, sale and brood stock.

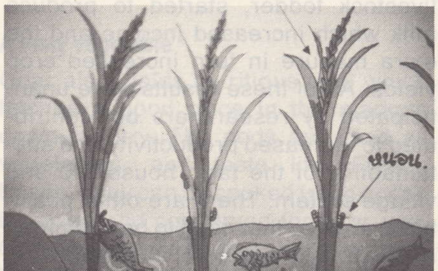
A list of the benefits from this system at the field, farm and community level based on data from NE Thailand is presented in Table 1. Somewhat similar results are now being shown for Indonesia under irrigated, high-input conditions (Fagi et al 1990). Research to explain many of the benefits of the fish introduction into the paddy system has started only recently and is summarized in dela Cruz (1990).

**Animal rearing (chicken, ducks, pigs) often increases after the family has settled on the farm. Photo: IIRR.**

**Evidence of benefits**

At the field level the rice-fish combination increases the yield of rice in spite of a reduction in rice planting area due to the trench. Production costs of rice are reduced as less fertilizer appears to be needed probably due to faster turnover of soil nutrients, particularly phosphorus. Consistent evidence is emerging from Thailand, Indonesia and China showing considerable weed, insect and disease control due to the fish although at least for weed control it may depend on the species involved. There is some good evidence form China that fish in rice paddies significantly reduce mosquito populations and incidence of malaria (Wu Neng et al 1989). There is some anecdotal evidence from NE Thailand that land preparation after rice-fish is easier than in adjacent fields which were rice only the previous season. Water management is improved in the rice-fish situation as farmers usually raise the dikes of paddies for fish and they inspect the fields more frequently (daily) than when rice only is grown. Thus any damage (eg. rat or crab holes) to dikes is repaired immediately. In fact the improved water management may account for many of the other benefits of rice-fish culture. More labour is required in rice-fish, primarily the initial investment of raising the dikes and trench preparation, but also for maintenance, daily inspection and harvesting. However, there is no conflict with peek labour demands for other activities and farmers and their children view the daily inspection as recreation. There may be a decrease in native fish production in the paddies. These fish are usually considered as more highly desired species although yields are lower (Fujisaka and Vejpas 1989). In fact some farmers have stopped stocking some fields for rice-fish and preserve them for native fish production (J. Sollows, personal communications).

**Consistent evidence is emerging from Thailand, Indonesia and China showing considerable weed, insect and disease control. Drawing: Media Center for Development.**



**More food and income**

Thus at the field level there are considerable impacts of the introduction of fish into rice culture. Rice-fish is therefore being promoted as an entry point for Integrated Pest Management (Waibel 1990) and in Indonesia as means of decreasing phosphorous fertilizer use (Fagi et al. 1990). It is, however, at the farm and village levels where impacts of rice-fish can be seen.

At the farm level the increased income from the rice and fish is probably reflected in higher household incomes but the economic studies only examined agricultural income not total household income. Family nutrition and has probably increased although there have been no targeted nutritional studies. The families consumed about 1/3 of the fish produced (MacKay et al 1988) and women interviewed indicated that fish consumption was greater when fish were raised. This was particularly during times of peak labour demand (transplanting and harvest) to feed the family and additional labourers, and during the dry season. Some farmers would even stock fish prior to transplanting so they would have some fish during this period (Field notes, K.T. MacKay and J. Sollows personal communications).

The labour pattern at the farm level is also interesting as some farmers have claimed that the increased labour of rice-fish is more than compensated for by decreased labour searching for and catching wild fish although Fujisaka and Vejpas (1989) indicate there is very little labour involved in this activity. Thus rice-fish may result in a total saving of labour for the household.

### Integrated farm system

Of major interest for our discussion of entry points is the increase in integrated farming. This involves an increase of vegetable, fruit tree, and animal production on the farm. In many areas of NE Thailand the families live in a central village and travel to the farm. These nuclear villages were an important part of the anti-insurgency campaign of the 1970's and early 1980's. There is often a field shed on the farm which the family uses during the wet season particularly at rice harvest but during the dry season the farm is not inhabited and seldom visited. When fish are kept during the dry season in ponds someone has to spend time protecting them from theft. When the farm wife and children visit the farm more often this may lead to planting of fruit and vegetables which are irrigated with pond water. Increased animal rearing (chickens, ducks and pigs) follows, the field hut is fixed up as the family spends more time on the farm during the dry season. In some villages in Roi-et province most of the farmers have moved from the central village to their farms and are now involved in year round integrated agriculture. Seasonal out migration of the males seems to have also decreased. In other villages farmers are specializing in various fish rearing activities. Some are producing fingerlings for sale, other with ponds and enough water are moving to pond culture during the dry season including supplementary feeding.

Thus the changes at the household level have in turn had dramatic effects on the socioeconomics of the village. In addition there are also socio-political effects as in some cases the village leaders fearing loss of their traditional authority have opposed rice-fish culture and the result, migration to the farms. As a result of the above experiences the integration of aquaculture and agriculture is now being promoted as a route to sustainable farming systems (Lightfoot, 1990).

### Carefully chosen diversity

The important question, however, is whether the increase in sustainability of the field, farm and village system due to the addition of fish in to the paddy is a unique event or whether it is an example of more general application. I would argue the second case that it is an example of how carefully chosen diversity can contribute to the evolution of the system to a more productive and sustainable level. There are some other examples but very few have been described from the entry point perspective. One example is the development of an agroforestry project in Kenya (Chambers et al 1989). The objectives were to extend an alley cropping package for soil fertility improvement and staff were unsuccessful in obtaining farmer adoption until they changed their approach and emphasized "bottom-up" participation. The farmers adopted the nitrogen fixing trees for livestock fodder, started to produce milk which increased income and the extra manure in turn increased crop yields. All of these results were unanticipated by researchers but contributed to increased productivity and sustainability of the farm household and village system. There are other possible examples that need to be examined in detail. The spread of nitrogen fixing trees in Eastern Indonesia which resulted in the complete change in cattle rearing from open range to housed cut and carry systems is another example. One system that may need the entry point concept is the adoption of contoured rows of trees for soil erosion control. However, there are still problems of adoption of these systems and the evolutionary process has to be examined in more detail (Fujisaka, 1989). ■

**Changes in rice system after fish introduction** — In the end: less labour costs

| Field | | Farm | | Village | |
|---|---|---|---|---|---|
| Rice yield (1-3 t/ha) 10% | i | Income | i | Migration outside | d |
| Fertilizer esp. phosphate | d | Nutrition | i | | |
| Insect control | i | Labour | d? | Migration inside | i |
| Weed control | i? | Integrated farming | i | | |
| Disease control | i? | | | Political concern (subversive technology) | i |
| Water control | i | | | | |
| Labour | i | | | | |
| Land prep | d | | | | |
| Fish yields (50-100 kg/ha) | i | | | | |
| Native fish | d | | | | |

i = increase d = decrease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Slide serie on the integrated farm of Mäha Yoo Sunthornthai. More information: Media Center for Development, 19/6 Soi Aree 4 (North), Phaholyothin Rd., Samsennai, Phayathai, Bangkok 10400, Thailand.


**Ken T. MacKay**
International Center for Living Aquatic Resources Management (ICLARM)
MC P.O. Box 1501
Makati, Metro Manilla 1299
Philippines

# Guar – good prospects in the monsoon belt

Gerhard Dillenberger

**The Integrated Rural Development Programme (IRDP) Mardan offers support to communities in the Mardan area in the North West Frontier Province of Pakistan. In seeking ways to make the already hard-pressed farmland more productive without further aggravating the fragile ecology, IRDP has come upon a plant which could greatly change rainfed farming.**

Cutting of Guar during a field day. Local Pathan farmers and extensions staff virtually knew nothing about the crop. The crop was introduced into an area where it was not common before. Photo: Gerhard Dillenberger.

A multipurpose plant which could ideally supplement local farming systems is guar (*Cyamopsis tetragonoloba* (L.)), also known as cluster bean. This erect annual herb, which reaches a height of 1-2 m when mature, is not at all new to the Indian subcontinent; in fact, it originates from there. Guar growing is quite common in the Punjab and Sind, but it had never been grown as far north as Mardan. The local Pathan farmers and extension staff knew little, if anything, about the crop. Only a few people who had gone to work temporarily down-country were aware that guar was eaten there as a vegetable.

Guar grows from July to September and thrives on the monsoon rains. During that period, precipitation in the rainfed areas of Mardan normally ranges from 350 to 700 mm, which is sufficient for the crop to mature. In any case, as guar is a hardy plant – no major disease or pest has yet been reported – and very drought resistant, failure is very unlikely.

### A nutritious forage

Since it is common practice in the area to fallow the rainfed land during the monsoon, growing guar does not compete with other crops; it simply replaces the fallow. Its hairy, nettly leaves protect it to some degree from being browsed by free-grazing livestock. Camels accept guar in both fresh and wilted state as fodder, but other ruminants prefer it as hay. Guar hay is rich in protein, in which the common animal diet (wheat straw, maize stalks, range grasses) is highly deficient. Dry guar can be kept for months and can be fed to animals when fresh fodder is not available on the rainfed farm, e.g. during May and June.

Growing fodder on rainfed land not only results in more productive and healthier livestock but also has important ecological benefits. A gradual adoption of stall-feeding could give the badly degraded vegetation in the hilly areas a better chance to recover. In this forest pasture, which makes up about one third (ca 25 000 ha) of the IRDP project area, trees and shrubs for fuel and palatable herbs and grasses for fodder have become scarce because of deliberate cutting and grazing. Attempts to rescue the hills will gain support not only from growing fodder on arable land but also from integrating trees and shrubs into the farming system so that more fuelwood can be grown on the farms.

### A tasty vegetable

Guar also yields nutritious food which fetches a good price in the markets down-country. The pods are used as vegetables, and taste like French beans. They can be cooked fresh or can be dried and conserved for later use. Growing guar can thus help improve the nutritional status of the local people.

In addition, producing guar grain as a cash crop may be of future interest to the local farmers. Guar seed contains a gum (mannogalactan) which is of commercial and industrial importance and for which there is a world market.

### A soil ameliorator

A very important fringe benefit in guar growing is its nitrogen-fixing ability. Guar is self-sufficient in nitrogen and, despite its short-season character (80-110 days), a crop of guar can considerably reduce expenditures on nitrogen fertiliser for the subsequent crop, e.g. wheat or mustard. The organic matter content of the soil also benefits from including guar in the rotation. Moreover, by providing groundcover during the usually high-intensity monsoon rains, guar also helps control erosion.

### Finding the best fit

In the 1988 monsoon season, IRDP introduced guar in four locations in the project area on an experimental basis. The results were encouraging. The next year, the crop was demonstrated in 15 project villages on 2-ha plots. In 1990 the awareness and readiness was such that IRDP could bring in 6000 kg of seed from Punjab, sufficient to expand guar to some 200 ha involving about 500 farmers.

The project and the farmers are now trying to find how best to fit the crop into the farming system. Ways must be found of resolving the conflict of guar growing with the practice of letting livestock graze freely during the monsoon. Many farmers are reluctant to invest labour in stall-feeding the – until now – low-producing animals. The extension staff is therefore initially stressing the use of guar as a vegetable. The soil improvement aspect is taken up during the following cropping season. The best timing for cutting the crop as fodder must still be found. If it is over-mature when harvested, then it has to be chopped before it can be fed. However, some farmers use the dry, over-mature guar stalks as fuel.

Guar appears to have considerable potential for farming in the monsoon belt of North West Pakistan. The crop fits well into the existing rotational niche during the monsoon, and its widespread cultivation would result in a substantial increase in cropping intensity in the rainfed areas. Guar has a multitude of beneficial uses, e.g. fodder, vegetable, grain and soil improvement. IRDP does not regard it a miracle crop but rather as a chance for a change toward more sustainable agriculture. ■

**Gerhard Dillenberger**
c/o Wakuti,
P.O. Box 422,
Quetta
Pakistan

# Plenty of scope for NGO-GO partnership

Cropping on contour strips with Leucaena and other species interspersed with annual and perennial crops. The South Mindanao Baptists Rural Life Centre is a NGO in the Philippines which has more than 15 years experience in designing technology and management practices for sloping agriculture lands (rainfed). Photo: John Farrington.

**Recent donor interest in nongovernmental organisations (NGOs) could have negative effects by overstretching their capacities. John Farrington describes how the Overseas Development Institute (ODI) is working with agriculturally-oriented NGOs in the South and exploring ways in which they can link up with governmental organisations (GOs).**

**John Farrington**

Levels of donor interest in and funding for NGOs have increased dramatically: they now amount to over 15% of all net aid flows from North to South. Many North-based (or international) NGOs, in turn, finance local NGOs on a ''core'' programme or project basis. Often, NGOs also seek to support local membership groups such as small farmers' associations, though, of course, these may also have independent sources of funding through membership fees or levies on crop sales. There is a real danger that the ''megabucks'' syndrome will – through lack of understanding of the ethos, objectives and limitations of NGOs – have far more negative than positive effects. To those who have worked closely with NGOs, it is already clear, for instance, that the number and type of NGOs that can work successfully with the rural poor is often constrained by the overall political climate. In many areas they are regarded as ''politically suspect''. Similarly, it is now often the shortage of individuals having sympathetic and skilled leadership qualities that is a more severe constraint on the successful expansion of NGOs than funds alone.

## Documenting NGO achievements and needs

We need to understand more about NGOs if the potentially negative effects of this new interest in them are to be minimised. ODI is working with NGOs in Africa, Asia and Latin America with two main objectives.

The first is to invite NGOs to document the types of work they have been doing in agriculture (in its broad definition of crops, animals and trees, on- or off-farm). NGOs are widely seen by government organisations (GOs) as amateurish and transient. Only if we document how they have worked with farmers to identify new technologies and management practices – and place these in the context of NGOs' philosophy, their contacts with the wider scientific community and the levels of training of their own staff – can we dispel some of these prejudices.

The results of this documentation confirm what has been suggested in earlier issues of the ILEIA Newsletter and elsewhere (e.g. Farrington & Martin 1988), namely that NGOs are good at identifying farmers' requirements and combining local knowledge with that from the wider scientific community in responding to these needs. However, many NGOs lack specific technical skills and facilities (such as technical equipment and libraries) which are expensive and so difficult to acquire.

International NGO networks and newsletters reduce this problem by providing ideas on management practices and technologies for NGOs to try out, but newsletters can rarely help where such ideas produce unexpected results. NGOs need to be able to draw upon local skills to meet these eventualities, and this is a good reason for establishing working relations with government research and extension services which might, incidentally, also have ideas worth trying out.

## Forging closer links with GOs

The second objective of the ODI study is therefore also to look at the scope for closer two-way links between GOs and

NGOs. In some countries, government research and extension services are seeking to support NGOs by making technology available from research stations that NGOs may wish to try out. So far, very few GOs are willing to act on the "feedback" that NGOs can provide by, for instance, changing their own research priorities to make them more relevant to farmers' needs. Most of the 50 NGO case studies with which ODI is working show how NGOs and GOs have tried to work together, how far they have succeeded or failed, and why.

In a second stage, the study will bring together NGOs and GOs having "hands-on" experience of working together at a series of regional workshops in Africa, Asia and Latin America. These will aim to indicate to senior officials and representatives of funding agencies some "what-next" steps for closer NGO-GO working relations in each country.

Some preliminary findings from this work are the following:

### NGOs are on the frontier

The NGOs studied are highly diverse, varying in size, objectives, modes of operation and levels of skill, but most of them were found to be operating in the more difficult agricultural areas or with marginalised groups where government research and extension services tend to be weak.

For example, in Bangladesh government agricultural research – almost by definition – ignores the 50% of the working population that has inadequate access to land. NGOs have been innovative in working on backyard activities that require little land, e.g. work by Proshika and BRAC on poultry and sericulture; work by Friends in Village Development on ducks; work by several NGOs in providing small groups of landless labourers with the credit and skills to operate mobile pumps and so sell water to farmers. In several cases, these NGOs are seeking to (or have already) supplement their skills with those available from GOs. Some of these programmes initiated by NGOs are now being replicated by government.

### NGOs promote group action

Empowerment and group formation are important NGO objectives. They work on agriculture within the context both of these objectives, and of their wider activities in health, nutrition, education etc. They can therefore screen out as inappropriate those agricultural technologies and management practices that are inconsistent with these wider contexts.

For example, a consortium of local NGOs in Andhra Pradesh, India, has worked with an international NGO (Action for World Solidarity) and with national and international research services in devising and implementing farmers' integrated management of a major pest of castor. The method involved use of light traps to determine peak moth emergence followed by synchronised lighting of bonfires over a wide area into which the moths were attracted. This group action subsequently fed into village-based initiatives for castor seed production.

One of the other most innovative efforts in seed production is in The Gambia, where NGOs have helped to test varieties and multiply seed at village level, certification services being provided by a specialist GO. However, this work is threatened by the limited range of genetic material coming out of government research, and by some confusion over roles and responsibilities.

### NGOs have their own agenda

It was found that the NGOs are wary of any GO moves that might restrict their agenda. In particular, most NGOs are unhappy with the idea of, e.g., simply forming part of the government extension service in one district or other. However, they have responded well to invitations to work together on an equal-partner basis.

For example, World Bank-funded efforts in Bolivia to "involve" NGOs in tightly defined dissemination roles are running into trouble partly because they do not allow NGOs a voice in resource allocation decisions. In a separate initiative, a new Bolivian NGO (PROCADE), formed to service several smaller NGOs, responded well to GO invitations to "search" its shelves for technologies that might be useful to its partners.

**Same NGO also works on sustainable use of forest products – planting rattan (the horny bush) as part of a mixed tree species plot. Photo: John Farrington.**

### NGOs integrate research and development

The NGOs are free of the institutional barriers between research, dissemination and implementation that often characterise GOs.

For example, Bharatiya Agro-Industries Foundation (BAIF) in India pioneered research into frozen semen technology for artificial insemination in a crossbred dairy cattle programme. This was implemented by its own field-staff serving 1.5 million farmers in 6 districts, who provided feedback on progeny testing and on health and nutrition which stimulated further research and development in these subjects. GOs could learn much from this integration of functions.

### NGOs develop appropriate methodology

In some contexts, NGOs have provided a lead to GOs in participatory and rapid methodology for diagnosis of research needs and for the monitoring and evaluation of the technologies introduced.

For example, CARE and Mazingira in Kenya worked with farmers to understand their criteria for selecting tree species and monitoring their performance. These techniques have begun to replace some of the long-term species trials undertaken by the Kenya Forestry Research Institute, thus saving on scarce research resources, and led to the development of ICRAF's Diagnosis and Design methodology, which it now widely used.

### NGOs can have "pull"

Overall, there is plenty of scope for NGOs to "pull" government research and extension programmes round to small farmers' requirements. The pressing need is for sensitive approaches by GOs to work with NGOs in redesigning these programmes, and research is in progress to identify the respective merits of a range of different approaches. ■

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**John Farrington, ODI**
Regent's College
Regent's Park
London NW1 4NS, UK

# Christine's organic farm

**Christine Karuru took part in the ILEIA workshop on assessing farming techniques. She has a farm in Mangu village, about an hour's drive northeast of Nairobi. John Njoroge from the Kenyan Institute of Organic Farming (KIOF) and Laurens van Veldhuizen from ILEIA visited Christine at her farm in February 1991 and together they evaluated it. There were several interesting findings.**

**John Njoroge and Laurens van Veldhuizen**

Christine owns a 9-acre farm in the Central Kenyan Highlands, a 'high-potential' area, which basically means that rains are adequate for cropping. Population pressure is high and continuous intensive cropping has led to depletion and deterioration of the land. Christine's farm is scattered over 4 plots, some more than 1 km from her house. Two women labourers help her almost on a full-time basis, and she regularly hires 2-3 other labourers to help her complete tasks such as soil cultivation, preparing compost and collecting fodder and/or compost materials.

Even before she started organic farming, Christine bought few inputs for her farm: mostly concentrates for her dairy cattle and chickens which, in turn, provided her with enough animal manure to maintain soil fertility. Where most of her neighbours relied heavily on purchased fertiliser for their maize, coffee and other crops, she chose her own way. She strongly felt that the fertilisers were too expensive compared with manure. She had also observed several cases of health problems, e.g. swollen legs, which she related to incorrect use of fertiliser.

### Key changes

In 1986 Christine participated on behalf of her parish in a course organised by the Catholic Diocese. Training in organic farming techniques by the KIOF was a major part of this course. After returning to her village, she immediately started implementing several of the techniques. In the following years, Christine further developed her farm to make it a fully integrated organic farm. The key changes she made included:

Improved composting. She has learned to mix properly the dung of her cattle, goats, pigs and chickens with other organic waste materials from her farm.

With a wooden stick she monitors the cooking process, temperature and moisture content and adds water when necessary. She is thus able to produce good compost in only about 6 weeks.

Crop diversification. She planted more tree crops, integrated banana trees into her coffee field and intercropped them with french beans and sweet potatoes. She also started planting different kinds of vegetables for home consumption and sale.

Double digging. This helps to break a hard pan in the subsoil.

Liquid manure and plant teas. She lets all kinds of fresh dung decompose in water for 1-2 weeks to produce liquid manure. She also uses the shoots and leaves of non-oily broad-leaved plants to rot in water for 6-8 days to make a plant tea. She uses both liquid manure and plant tea for top dressing her vegetable crops.

Crop rotation. She rotates leguminous crops (mainly french beans) with here other crops.

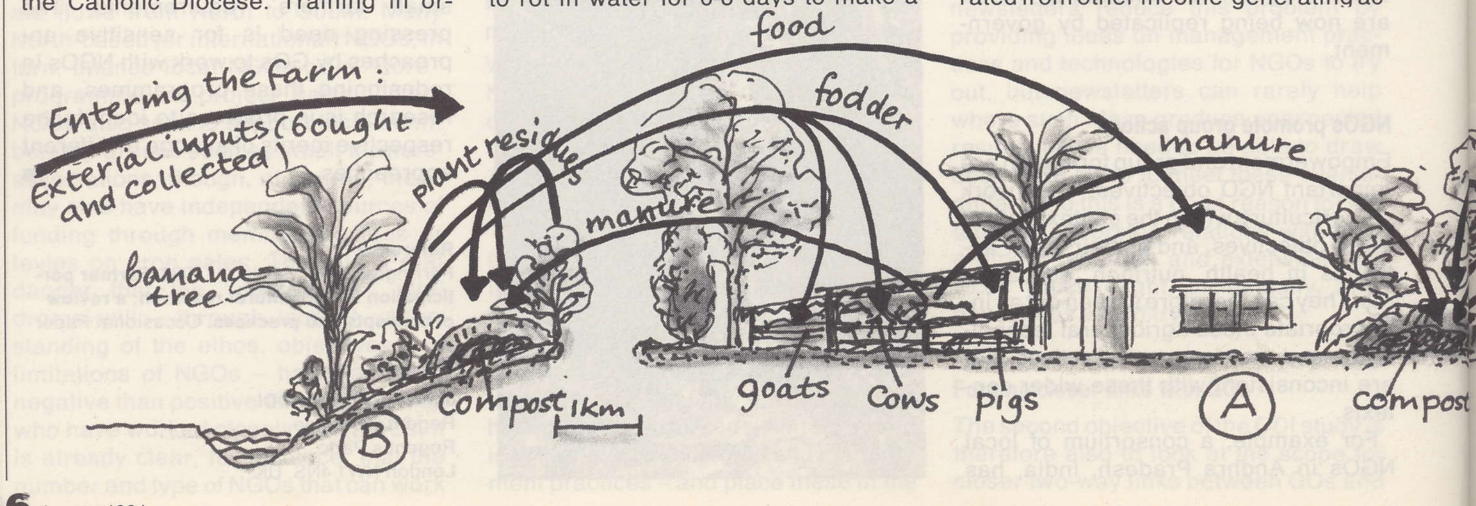
Natural pesticides. Christine uses the leaves of Mexican marigold (Targetes minuta) to make a pesticide to control blight and aphids. She is experimenting with various other preparations such as chilies (hot pepper), pyrethrum flowers, onion/garlic and tobacco leaves.

Other techniques. She is starting to use leguminous trees to obtain nutrients from deeper soil layers, using the leaves for fodder, mulch and compost material. On steeper slopes, soil conservation has become an important point of attention.

Through her recent experience with her own farm, Christine's motivation and commitment to organic farming have increased even more. She saw the colour of her soil darkening and noticed a considerable increase in soil life. When strong winds blow the topsoil of her neighbours' farms away, she sees no soil movement on her own fields. Christine showed how her maize managed to produce a reasonable crop, now at the end of the short rainy season that brought very erratic rains. The reason is the improved moisture retention capacity of her soils. Her neighbour's crop was about to fail completely.

### Assessing Christine's farm

To what extent does this farm provide an example of a sustainable farming system? Are her practices applicable on a wider scale? We discussed the socioeconomics of her farm in detail. Although Christine was confident that she and her family can live off her farm alone, she had to admit that she had no clear picture in this respect. The farm as an enterprise has never been separated from other income-generating ac-



tivities, as is not unusual among small farmers. Her husband is involved in a local taxi service and Christine herself does some trading with produce of her neighbours.

To gain a better understanding of the economics of her farm, we did a simple, theoretical comparison between her farm and a similar one using high-input techniques. On the cost side, her organic farm incurs very few costs for inputs such as fertilisers, pesticides and concentrates. But this was possible only by hiring more outside labour. Christine estimates she needs at least two extra labourers in the peak seasons, but feels she still wins compared with earlier expenditures on inputs. Fortunately for her, this extra labour is generally available in the Kenyan Highlands (for little more than $1 a day). And the money paid for labourers stays in the area, supporting the local economy, instead of enriching the economies of Nairobi or other countries.

The comparison became more favourable for the organic farm when we considered the benefit side. Here, the differences are considerable. According to Christine, ''yields are higher, especially under adverse conditions such as water stress''. Soil fertility is much better cared for in her organic farm, not only because of the sheer number of nutrients added through compost and liquid manure. Also the variety of nutrients available through compost and the more efficient application methods contribute to soil fertility. In her experience, artificial fertilisers often do not make the nutrients available at the right time and place, and in the correct mixture.

### Nutrient balance

Another major issue in discussing the sustainability of her farm with Christine was the nutrient balance. We started the discussion by studying the nutrient flows, both within as well as into and out of her farm. Preparing together a map of her farm with arrows indicating biomass flows helped all of us understand the dynamics of her nutrient management. Christine obviously manages to realise a very extensive and complex recycling of nutrients. All waste materials, including weeds, are used as fodder, as compost or liquid manure ingredients, or as mulch. The pattern of arrows clearly showed two important features of her organic farm:

Recycling: the amount of actual transportation of materials taking place within her farm: Napier grass and banana trees brought to the cattle shed for fodder; the bedding with dung from her cattle-shed brought to the compost heap; added to the heap are residues brought in from all over the farm; compost taken again to all corners of the farm etc.

The complexity of management of the organic farming system to arrive at an optimal use of available resources.

Transporting organic materials is a problem because, as a newcomer in this village, Christine had to buy her land plot by plot in different places. On the other hand, her husband's taxi helped her keep this problem manageable. Yet, every day she goes to one of her plots she carries either dung or compost on her back: every day a little makes a lot in the end.

### External inputs

The discussion became especially interesting for Christine when we started to study the nutrient flows to and from her farm. At first she said she virtually did not obtain inputs/nutrients from outside. But confronted by a list of produce leaving her farm, prepared by herself, she listed in fact an impressive list of inputs bought or collected to replenish her lost nutrients. Table 1 summarises both the sources of nutrient losses as well as those for replenishment.

Although the present nutrient balance cannot be determined in detail during just a one-day visit, the above table suggests a favourable situation. Preparing this table helped Christine once again realise the importance of nutrient management. There is doubt, however, to what extent her model for nutrient management can be applied at a larger scale in her area. There would not be enough pulp waste at the coffee factory, neighbours might stop supplying materials for liquid manure, and even chicken manure might become short in supply. Other sources of nutrients would then have to be found.

### Replicability

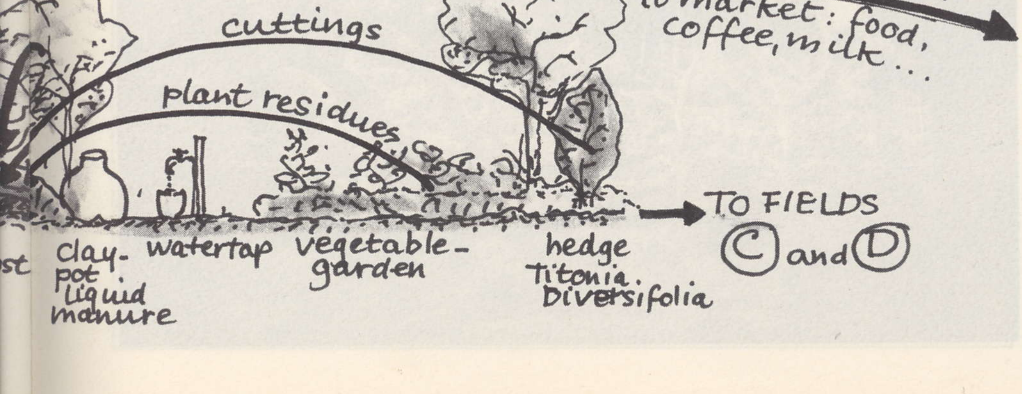
Although the study of Christine's farm was a brief one, all the evidence seems to suggest that her farm as such does provide her and her family with a good living and will continue to do so in the future. Asked at the end of the discussions whether she feels that her farm is a model for a sustainable farming system in her area, she answered in very positive terms. Yes, other farmers may have to scale down to a certain extent, a smaller acreage, less cows, less transportation from far away, but still it would be viable.

Looking at it from an outsider's perspective, however, several bottlenecks are apparent that may limit the replicability of Christine's farm. These include:

- complexity of her farm management, the level of technical knowledge and understanding required;
- labour availability, the need for cash to advance labourers' salaries where credit is difficult to obtain, especially for most women;
- supply of nutrients from sources outside the farm;
- water supply for animals and compost production.

Yet, farmers may judge differently. Christine has been asked by the local parish to meet every Tuesday with interested farmers at the church to explain organic farming techniques step by step. Between 30 and 40 farmers attend these meetings, both men and women, which has led to more than 80 farmers applying several of these techniques. Because, according to Christine: ''ordinary farming has failed so obviously in our area''. ■

KIOF
P.O. Box 34972
Nairobi
Kenya




**This is a simplified model of the complex organic farm of Christine Karuru. The homestead (2 acres): compost, trees, animals, vegetable garden with tomatoes, seed beds, French beans and leaf cabbage. Field B (2.5 acres): compost, bananas, Coffee + sweet potatoes, tomatoes, leaf cabbage/ onions, arrow roots, napier grass, reed. Field C (4 acres): compost, coffee + sweet potatoes/French beans, organic maize, arrow roots, bananas. Field D (0.5 acres): napier grass, bananas.**

**Similar exchanges, as between the homestead and field B, can be found between the homestead and the fields C and D.**

**Leaving the farm: food, coffee and milk to market; human consumption.**

**Entering the farm: external inputs (bought and collected).**

# 'Transition is a matter of watching and observing'

**In 1989-90 the Agriculture, Man and Ecology (AME) Programme, Pondicherry, studied the transition experiences of 12 ecological farmers in South India. Erik van der Werf reveals the difficulties these farmers faced and how, drawing upon their own inventiveness and traditional farming techniques, they managed to succeed.**

**Erik van der Werf**

Transition is the process of converting a farm from an ecologically unstable conventional (''modern'') or traditional farming system to an ecological system with sustainable production. After all needed technical changes have been made, it might still take some time before the transition is complete, especially when perennials play a major role in the new system. A transition can be considered as successfully completed when the farmer feels the yields have stabilised at an acceptable level with the new practices.

Most of the farmers surveyed had 7-10 years' experience with ecological agriculture. Three farms converted from virtually traditional farming, using locally available inputs. Six converted from conventional farming, making considerable use of external inputs of fertiliser, pesticides and information. Three farms were started as ecological farms by the current owners, who had no or limited prior farming experience.

Reasons to opt for ecological agriculture varied greatly (Table 1) Production of healthy food, environmental aspects and sustainability of the farming system were mentioned by many. Philosophical motivations and the expectation of a better farm income were important in several cases.

### The transition process

The greater the difference between the initial and final situations, the more distinct was the process of transition. Where the farming system had been close to traditional (with only limited use of external inputs), one can hardly speak of a transition process. The use of pesticides was stopped, and the little fertiliser were replaced by organic manures. These changes could be successfully made within one growing season without affecting yields.

In the other cases, farmers went through a distinct transition over an average of 3-5 years from conventional to ecological farming. Where the original

**The whole farm of the Reddy family is now developing into a widely spaced orchard with annual crops growing between the trees. Photo: Erik van der Werf.**

Mrs. Saroja Reddy sharing her experiences in ecological farming with her colleagues. Photo: Erik van der Werf.

use of external inputs had been high, it took up to 7 years to complete a transition without major negative effects on farm income. When high fertiliser inputs were dropped at once, serious yield decreases resulted (up to 60%). In such cases, farmers had to switch back to using fertilisers and opt for gradual replacement by organic manures.

Several farmers said that, as soil fertility improved, yields increased during transition and even surpassed conventional levels. In rice, average grain yields of over 6000 kg/ha were realised under ecological cultivation. Several farmers said that ecological farming enabled them to reach self-sufficiency in foods which earlier had to be partly purchased. Furthermore, a number of farmers mentioned distinct decreases on expenditures for inputs such as fertiliser, pesticides, concentrates and tractor tillage.

In certain cases, transition could have been completed faster (e.g. through extra investment in organic manure) if farmers had been better informed about transition and related problems. This lack of information, combined with having to learn ecological agriculture while implementing the transition, had a great impact on the transition and the time needed for it. Farmers said that, with the experience they gained, they would now be able to convert a farm similar to theirs in little more than half the time it had taken them.

### Changing soil management

In most cases, changes in soil fertility management were well prepared. All at once or gradually, chemical fertilisers were replaced by N-fixing crops, green (leaf) manures, animal manure, irrigation tank silt and agroindustrial byproducts or waste.

## Farmers list ecofarming "musts"

The transition research was concluded by a meeting in which the farmers listed the following points as essential aspects of ecological farming (Werf 1990):

* The organic matter content of the soil must be increased so as to reduce dependency on chemical fertiliser. This can be achieved by cultivating (N-fixing) fodder crops and green-leaf manure and increasing livestock numbers to produce manure.
* Soil tillage should be minimised and where possible replaced by mulching, cover crops, intercropping and inclusion of trees in the fields.
* Weeds can be used as a (living) mulch to prevent soil moisture evaporation and can be used in compost preparation.
* A variety of selected trees should be planted to provide cattle fodder, improve the soil, supply green-leaf manure and serve as a wind break.
* Drought-resistant species should be preferred for annual crops and trees.
* Erosion control by contour bunding and soil cover is essential.

Different methods were adopted to improve soil fertility, all focusing on increasing organic matter production on the farm. Fallowing was done to permit natural regeneration of fertility in a degraded area. Green manure crops (*Sesbania* spp and *Crotalaria* spp) were used to reclaim alkaline lands. Six of the 12 farmers increased cattle holdings and produced more fodder to decrease the need for outside grazing, so that less manure was lost. In 3 cases, cattle urine was collected. Composting and green manuring were common. Several farmers collected organic matter from outside the farm (green leaf manure) or purchased it (e.g. manure, irrigation tank silt, granite dust).

### Changing pest management

In most cases, the need to change pest and disease management was not foreseen and caused serious problems. Ability to cope with these problems differed greatly between farmers. Adaptations made included changes in the varieties grown (e.g. replacing high-yielding varieties by local ones) and dropping susceptible crops (e.g. cotton).

Certain farmers claimed to have less problems after some years. They attributed this to the use of organic manure, creation of an overall healthier field ecosystem and increased presence of natural predators. Pest control techniques were mainly derived from traditional farming. Companion planting, decoctions of insecticidal plants (e.g. *Azadirachta indica*), spraying of diluted cow urine and the use of oil lamps to catch night-flying insects were frequently practised.

### Changing crop management

Changes in crop management include increased growing of leguminous and fodder crops, higher cropping intensity through multiple cropping and a shift toward local varieties. In several cases, the number of trees on the farm was increased. A few farmers broadened their crop rotations. Weed control remained unchanged: mainly hand weeding and some intercultivation.

### Erosion control

A growth of environmental awareness led to an increase in erosion control activities. Higher priority was given to increasing vegetative soil cover, e.g. through use of cover crops, intercropping and increasing the percentage of perennial crops and trees. Mechanical measures like contour bunding, mulching and decreased tillage were also practised.

### Farmer traits

Experience in agriculture and willingness to experiment were farmer traits

**Table 2: Method used and time needed for successful completion of transition in relation to the original farming system.**

| No | Holding size in ha | Original farming systems | Transition method: at once | Transition method: gradual |
|---|---|---|---|---|
| 1 | 3.0 | traditional | + (1 yr) | |
| 2 | 3.2 | traditional | + (1 yr) | |
| 3 | 2.8 | traditional | + (1 yr) | |
| 4 | 4.3 | conv. aver. | | + (3 yrs) |
| 5 | 14.0 | conv. aver. | | + (4 yrs) |
| 6 | 40.0 | conv. high | – | + (4 yrs) |
| 7 | 4.2 | conv. high | – | + (7 yrs) |
| 8 | 2.4 | conv. inst. | + (5 yrs) | |
| 9 | 2.0 | conv. inst. | ongoing (2 yrs) | |

+ = completed succesfully - = failed

**Table 1: Reasons for transition and frequency of mention by 12 farmers**

| Reason for transition | Frequency |
|---|---|
| Environment/sustainability | 9 |
| Health/food quality | 7 |
| Philosophy | 5 |
| Farm income | 4 |
| Independence | 1 |
| Water and labour scarcity | 1 |

which made the transition easier. The financial freedom of a farmer directly influenced the length of the transition. Limited investment possibilities (e.g. for soil fertility improvement) prolonged the transition. A family tradition in farming had a positive influence, as traditional farming was an important source of information for the farmers. In South India, farmers normally live in villages and not on the farm itself. However, living on the farm proved to be of major importance for an effective and efficient transition. As one farmer said about the need for continuous attention in ecological agriculture: "Transition ... is a matter of watching and observing".

### In summary

Lack of technical information on ecological farming was a serious problem for all farmers. More than half worked without any information and had to develop their new system on their own. Others made some use of existing extension services and foreign literature. This stresses the importance of individual farmer capacity to observe and analyse the change processes in one's own farm. It also explains the strong influence of farmer traits on the length and smoothness of the transition.

The main changes implemented were in soil fertility and pest and disease management. Farmers focused on decreasing use of pesticides and fertilisers, increasing cultivation of perennials and leguminous crops, and intensifying application of organic manure. Specific problems lie in producing sufficient organic material on the farm and lack of knowledge on alternative pest control measures. As such, economic aspects did not prove limiting, but additional off-farm income permitted the financing of a faster transition. ■

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**Eric van der Werf**
ETC Foundation
P O Box 64
3830 AB Leusden, Netherlands

**Mr. Tangasamy, one of the participating farmers, admiring a heavy Jack fruit in the farm of the Reddy family. Photo: Erik van der Werf.**

## The Reddy farm

Mr. Reddy was one of the farmers participating in the ILEIA workshop.

The Reddy family lives on a 4.2 ha irrigated farm 25 km east of Bangalore, Karnataka. They have been farming there since 1975, initially under conventional management using high levels of external inputs such as fertiliser, pesticides and tractor ploughing. As a conventional farmer, Mr Narayana Reddy was twice elected most progressive farmer of the region. However, his profit margin was low due to the high costs of the external inputs. It was a combination of these high costs and the environmental effects he saw in his farm which motivated Mr Reddy to switch to ecological agriculture.
In 1979 the family completely stopped using external inputs and yields plummeted to 40% of the former average. It was then decided to use fertilisers and pesticides again and reduce them gradually, while increasing the amount of organic manure. The yields remained depressed in the first 3 years but then started to improve. After 7 years, fertiliser use was stopped completely and crop yields were back at the pretransition level.

**Soil fertility**. Decreasing the use of fertiliser required increased inputs of organic manure. This was done initially by bringing more organic manure into the farm: leaves were collected on roadsides and in the forest, tank-bed silt was carried in and animal manure was bought. Gradually the on-farm capacity to produce organic matter was increased. Green manure crops (*Sesbania sesban and Crotalaria spp*) were included in the rotation in the first 4 years. These were later replaced by pulses, of which the residues were ploughed under after harvest. Crop residues formally burned were used for compost or mulch. Tillage could be decreased in the latter part of the transition due to increased microbial and earthworm activity.

**Pests and diseases**. Pests were controlled by spraying soapy water, herbal extracts and diluted cow urine. Changes in cropping pattern and enhancement of soil health resulted in sufficient pest and disease control. The only remaining problem is an insect pest in guava for which no satisfactory organic control method has been found. If this cannot be solved, the guava will be replaced by another tree crop.

**Crop management**. Cropping patterns were changed to include more leguminous species and avoid monocultures. Species sensitive to pest and insect attack on account of unsuitable climatic conditions (cabbage and cauliflower) were dropped. The whole farm is now developing into a widely spaced orchard with annual crops growing between the trees. The bunds of the irrigation channels were planted with Napier grass and *Leuceana leucocephala*, using the water seeping and infiltrating in the channel sides.

**Livestock management**. Since starting the transition. Mr Reddy gradually raised his cattle numbers from 2 to 10, as the farm's capacity to supply the necessary fodder increased. Furthermore, rabbit breeding and sericulture were taken up, and more sheep and local poultry were kept. All animals are fed from the farm's own resources. A new cattle shed was built to facilitate collection of dung and urine and to free the cattle from their ropes.

**Socioeconomic aspects**. Labour increased greatly during the early years of transition, especially for collecting external organic manures. Establishing a new farming system was a matter of trial and error, each error resulting in an extra labour demand. Now, as a result of diversification of farm activities, distribution of labour over the year is more even than before transition.
During the first years of transition, net returns remained stable. The slight decrease in yields was counterbalanced by a decrease in costs. After 5 years the net returns improved enormously; soil fertility was improved, crop yields returned to the previous level and the planted trees started yielding. The net returns have now stabilised at a higher level than before transition.

**Around the middle of the 1980s something rather exciting began to happen to soil and water conservation in developing countries. After decades of trying to save the soil "from the people", a few small projects discovered a more promising approach: to help the land users to save the soil and the water for themselves – for improved plant production. Some important lessons were learned and a new way of thinking began to emerge.**

# New approaches to soil and water conservation

**Will Critchley**

The "new approach" to soil and water conservation has come about more by necessity than by design. The conventional type of SWC project – with its emphasis on building structures and reducing soil erosion – has failed so often that there has been no option but to change strategy. With the new thinking, kilometres of expensive terracing and rigid targets are out – and people's participation, flexible workplans and conservation for production take centre stage.

### Change in attitude

An increasing number of documents have appeared over the last few years articulating the change in attitude. One of the first contributions to the the debate criticized aid agencies and soil conservation departments for persistent failures in SWC projects, and simultaneously stressed the importance of basing technology on farmers' traditional systems (Reij et al. 1986). Several more recent publications have brought the new approach into the mainstream of thinking, and have highlighted, particularly, the potential of biological methods and the need to move away from a purely engineering approach to SWC (e.g. Shaxson et al 1989; Moldenhauer and Hudson 1988; Young 1989). A recently developed video has distilled the lessons into a training module for local development workers in dryland Africa (Critchley 1991). Perhaps most significantly the language and content of project proposals has subtly begun to change as well. The first step from thinking to doing is underway.

The new attitude acknowledges that it is useless to coerce people into accepting systems of conservation that they don't appreciate. This seems self-evident, but it's not so simple. Conventionally, technicians design the structures, and the implementors ensure the "cooperation" of local farmers with incentives such as food-for-work or even payment. The farmers often don't understand the purpose of the terraces and bunds, and because they expect incentives to continue for maintenance, the structures are commonly left to deteriorate in the post-project phase. The result can be breached bunds and increased environmental damage.

### Participation essential for lasting impact

Participation has become the "buzz-word" of the moment, but it is not just a passing development fashion, it is essential for lasting impact – for sustainability. Participation means the involvement of the land users in all phases of project planning and implementation. It is now realized that the target group has a wealth of knowledge and experience, and is receptive to training – women as well as men. Developing skills in land use planning and surveying, for example, demystifies technology and instills a sense of achievement. Training helps to mobilize the wealth of popular enthusiasm that exists untapped in so many areas.

Group work on terracing as soil conservation. It is important to recognize that participation is a two way process. The conservationist has a vital role in helping to generate appropriate technology in cooperation with local land users, taking into account their traditions and experience. Photo: Will Critchley.

It is important to recognize that participation is a two way process – and that the conservation specialist and other programme staff are not redundant. The conservationist has a vital role in helping to generate appropriate technology in cooperation with local land users, taking into account their traditions and experience. It should not be forgotten that the land users don't always appreciate the full implications of improved SWC systems immediately. Techniques which lead to rapid increases in crop yields by making moisture more available in dry areas, for example, will certainly be attractive to farmers – but unless the question of soil fertility is simultaneously addressed, the effect may diminish in the future due to nutrient "mining". Technical guidance is not outdated – but needs to be more farmer-sensitive, and less rigid and pedagogical.

### The key to new technology

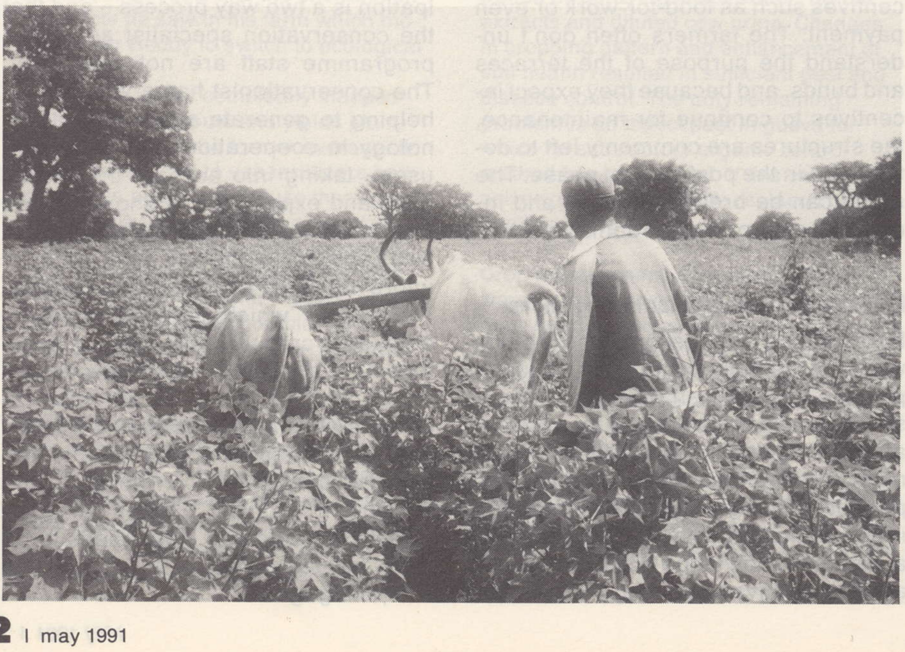
If participation is the key to the management aspect of the new approach, then it is the key which opens the door to new technology also. The two most interesting developments are the emphasis on biological methods of conservation in the more humid regions, and water harvesting in the drier areas. It is significant that both of these are linked to improved, and more reliable crop yields.

"Conservation Farming" and "Land Husbandry" are terms which some specialists now use in preference to "Soil and Water Conservation" (Moldenhauer and Hudson 1988; Shaxson et al 1989). The essence of these terms is an emphasis on biological methods of conservation. Better farming practices and maintenance of soil fertility lead in turn to improved conservation. No longer are engineering structures seen as the essential backbone of conservation programmes, but merely as "support practices". Where structures are required, for example on higher slopes, semipermeable vegetative barriers are given priority over solid earth bunds. These barriers filter out sediment while allowing excess runoff to pass through at non-erosive velocities. Establishing vegetative barriers almost always involves less labour than constructing earth bunds – though they often take two seasons or more to become really effective.

### Soil conservation increases productivity

To farmers this approach makes sense. Soil conservation is linked to productivity. Increased yields are the tangible benefit, and soil is simultaneously conserved. Farmers are encouraged to improve their husbandry practices by, for example, cultivating along the contour, intercropping cereals with legumes, and by making more use of farm yard manure and compost. The result is twofold: a healthier crop which protects the soil from the erosive effect of rainsplash through its increased vegetative cover, and a more fertile, better structured soil which is less erodible.

Good ground cover is the key to "conservation farming" – cotton in Southern Mali. Photo: Will Critchley.



### Water harvesting

Water harvesting is a specialized form of soil and water conservation which has its place in the semi-arid zones. In the past these regions were largely overlooked by governments and development agencies, who viewed them as being unsuitable for cropping. But the inescapable fact is that millions of land users have little other choice than to cultivate such dry areas, and any system which can improve the reliability of cropping is welcome. WH is simply the collection of rainfall runoff from a "catchment area" and its concentration on a "cultivated area". Small rainfall events can be effectively magnified by trapping runoff and making it available to plants (Pacey and Cullis 1986; Reij et al 1989).

A rich diversity of WH systems can be found in semi-arid regions. Some are traditional – however there is little knowledge about these – the experts have usually turned a blind eye to what the local land users do themselves. Other systems have been implemented through projects. One basic difference between WH and soil and water conservation in more humid areas is that structures generally are required in WH systems because runoff has to be captured. Nevertheless, semipermeable stone bunds offer advantages over earth bunds because they do not require spillways and are less vulnerable to breaching.

### From the project documents to the fields

The new approach to soil and water conservation implies changes in both techniques and managerial aspects of SWC projects. Greater sensitivity is required of project designers and soil conservation specialists alike. There are signs that projects are now being designed in a more enlightened way – project documents often stress "participation" and the need for a degree of flexibility in workplans. Soil conservation is less often quoted as an objective in itself. Conservation through productivity has become the target. It is now, rightly, an unwritten rule that gender aspects are given attention.

But the truth is that project documents do not always determine precisely what happens in the field. There is still a considerable gap between rhetoric and reality. The challenge now is for the new approach to soil and water conservation to be increasingly translated from the pages of the project documents to the fields of the farmers. ■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**Will Critchley**
Sycamoor Terrace
Bootham, York YO3 7DN
United Kingdom

Integrated land use management will be possible only if there is a community consensus. Photo: Matthieu Ouedrago/OXFAM.

# Projet Agro-Forestier

**The Agroforestry Project (PAF) of Yatenga Province, Burkina Faso has evolved from a successful water conservation project into a project that promotes "integrated land-use management". What are the lessons that can be learned from this project?**

In 1979, Oxfam commenced an agroforestry project (PAF) in Yatenga Province. This region has the double problem of high population density (70-100 people per square kilometer) and severely degraded land. Over 50% of the land is under cultivation these days and little or no fallowing is practiced. Much of the remaining land is eroded and encrusted with a hard cap. It cannot be cropped without being improved. Overgrazing adds to the problem. To make matters worse, rainfall has decreased significantly from the long-term average of 720 mm/annum to 440 mm within the last twenty years. Not only is the rainfall low, but it is also very unreliable.

### Little enthusiasm for planting trees

The original idea was to promote the use of microcatchments to enable farmers to grow trees for wood. The farmers showed little enthusiasm for planting trees, but were in favour of microcatchments for growing food crops. Fortunately, the project had the flexibility to change its direction, and began to promote rock bunds as a means of increasing crop production. This was a technique traditionally used in Yatenga, but the project introduced the improvement of building them along the contours, using a water level made of a hosepipe and two sticks. Rock bunds require a high initial investment of time and labour to collect and transport the rocks, but once the bund has been established, little maintenance is needed.

### Zai, a traditional technique

PAF also promotes various other improved agricultural practices. One of these is the zai method of tillage, a traditional practice of digging a 20 x 20 cm planting hole 10 cm deep during the dry season and filling it with compost. This leads to increased termite activity which, in turn, increases the rate of water penetration when the rains come.

Rock bunds have proved to be highly effective in increasing crop yields in their immediate vicinity. Photo: A. Khan/OXFAM.

Millet is planted in the individual holes, which also help collect water and protect the seedlings from wind damage.

### Local people convinced of profitability

Rather than relying on food-for-work as an incentive, as is commonly done in the region, PAF did not pay villagers to build the rock bunds. The project did, however, provide information and training, as well as materials and equipment such as water-levels, pickaxes and carts, either free or on loan. Some food loans were also given, most of which were paid back after the next harvest. Despite the lack of material incentives, the rock bunds have been widely adopted. Local people are convinced they repay the input of time and labour by bringing higher yields and increased yield security. The bunds also extend the area under crops by enabling land which had previously been considered useless to be brought into production.

### Measuring results

Few yield measurements have been made by the project which is seen as an important shortcoming as monitoring and evaluation are extremely important. Adequate systems of monitoring and evaluation, however, are not available. Improvement of existing methods is urgently needed and the project is working on this.

Measurements made by PAF showed

that the average grain yields in plots with bunds and zai were consistently higher than in those without bunds and zai, ranging from 12% in 1982 to 91% in 1984. The rapid increase in food production provided by rock dams and zai is obviously of crucial importance to the Yatenga farmers.

### Training and extension

PAF has been building up its extension programme since 1983. Initially, it relied on the use of the flannel board and other techniques to raise awareness. It then moved on to providing training in rock bund construction. Since it is too costly to provide individual instruction for all farmers wishing to construct bunds, PAF asked villages to nominate representatives who could learn the technique and then pass the knowledge on to others.

PAF avoids the temptation to carry out its extension work independently, and joins hands with three Government services operating in the province. PAF helps train the extension agents of these services, who then collaborate in extension work. Collaboration has led to more widespread achievements, and means that the activities should continue after the project comes to an end. In all, several thousand people have now been trained, covering about 500 villages. Initially, the focus of training and extension work was on male farmers but in 1985 the project began training women farmers in rock bund construction, and women are now included in the extension team.

### Attitude to tree growing changed

PAF staff have found that attitudes to tree growing tend to change once the initial activities lead to higher food production. In some villages, farmers are now prepared to plant trees along the bunds if they are provided with seedlings. They are also willing to provide protection for the trees against grazing animals during the dry season. In Longa village of Yatenga Province for example, the use of rock bunds along the contours has been integrated into an approach which concentrates on land-use management. The villagers constructed rock bunds on 70 ha of agricultural land. They also agreed to impose severe restrictions on movement of animals. All livestock are now held in shaded enclosures, and fodder is collected from the cultivated areas. Trees have been widely planted, and natural regeneration is also evident. Neighbouring villages are now copying Longa's example. Seedlings are supplied by the Forestry Department, and guidance in stall feeding is provided by extensionists from the Ministry of Agriculture. The costs of stall construction and other inputs are borne by the villagers themselves.

### Mobilizing the community

One of the principal lessons of the project is the importance of mobilizing the community. Although PAF found that the quality of rock bunds on individual land was better than on communal land, it gradually became clear that much of the work can be done effectively only if there is community consensus. If, for example, rocks are not available nearby, collection needs to be organized on a community basis. Similarly, if land is to be protected from grazing, the animals of all farmers must be controlled. The community orientation also helps ensure that the poorer farmers benefit from the project.

### Farmer-to-farmer extension

Because of the progress which has been made, there is no longer any need for measures to raise the general level of awareness. People see the innovations in neighbouring villages and discuss them as part of their normal day-to-day contacts. In areas where the innovations have not yet been adopted, PAF promotes exchange and communication through excursions. The villagers are then left to reflect on what they have seen, discuss the issues and organize themselves when they feel ready for action. The farmers know where to find the PAF office. In the final analysis, it is up to them to get together and undertake development activities for their own benefit.

### Sustainability not yet achieved

PAF also recognizes that problems remain. There is, for example, the question of uneven distribution of costs and benefits. Rock collection and bund construction make heavy demands on the available labour, particularly on women. Rich farmers are more likely to be able to mobilize and provide food for communal groups to build bunds on their land. The sustainability of the increased yields obtained when using the bunds is another cause for concern. Because higher crop production means greater mineral extraction from the land, there is a danger of long-term depletion unless methods of increasing inputs of organic matter and mineral fertilizers can be put into operation. Thus, recovery of manure from stall-fed animals and encouragement of composting assume critical importance in the longer-term perspective.

### Techniques and participation

The project accepts the need to identify and resolve such issues, but is fully aware that the proposed solutions must be acceptable to the local people. Project staff stress that the reasons for its success are not primarily technical. The techniques work because they fit into the local context and meet the farmers' need for low-risk and low-cost strategies. More important than its ability to develop techniques is the fact that, by involving the local people in all stages of project implementation to guarantee that their needs and priorities are met, the project has won their confidence.

### Lessons and conclusions

- PAF is an internationally known success story. This is because of its impressive achievements and use of appropriate techniques. However, the special combination of factors which make PAF so successful is not found everywhere in sub-Saharan Africa. PAF's techniques are rather site-specific and therefore need to be adapted when transfered to other sites.
- Participation of villagers in decision making and in implementation of soil and water conservation measures is central to PAF's philosophy and to its success.
- Training and extension are among PAF's greatest strengths. PAF has a well developed training scheme for villagers during which they are taught how to lay out and build the bunds.
- Flexibility in allowing the programme to evolve and change is a feature of the project. Having started as an agroforestry project, PAF achieved considerable success with stone bunding techniques, and is now moving towards village land-use management.
- The main technique, contour stone bunds with zai or planting pits, is simple, relatively cheap to implement and based on traditional techniques.
- The techniques are particularly popular because they give farmers a rapid increase in crop yields, and allow at least some harvest in very dry years.
- PAF is a small NGO project which is able to have an important impact on soil and water conservation by acting together with both government agencies and other NGOs. ■

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**Contact:** Projet Agro-Forestier (PAF), Mathieu Ouedraogo, project manager, B.P. 200, Ouahigouya, Yatenga, Burkina Faso.
Oxfam, John Rowley, 274 Banbury Road, Oxford )X2 7DZ, UK.



# Farmers as good managers and cautious gamblers

**There are two great challenges which face the world today. Firstly, the development of appropriate technologies to compete in the race to save Mother Earth. Secondly, the search for the right strategy to bring about change in peoples' perspective of agricultural production. Angie Ibus shares the experiences of farmers with regenerative agriculture.**

**Angie Ibus**

One emerging answer in the quest for sustainability is regenerative agriculture. It is synonymous to low-input agriculture, sustainable agriculture and alternative agriculture (Crosson 1989) or LEISA. It is a system which attempts to bring back into the farm ecosystem the practice of sound indigenous knowledge combined with simplified scientific findings to produce the desired results without compromising the depletion of the farm resource base, food security and income generation.

In 1990, a survey of the participants to the Farmer Advocates in Regenerative Agriculture (FARA) was conducted by IIRR. It showed that given the prevailing condition of poverty, increasing household income is the primary motivation among the active FARA members for the adaptation of regenerative agriculture technologies in their farms. It was further found that other farmers in the same localities think the same way. The larger ecological benefits, being longer term, do not appear to be their main consideration (IIRR FARA Report 1990).

### Increasing cash and soil fertility

Conventional agriculture in the Philippines is highly capital intensive, chemical-based and relies on high-cost inputs. The farm practices associated with conventional agriculture lead to the death of soil structure, death of soil micro-organisms and to eventual soil fertility reduction and losses. There are several techniques which have been tried and found effective in addressing soil fertility degradation and the issue of cost reduction. Some of these are long-term, others show immediate effects.

### Rice-fish culture

Rice-fish culture is an example of an indirect approach. It is a dual raising of rice and fish in the same paddy in the same season known to be a traditional practice in Asia, though in those early years the fish grew naturally. The indiscriminate use of chemicals, especially herbicides, has led to the slow loss of such a traditional practice and the loss of native fish species in the paddy. Raising fish along with rice has been documented to increase rice yield from 20 to 47.5 percent (Fermin 1989). Presence of fish in the paddy enhances aeration which encourages tillering, besides providing excreta to fertilize the soil. Fish in the paddy also reduce weed problems and the insect population, thus, the need for chemical pesticides is eliminated, allowing for maintenance and preservation of the aquatic life. Most importantly, rice-fish culture proves to farmers that there are alternatives to chemicals. It presents a promising technology to be introduced during the transition period.

Mang Jose's rich-fish culture. Note the trench on the sides of the paddy field. Photo: IIRR.

Rice straw utilization. Rice straw is one of the cheapest and most available sources of organic material found on most farms in Asia. In the tropics, 1.5 tons of rice straw contain about 9 kg Nitrogen, 2 kg each of Phosphorus, Magnesium and Sulfur, 25 kg Potassium, 70 kg Silicon and 6 kg Calcium (IIRR LIRP Kit, 1990).

Greenleaf manuring. Another direct alternative to improve soil fertility is green leaf manuring (GLM). This has been a common practice in South Asia for centuries. It is known to increase rice yields by up to 2 tons per hectare, as compared to an unfertilized field (IIRR LIRP Kit, 1990). By growing grain legumes, it is possible to substitute at least one-half of the chemical nitrogen used by farmers in the Philippines in their rice crop.

Intercropping grain legumes such as cowpea, mungbean (*Vigna radiata*) and bush beans to name a few, with upland rice shows no reduction in the harvest while maintaining current levels of chemical inputs and providing additional earnings from the legume crops. A field trial, in four villages in Cavite, Philippines with 58 farmer cooperators, showed that with the same level of chemical inputs, rice yield could be increased form 2.1 ton per hectare with mono crop rice using traditional variet-

Bert's farm is a rice-fish-duck system. The housing on the left back side is for pigs and cattle. Photo: IIRR.

ies to 2.75 tons/ha with modern rice varieties. With new rice varieties intercropped with legumes, the yield could increase further to 3.55 tons/ha. As encouragement in areas where intercropping is not commonly practiced, field trials could be coordinated with varietal trials of rice varieties which farmers are interested in trying.

### Farmer-to-farmer extension

It has been shown repeatedly that farmers have their own language and can put their experiences in the context similar to other farmers. When this fact is recognized and properly managed, farmers are the most effective channel for spreading the technology. In Sto Domingo, Albay, a soil and water conservation (SWC) project (collaborative project of World Neighbors and IIRR) initially started with five farmers. These farmers, after one year of successful adaptation of the technologies, became farmer leaders who organized groups around the same technologies. As they developed their skills and gained confidence on the technology as a result of the improved farm condition, they were chosen to be farmer instructors. A farmer-instructors' style and point of view are closer to their peers than those of the extension worker. In a span of four years, the cooperators in the SWC project grew from 5 to 150 and a lot more farmers are requesting help from the farmer instructors.

A supplementary scheme being tested by IIRR is for farmers to make a conscious effort to do their own farm analysis, taking off from the indigenous practice of using wall calendars. This is based on the premise that if farm record keeping is institutionalized at the farmer-level, the farmer can analyze and decide for him/herself whether a technology should be pursued or not.

### Mang Isko

Mr. Francisco Hayag, Mang Isko to many, started rice-fish culture in an 800 sq. meter rice paddy. He stocked his paddy with tilapia and common carp, (*Oreochromis nilotica* and *Cyprinus carpio*). His first trial was a success in spite of the hesitancy and doubt he initially had about the technology. He increased his rice yield from 8 to 12 sacks, harvested 48.5 kilograms of fish and reduced his production cost by P 52.00 (savings from non-use of weedicide and insecticide). That season, Mang Isko more than doubled his net income from his 800 sq m. paddy simply through the introduction of fish along with rice.

Predictably, the next cropping season witnessed Mang Isko expanding the rice-fish technology to his other paddies to cover an aggregate area of 2,200 sq.m. Farmers are good managers and cautious gamblers. Like businessmen, they base their decision to adapt, expand or discard certain technologies after careful analysis of the socioeconomic benefits brought to them. Today, there are 40 cooperators in freshwater fish culture and the number grows as more farmers are exposed to the achievement of their peers.

### Transition in one year?

Another farmer, Lamberto Ignaco, also provides a very good example. In contrast to Mang Isko who choose to work with just one kind of technology and master the whole thing, Bert, as he is fondly called, adapted several technologies in his farm. However, like Mang Isko, he started with one technology at a time and progressed through a step by step inclusion of other technologies. Today, Bert has eight different regenerative technologies – mini-fishpond, rice-fish, market garden, bio-intensive garden, rice production using combinations of bio-fertilizer sources (*Gliricidia sepium* leaves and *azolla*), swine production, duck raising and other livestock.

Bert's experience shows that in a year, integrating several technologies in a farm is possible but the total positive net return will only be realized after two or three years of implementation. This is especially true if heavy emphasis is placed on large animals (cattle and pigs) which require high capital investment for the purchase of stocks and for housing construction. However, by increasing the area devoted to vegetable, there is a promise of increasing income in a short run. High costs of other components, like livestock can thus be offset. Therefore, farmers and programme practitioners should be aware that multi-enterprise integration requires high initial investments and start-up costs, especially if these components are introduced in a short period.

The vegetable and non-vegetable crop components are the most reliable technology components in terms of addressing cash flow needs during periods when investment costs are high. The livestock production however, proves to be a high potential stable source of income but requires longer gestation periods before cash returns are realized, besides being a steady source of manure for crop production (IIRR FLM Report 1990).

### Short and long term benefits

The soil fertility problem of most farmers is a big concern. There are already several technologies which are found effective to address soil degradation. It is now a matter of looking at these technologies and identifying those which suit farmers' criteria for acceptance. With this realization, institutions should be able to translate their long-term objective of improving soil fertility into the farmers' short-term objective of increasing farm income. ■

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**Angie Ibus**
International Institute for Rural Reconstruction (IIRR)
Silang, Cavite
Philippines

# Follow-up needed

**Readers are invited to reflect on the conclusions and recommendations of the ILEIA Workshop and, as ILEIA will also be doing, try to work with them and provide feedback.**

**Interaction between farmer and researcher is indispensable. Farmer explaining why she liked some bean varieties better than others. On-farm Research in Machakos District, Kenya. Photo: Ann Waters-Bayer.**

Rural economies are often poorly understood by outsiders and their diversity, complexity and risk-proneness is underestimated. Farmers' perception and therefore farmers' criteria and priorities are often overlooked or not well understood. As farmers use other concepts and terminology than outsiders, their reasoning and actual choices are not seen by outsiders. Technology assessment by outsiders is based on wrong premises. Where the focus is on sustainability, the matter becomes even more complex, as farmers' reality in all its aspects is involved. However, farmers' perception and criteria do not necessarily cover all aspects of sustainability. Scientific insight may be necessary to complement farmers' insight.

Further investigation is needed into farmers' views of sustainability as a concept and into the complex agroecological, socioeconomic, sociocultural and political processes and interrelationships involved in sustainable agriculture and livelihood management. These should be looked at from the farmers' as well as the outsiders' point of view. The limits to local rural economies determined by these processes, the availability of resources, the historical context and farmers' survival strategies have to be understood. Indigenous knowledge provides a wide source of information. The economic implications of LEISA for local economies as well as for the regional, national and international setting should be studied further to see how these can best be enhanced and guaranteed. Special attention should be given to preventing that sustainable agriculture ends up in the hands of an elite (of the rich, of men) because of economic advantages (Altieri 1989).

## Criteria and indicators

The bulk of quantified cases comes from on-station research. This kind of research is very much biased to one or two criteria: productivity and cost/benefit. Little attention is given to food security, taste and quality of food, minimising risks, labour needs and availability, equity in work load between gender, or to effects on soil life, erosion, nutrient balance, genetic diversity, or to interactions between techniques. Despite concerted efforts, ILEIA could not find cases where all major aspects of sustainability were analysed.

Most experiments cover one or only some seasons; research over several years is very scarce. In most publications there are many gaps in the data on the agroecological and socioeconomic conditions under which the experiments took place. These conditions and the ways the techniques are managed (e.g. quantities of inputs applied) generally cannot be compared with the conditions or resources that most farmers have to work with. These data, therefore, have only very limited relevance for farmers. Using these data to compare techniques with those presently being used by farmers or to compare with other research data is like comparing termites with mangos. Therefore, these research data give only limited indication of technology performance and but not "hard" evidence. Poor, incomplete reporting makes the data even less useful.

In technology assessment, all major effects of techniques should be assessed and related to farmers' conditions. Conclusions should preferably based on several years of monitoring. Complementarity between farmers' and researchers' criteria and indicators should be sought. We recommend use of the criteria checklist developed by the workshop participants, and welcome suggestions for improvement. The need to use a more holistic set of criteria and the difficulty of assessing many of these criteria with quantitative indicators cast a different light on the relevance of quantitative data. ▶

### Methodology

Appropriate methods to assess complex LEISA techniques are needed. However, in view of this complexity, the question can be raised whether outsiders will be able to fully analyse and understand rural economies in a time- and cost-efficient way. Participatory methods such as RRA, farmer surveys, farmer meetings, field days and farmer-to-farmer extension are indispensable for assessing technology under low-external-input conditions. Some interesting experiences with participatory methods are being made by NGOs, e.g. CARE in Kenya. Further information on and experiences with these methods are needed.

At the same time, long-term fundamental research such as that being conducted by TSBF, TropSoils and IBSRAM is needed to gain a better understanding of the ecological processes within agroecosystems and related to farming techniques. On-station and especially on-farm research is needed to preselect easily comparable techniques such as those which use different quantities of identical fertilisers, different kind of cover crops, different varieties of crops etc.

Technology assessment should be primarily based on farmers' opinion. Outsiders' insights, criteria (e.g. on nutrient balances, national economics) and indicators (e.g. chemical analysis) should be used in a complementary way, as when farmers' experience cannot cover all aspects of sustainability in the assessment. Participatory methods of technology assessment should be developed further. Training and information on these methods should be provided. Methods of participatory RRA should be given particular attention.

Research agendas and conditions should fit farmers' interests and conditions to the greatest degree possible. This is best guaranteed by farmer participation on all levels.

### Soil management techniques

There are relatively few data available on ecological techniques of soil fertility management. Attention is still very much biased toward chemical fertilisers. Integrated Plant Nutrient Systems have received very little attention thus far from research.

Some ecologically-oriented techniques, e.g. agroforestry, are beginning to receive more attention, but next to no data on performance are available yet (Scherr & Muller, this issue; Jickling 1989). Research on such techniques as green manuring, mulching and cover crops is still very limited. These techniques are very species-, site- and farmer-specific and therefore need extensive experimenting, preferably in a PTD context, to adapt them to local conditions (see Floquet, this issue).

### Ecological or chemical

The available data gives the impression that the effect on yield of ecological techniques of soil fertility management compares very well with the effect of chemical fertilisers, if comparable amounts of nutrients are applied (see "Researchers assess soil fertility techniques" and Van der Werf, this issue).

Chemical fertilisers are easy to handle, need little storage space, may give a fast yield effect and replace exported nutrients. Ecological techniques enhance control of erosion control, soil life, soil structure, water- and nutrient-holding capacity. They are also are cheap, decrease risk and may save foreign currency. Both ecological and chemical techniques, depending to some extent on how they are used, may have negative impacts. Ecological techniques may mine nutrients, enhance pests, be too labour-intensive or increase the workload of women. Chemical fertilisers may disturb soil life and micronutrient uptake (Chaboussou 1985), decrease soil organic matter and hence soil structure and water-holding capacity and disturb the nutrient balance, and they may be responsible for acidification of the soil, severe soil erosion and increased risk (Huijsman 1986). Efficiency of both types of techniques may be low when not well applied. In some experiments (see "Researchers assess soil fertility techniques") the highest yields were obtained when ecological and chemical techniques are used complementarily (Integrated Plant Nutrient Systems). In IPNS, the negative impact of chemical fertilisers is probably buffered to some extent.

But these are all not much more than impressions. Much more assessment of field experiences is needed to obtain convincing evidence of the real potential and limitations of combining these techniques. In older literature (pre-"green revolution"), useful information on ecological techniques can be found which should be made more widely accessible.

An important conclusion of the workshop was that farmers and scientists agree that ecological soil fertility management techniques are indispensible for sustainable soil management.

### Special attention

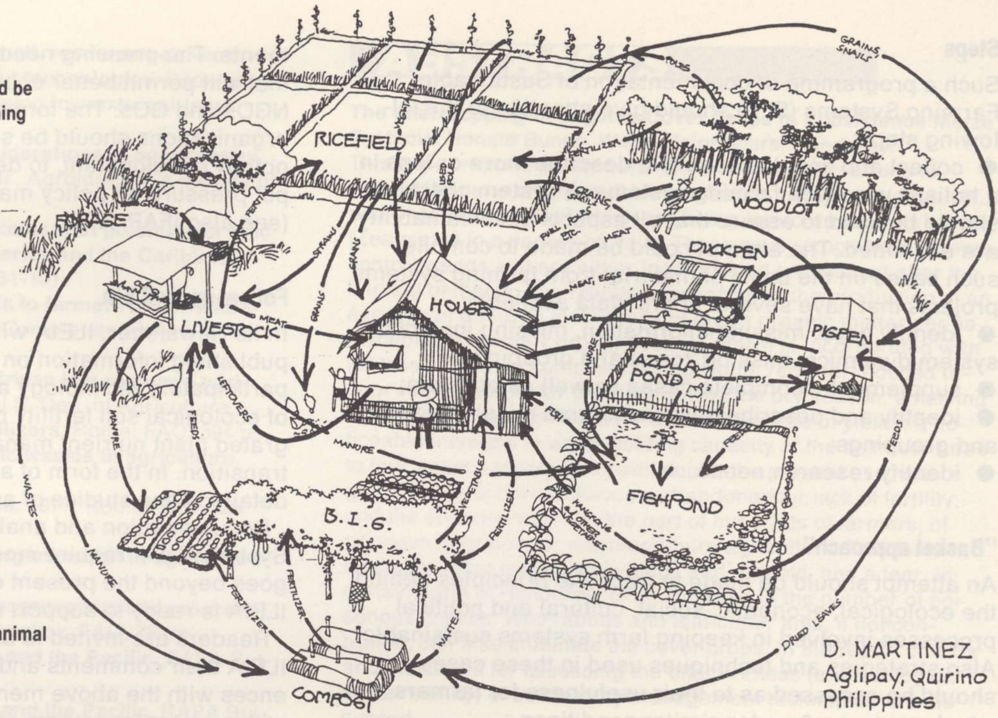
Four aspects need special attention in technology assessment:

Labour needs. The question if ecological techniques require more labour than chemical techniques, when and from whom, has been largely ignored by research. As this could be one of the main bottlenecks, this aspect needs much more attention. Important issues at farm as well as policy level seem to be: relative return to labour (in terms of products, cash and functions); different quality of labour tasks; distribution of labour within the household and over the season.
Development of implements and mechanisation adapted to LEISA should be given much attention so that the labour load of farmers, particularly women farmers, can be reduced.

Soil and water conservation. This should be enhanced by improving the farm system as a whole (improved land husbandry) instead of being approached separately. Techniques should be preferred that both increase yields and enhance water and soil conservation (Critchley, this issue). Besides their effects on yields, ecological techniques of soil fertility management techniques also prevent erosion. These techniques should be valued for this function, just as, e.g., chemical fertilisers should be given a "score" for only having an indirect function in erosion control or even having a negative impact. Participatory approaches to improved land husbandry e.g. as in the Projet Agro-Forestier in Burkina Faso, should be followed. Such approaches promise to lead to sustainable, integrated farm systems.

Nutrient balance. There is an increasing threat of nonsustainability due to nutrient mining under low-external-input conditions, as well as where chemical fertilisers are widely used (Smaling, this issue). The implications for food security and technology use have to be seriously studied. Where there are losses and export of nutrients (NPK and micronutrients), these have to be replaced by organic or mineral inputs of nutrients to guarantee sustainability. Where the available organic fertilisers do not suffice, mineral fertilisers are indispensible (Breman 1990). The positive yield effect of leguminous green manures may be only temporary when part of their biomass is exported from the field. Efficient IPNS may also be efficient in mining nutrients. Much more attention should be

Cases of Sustainable Farming Systems should be documented and principles of ecological farming should be analysed. Drawing: IIRR.




Seven village complex. Organic farming with animal husbandry is an integrated part of sustainable agriculture. Photo: Leonard Peries.

given to techniques that use nutrients efficiently, prevent losses of nutrients or recycle them. For example, how can nutrients be brought back from the town to the farm? What implications does this have for farming systems, rural economies and community organisation, especially where external inputs of nutrients and fossil energy are expensive, not available or ecologically harmful? Also: how can macro- and micro-mineral fertilisers be made available to low-external-input farmers at affordable costs? The IPNS Programme of FAO could be of value in gaining answers to some of these questions and in developing adequate strategies on national level. Due attention, however, should be given to ecological criteria, constraints and viewpoints of farmers.

Impact of chemical fertiliser. More research is needed on the impact of chemical fertiliser on, e.g., soil life, uptake of micronutrients, crop resistance to pests, and food quality. To what extent can negative effects of chemical fertilisers be counterbalanced by ecological soil management? What are the best combinations of chemical and ecological techniques under which conditions?

### Transition

There are many constraints that impede farmers from adopting techniques that are necessary to convert their farm systems to sustainable ones. There may be a lack of resources (e.g. financial, labour, knowledge, skills) or inputs (mineral fertiliser, seeds, planting material); or the results (yield, income) may not be attractive enough; or farmers may not feel comfortable with the technique (chemical fertiliser but also ecological techniques). It is therefore important to find the right "entry points" (see Mackay, this issue) or starter techniques and the right combination of follow-up techniques (van der Werf, this issue) that may relieve these constraints. Also participatory approaches to strengthen farmers' capacity to innovate can play an important role in enhancing transition (see Projet Agro-Forestier, this issue).

Experiences with transition toward sustainable agriculture should be collected and analysed. Constraints to and opportunities for transition urgently require further research. Which techniques have been used successfully, where, under which conditions and in which sequence? What role should field organisations and policy makers play in order to create conditions that give farmers access to the necessary resources and inputs in an economically viable way?

### Sustainable farming systems

The workshop concluded that there is a need to collect and document case studies of farming systems that managed 'change' in an effective way, systems which adapted and managed to keep functioning despite considerable stress. This should be done for the main agroecological zones and socioeconomic and cultural groupings. For this purpose, it may be useful to distinguish different groups of farmers based on the following factors:

agroecosystem: humid, subhumid, semiarid, highland; different soil types;

cultural background: indigenous pastoralists and cultivators; transmigrants without sound traditional knowledge for the new site and/or socioeconomic institutions concerning the use of the local natural resources;

history: place in change process, e.g., from shifting cultivation to permanent cultivation; from traditional to "green revolution" to post-"green revolution";

intensity in which the ecosystem is used: underexploited, balanced, overexploited;

market orientation: mainly subsistence – producing marketable surplus on the basis of low-cost external inputs – completely market-oriented. ▶

## Steps

Such a programme of documentation of Sustainable Farming Systems (SFS) should give attention to the following steps:

- collect and collate cases that describe more or less in a holistic way such farming systems. A system checklist should be used to assure that all aspects of sustainability are examined. The attempt could be made to compile such cases on the basis of material from farming systems projects that have several years' data available;
- identify gaps: missing information, missing insight in system dynamics, missing zones and groupings;
- supplement incomplete cases as well as possible;
- identify and describe new cases from missing zones and groupings;
- identify research needs.

## "Basket approach"

An attempt should be made to trace the principles behind the ecological, economic, social, cultural and political processes involved in keeping farm systems sustainable. Also strategies and techniques used in these cases should be assessed as to their usefulness for farmers who have to work under similar conditions.

In this way, for every major agroecozone and socioeconomic grouping, a compilation of possible appropriate management principles, strategies and techniques could be made. Because LEISA techniques can be described as site-specific and knowledge-intensive, the conventional way of handling and/or transferring knowledge by delivering a technology package from research via extension to the farmer cannot apply. Instead, the workshop participants recommended a "basket approach". Strategies and techniques adapted or developed by farmers (perhaps in cooperation with research) are presented in such a way that farmers can make their own selection.

## Strategies and policies

In the same way, an attempt should be made to develop – per zone and per grouping – methods, strategies and policies to develop the present systems toward Sustainable Farming Systems (SFS). Here, importance is given to:

- entry points or starter techniques
- sequencing of techniques
- communication systems between the different actor groups, e.g. farmers, fieldworkers, researchers, policy makers.
- methods to strengthen the innovative capacity of farmers and the role of the different actors in this process
- methods to create the necessary preconditions for sustainable agriculture such as guaranteed landuse rights (with special attention to women's rights), commercial infrastructure, credit, subsidies, pricing, training, education, extension services, research.

## Institutionalisation

The quest for sustainability calls for cooperation between the different actors involved, to guarantee the best use of available experiences, knowledge and skills and a democratic balance between all interests involved. This asks for effective participation, communication and interaction on all levels. To achieve this, considerable changes in the vested development institutions are needed. Research of OBI (see Farrington, this issue) revealed that, as NGOs are often more open for and skilled in communication with farmers, they should play an important role in technology assessment and development. NGOs have an important task to "pull" government research and extension programmes round to meeting small farmers' requirements. The pressing need is for sensitive approaches that will permit better cooperation between farmers, NGOs and GOs. The formation of rural-based farmers' organisations should be supported as vehicles for technology development, to defend farmers' interests and to put pressure on policy makers to promote LEISA systems (see also IFAP 1990).

## Follow-up by ILEIA

In its Newsletter, ILEIA will follow up on this workshop by publishing information on local economies, methods of participatory technology assessment, farmers' evaluation of ecological soil fertility management techniques, integrated plant nutrient management, and experiences with transition. In the form of a reader, ILEIA will publish more detailed case studies of assessing LEISA technology.

Documentation and analysis of "Sustainable Farming Systems" will require more systematic research which goes beyond the present capacity of ILEIA. Nevertheless, ILEIA is ready to support initiatives in this field.

Readers are invited to assist in the follow-up by sending ILEIA their comments and further information on experiences with the above mentioned subjects. Experiences with and improvements of the criteria checklist for assessing technology are especially requested. ■

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## ABSTRACTS

**The Intercropping of Legume Cover Crops in Subsistence Maize Systems.** Ronald Bunch, World Neighbours, Honduras.
This paper reports on farmers' experiences with various legumes (*Mucuna pruriens, Dolichos lablab, Lathyrus nigrivalvis, and Crotalaria juncea*) which are being intercropped with maize (*Zea mays*) in a variety of ways. These cover crops help farmers control weeds and are either incorporated or mulched after the harvest of maize. The results have included the production of an average of about 35 metric tons of green organic matter per ha (except in extremely drought years), which is incorporated with far less work than compost making would require; reduced labour requirements for weeding during the dry season; a halving of previous chemical fertilizer use with no loss of yields; a noticeable increase in water holding capacity of the soil over three to four years; increased topsoil depth; the present use, with good yields, of soils previously abandoned for lack of fertility; and the abandonment, on the part of hundreds of farmers, of previous migratory or slash-and-burn agriculture. Problems include probable increases in slugs and rodents, and a fear, in certain parts of Honduras, of an increase in the number of poisonous snakes. Wild rabbits and leaf-cutter ants, if not controlled, can also eliminate the cover crops. In the report criteria and indicators for assessing the effectiveness (a.o. ecological sustainability) of soil fertility management techniques are discussed.

On-station research of green-manures in Paraná, Brazil. Photo: R. Derpsch.

**Winter cover crops for corn production under minimum till system.** Ademir Calegari, IAPAR, Brazil.
This paper describes a four year field experiment in which various winter cover crops (*Vicia villosa, Vicia sativa, Lathyrus sativus, Ornithopus sativus, Avena sativa, Raphanus sativus, Spergula arvensis*) are evaluated to determine their contribution to the replacement of fertilizer-nitrogen requirement of minimum till maize. The efficiency of nitrogen in maize production was enhanced by the use of an annual winter leguminous cover crop. Vicia villosa supplied nitrogen to subsequent maize equivalent to 170 kg/ha fertilizer-nitrogen. The overall results indicated that a substantial increase in maize yield usually occurs in response to the advantages of an annual winter cover crop.

**Development of Low-External-Input Sustainable Agriculture in San Pedro Norte, Paraguay.** R. Derpsch, Proyecto de Desarrollo Rural San Pedro Norte.
Research is directed to improve the traditional farming system especially by introducing cover crops and green manuring as well as crop rotation and eventually agroforestry. Experience has shown, that green manure crops will only be used by farmers if yield increases can be expected in the succeeding crop, and if costs and labour requirements can be reduced, or other advantages can be obtained in the short term. Highest average yields of cotton was observed after *Crotalaria juncea* (3,14 t/ha)

and *Mucuna pruriens* (grey seed) (3.03 t/ha), with yield increases of 40% and 37% resp., as compared to the yield after traditional fallow (2,21 t/ha). The highest grain yields of maize were observed after *Mucuna pruriens* (black seed) (5.18 t/ha) and *Mucuna pruriens* (grey seed) (4,67 t/ha), when yields were 95% and 76% higher resp. than the yield after traditional fallow (2,66 t/ha). Research results show, that not always will green manure crops have a positive effect on the succeeding crops, and therefore no general recommendations on the use of green manure crops can be made. Many farmers are adopting green manuring more because of the reduction in the weed infestation and the consequent reduction in labour requirements, than because of expected yield increases.

**Soil fertility management of paddy fields by traditional farmers in the dry zone of Sri Lanka.** Rohana Ulluwishewa, University of Sri Jayewardenepura, Nugegoda, Sri Lanka.
Traditional farmers in the Dry Zone of Sri Lanka maintained soil fertility of paddy fields for centuries without applying mineral fertilizers. Some of their traditional cultivation practices not only preserved the natural processes which lead to the regeneration of fertility, but also added nutrients to the soil. The paper highlights those traditional practices – fallow period, application of green manure and animal waste, aquaculture in paddy fields, utilization of nutrients in irrigation water and planting trees on paddy fields. Why these practices ceased to exist with the introduction of agricultural modernization and increased population is examined.

**Assessing low-external-input farming techniques. The agroforestry project of the Ghana Rural Reconstruction Movement.** David Yaw Owusu.
This paper describes farmers' experiences with agroforestry in the Mampong Valley. Farmers have their own indicators for assessing soil fertility improvement and these are usually qualitative rather than quantitative: e.g. growth performance (a.o. during dry season), yield, soil fauna (earthworms), soil colour (darkness), soil structure (softness of soil), moisture content (soil temperature). Labour need, root competence (with cassava) and risk of tree seedlings becoming weeds are experienced as problems. By giving support to farmers who experiment with agroforestry, GhRRM has gained important insights: the problem of land tenure has to be tackled much more seriously; cultural background of farmers has to be studied critically so that the proper educational approach can be made; farmer-to-farmer extension is a highly recommended approach.

**Some experiences with low-external-input cropping systems in a former transmigration area in Lampung, S. Sumatra, Indonesia.** Meine van Noordwijk, Kurniatun Hairiah. In a collaborative research project of Universitas Brawijaya (Indonesia) and the Institute of Soil Fertility Research (The Netherlands) long-term soil fertility trials were started which are focused on nitrogen management in three types of cropping systems: 1. cassava-based cropping systems with various intercrops; 2. maize/legume rotations; 3. hedgerow intercropping with maize and soybean a food crops. The experiments are aimed at evaluating the nitrogen balance of the various cropping systems and to evaluate their sustainability. Preliminary results are given on processes (N-loss, erosion and weeds), components (performance of various crops, cover crops and hedgerow species) and cropping systems. Some remarks are made on the communication between farmers and researchers.

**A socio-economic analysis of the sustainability of bush-fallow system in Nigerian agriculture.** P. Adebola Okuneye, Nigerian Institute of Social and Economic Research, Ibadan, Nigeria.
Today, the small scale farmers still represent about 90% of the farming population and produce over 85% of the total Nigerian agricultural output. The fall in fallow period has led to poor agricultural productivity particularly in areas with marginal or steep lands where the traditional "slash and burn" farming system has caused severe environmental degradation. "Structural Adjustment" will lead to a minimisation of the use of external inputs. It is therefore important to evolve improvements in the bush-fallow system through self-sustaining and low-input technology and a re-orientation of farm research using the bottom-up approach rather than top-down approach, for effective farmer participation.

**Analog forestry – A strategy to reverse the trends of rainforest loss.** Ranil Senanayake, NeoSynthesis Research Centre, Mirahawatte, Sri Lanka.
This paper compares the different characteristics of tropical rainforests, traditional forestry and analog forestry. This last type of forestry being an attempt to create a physical structure and a set of ecological relationships that is analogous to the natural climax state, or end condition of an ecological process termed succession, by using trees and plants similar to the natural structure, but being useful to man as crop plants. While much of the hill zone villages of Sri Lanka possess rudiments of forest analogues, its potential for development was not recognized until 1980, when experiments on design and development of these forests were begun at the NeoSynthesis Research Centre. These experiments confirmed the ecological and economic validity of such plantings. The creation of national centres, capable of testing and designing a wide array of tree crops to fit into the economic, social and ecological needs of communities, will be required if the data now emerging is to be translated to the ground.

**Some observations on farming techniques and designs during transition stage to low-external-input sustainable agriculture.** Teodoro C. Mendoza, Dep. of Agronomy, U.P. at Los Banos, Philippines.
This paper describes the transition process of a farm in Central Luzon. The experiences emphasize the need for re-landscaping the farm for the following benefits: 1. to develop a suitable micro-environment; 2. to achieve proper "crop species – soil environment mix"; and 3. to achieve farm level diversity of crop species. Complementary farming techniques that minimize the need for external input are described. Insights learned in the process of adopting LEI-farming techniques are: 1. farming in practise is dynamic. Practices vary from season to season; 2. mistakes cannot be avoided but by crop diversity greater probability of success can be obtained; 3. an important determinant of LEI-farming is the motivation and vision of the farmer.

**Strategy for increasing land and livestock productivity in the Himalayan environment.** Vir Singh, G.B.Pant University of Agriculture and Technology, Ranichauri, India.
The land-use system of Dwarahat Block is analyzed. At present rapid deforestation threatens the future productivity of the entire system. Community forestry on common land to meet the people's firewood and fodder requirements needs to be undertaken in order to stabilise the system and improve its productivity. The probable impact of community forestry on the system is an increase in the productivity of the land, estimated to be 60 and 185 percent for foodgrains and milk, resp. Commercial timber production from reserve forests could increase several fold.

**Peasant's production systems and their knowledge of soil fertility and its maintenance. The case of Iringa District. Tanzania.** Helle Munk Ravnborg, 1990. CDR Working Paper 90.1. Centre for Development Research, Gammal Konjevej 5, 1610 Copenhagen V, Denmark. 44 pp.
The field study was carried out in order to identify to which extent peasants have a concept of environmental sustainability in relation to their agricultural production. in particular, emphasis is given to the utilization and maintenance of soil resources. Systainability is not the ultimate goal for peasants in Iringa District. The goal is rather to maintain or increase the output, given the resources available. Farmers surely have a notion of unsustainability, but not until signs of unsustainability have appeared. Such signs have appeared in part of the study area with soils generally being of low fertility and with pronounced land scarcity making fallow rotation difficult. However, since means of improving soil fertility, such as manure and to some extent fertilizers, were hard to get hold of, these farmers saw no other solution than continuing their present practices. In an other part of the study area farmers largely benefitted from yield increases due to the use of fertilizers. However, the sharp increase in the price of fertilizers and diminishing effectiveness of fertilizers, after using them for maybe 10 years in countinuous maize cultivation, led to reduction in the gains of fertilizers and the necessity of a fallow period of 3-5 years. Although this was often raised as a problem, land allowing for fallow rotation is still available. ■

# A workshop on Networking for LEISA

**In March 1992, ILEIA together with IIRR and World Neighbors will be organizing a workshop in the Philippines. The basic objective of the workshop is 'to document experiences of field based organizations in creating a favourable environment for LEISA development, and to draw conclusions on strategies which hold promise for enhancing LEISA'.**

Gradually the principles of LEISA are more widely understood and farming techniques that lead to LEISA are being documented and developed in a wide range of different agro-ecosystems. However, perceiving and handling the problem of LEISA as a technology development problem, at the farm or community level, is not sufficient. There are many socioeconomic factors at local, regional or national levels that determine what is produced, how it is produced and what the benefits are for farmers. These in turn are influenced by national and international policies and politics, e.g. farm prices, subsidies on inputs and legislation on land tenure and land-use rights. Programmes for rural and agricultural development of government agencies and NGOs have a significant impact in many rural areas and form important opportunities as well as constraints for enhancing LEISA.

### Networking for LEISA

These factors have to be considered in a strategic way by organizations wishing to promote LEISA. Informal and formal networks to promote LEISA are emerging in different parts of the world, either on a local, national or international level. Activities taken up by such networks include joint training of staff, political lobbying, setting up documentation and information centres, cooperation with research institutes, joint campaigns, etc.

Yet such strategies to enhance LEISA, the methods to implement them, and the institutional implications are not well documented. Basically many organizations and emerging networks are struggling on their own, using their own intuition or philosophy.

Experiences of similar efforts in other fields (e.g. village health care, renewable energy, small farmers' participation) have often been neglected. As a result a wide variety of strategies in institutional cooperation and networking to enhance LEISA exist and questions on how to proceed are being asked with increased urgency.

How can networking help to promote LEISA, for example in Ghana? Photo: Berna Haverkort.

### The focus of the workshop

The workshop will build on the experiences of grassroot organizations as well as their support organizations in their efforts to further develop and promote LEISA. It focusses on two questions:

– How can networking between individuals and organizations help to promote LEISA: what forms and what processes are effective?

– What would be adequate strategies for such networks in the choice of activities, their timing and sequence?

### Questions to be dealt with

In relation to the question on networking, experiences of existing networks should help us to answer questions such as: What are roles and functions for such networks? What is the process of establishing networks; who should take the initiative and when? (how) Are participants selected? What are different stages in the process? Is there a need for support from elsewhere? What forms and organizational structures are appropriate; what is the optimal size? Should the network focus on government agencies, NGOs or farmers? Is there a need for and what is the role of staff employed by the network? Are financial contributions needed? How should communication within and decision making by the networks be organized?

In relation to the second question, on strategies to enhance LEISA, we ask ourselves what are the activities that organizations/individuals should do jointly, how could they be planned and what would their sequence be. Activities frequently mentioned in this respect include: training of field staff in LEISA, Participatory Technology Development (PTD) or other issues; documentation of LEISA/PTD results and making these results available to network members and others; publicity for LEISA/PTD to the general public; liaison with agricultural research institutes, aiming at influencing the research agenda; influencing policies of governments and/or international organizations (e.g. on subsidies, pricing of agricultural products, land tenure and land-use rights); marketing, i.e. developing and organizing the market for organic or LEISA products.

### Your help is essential

As it is now, the subject is still broad and many questions are asked. Your response should indicate how the subject is to be narrowed down. In what stage or field arise most problems, what are the most burning questions to be studied? Readers are therefore urgently invited to write down their experiences with the issues mentioned earlier. Attempts of networking that failed are at least as valuable. It would greatly help if you could describe your experience with the help of the following questions:

planning: what was the initial justification, plan and objectives?

implementation: what activities have actually been implemented?

evaluation: what has been achieved? how was monitoring and evaluation organized?

recommendations: based on the experiences described, what actions would be recommended?

As your contribution is meant to further develop the focus of the workshop, it is needed in an early stage. We would be happy to receive it before 15th July 1991. ■

GLOBAL

# Whose common future?

**In preparation for the 1992 United Nations Conference on Environment and Development (UNCED) in Brazil, the journal "The Ecologist" is compiling a report "Whose Common Future?" It will try to reflect, as far as possible, a grassroots view of a just and sustainable economy. The issues to be addressed in the section on agriculture, entitled "Agricultural Development – In Whose Hands?", are outlined below. You are invited to share your experience, both if you agree or disagree.**

**Nicholas Hildyard**

Over the last 40 years, almost all farms in the industrialised world have abandoned nonchemical or organic agriculture in favour of farming with chemicals and modern machinery. Developing countries have seen their traditional farming patterns transformed. Many farmers have been persuaded to specialise in a few export crops, in order to gain competitive advantage in the world market.

### "Development"

The overall effect has been devastating for rural people. Farmers have lost power over their lives and land, as pursuing their livelihood relies increasingly on cash and credit controlled by others. Crops are more vulnerable to pests. The soil is increasingly beset by new problems such as salinisation, erosion and reduced fertility. People have been forced off their land or compelled to adopt environmentally harmful practices by debt burdens or because communal land-use rights are ignored. Malnutrition results from a lack of variety in available food. Intensive monocropping disturbs the ecological balance.

The "green revolution" has failed. While greater yields have been achieved for single crops, when output is measured over time, taking into account the costs of subsidies, fertilisers, pesticides, the loss of other biological resources (e.g. other crops, fodder, fish) and the damage to the ecological balance, the final output is a disastrous "deficit" and drain on the rural economy. Economic growth cannot be sustained as the natural resources are being rapidly depleted. Today, malnutrition, starvation and famine are on the increase. In Africa we are now witnessing famine on a massive scale, with two out of every three countries affected. In many regions malnutrition is no longer a periodic phenomenon; it is constant.

- Do you agree with the above description of "development"?

"Whose Common Future?" Has your area been affected by "official solutions"? On what do sustainable livelihoods really depend? Photo: Wim Hiemstra.

- What specific "development" policies have affected your area?
- How has your community been affected? Do you have some specific examples of the effect on one family, one village, or statistics or analysis for the overall region/community?

### Official "solutions"

Despite the clear link between current agricultural "development" policies and the growing social and ecological impoverishment, the agencies charged with addressing the world food crisis continue to propose "solutions" that can only intensify the destruction.

Major research or development agencies such as the international research centres, FAO, World Bank and the UN Development Programme continue to advocate agricultural modernisation. Their solution is to extend the area under crops, sacrificing forests or opening up marginal farming areas vulnerable to serious erosion; increasing the use of chemical inputs, hybrid seeds, machinery and irrigation water; reinforcing export-led development strategies; and promoting biotechnology (particularly genetic engineering).

Through these policies, greater numbers of farmers are losing control over their lifestyle, resources, land and income.

- Has your area been affected by "official solutions"? If so, which ones and how? What are your views on these solutions?
- Have you cooperated with or resisted such plans? What was the outcome?
- What regional programmes would you advocate to achieve a just and sustainable agricultural economy?

### Sustainable alternatives

Numerous well-proven systems of farming still exist throughout the world which do not require chemical inputs and do not cause erosion, salinisation or other problems associated with modern intensive agriculture. Many combine the insights of modern holistic science with the wisdom of traditional practices. They include permaculture, no-tillage system, organic farming, biointensive agriculture, sustainable systems using perennial varieties, and systems of mixed cropping and companion planting. Such systems are economically viable and productive.

- What agricultural alternatives is your group, movement or organisation proposing or engaged in?
- How has your group promoted these alternatives?
- What hinders or prevents you from carrying out your alternatives?
- What assists (or would assist) you to carry out your alternatives?
- On what do sustainable livelihoods of farming communities depend?
- Does the problem of land-use rights affect you? In what ways?
- Have you experienced government land reform? What are your views on this?
- Is your community dependent on the export market? If so, what would you do about this, if anything?
- Are the richer becoming richer and the poorer becoming poorer in your community and, if so, how do you deal with this?
- Is there increasing government influence over agriculture in your area and, if so, how do you deal with this?

**Write about your experience to**: The Ecologist – Whose Common Future? Attn: Nicholas Hildyard, Station Road, Sturminster Newton, Dorset DT10 1BB, UK. Or at least send your reactions to the above text, as this will also contribute to the report. ■

# FAO moves into sustainable agriculture

**Coen van Beuningen and Bertus Haverkort**

**From 15 to 19 April 1991, the FAO and the Netherlands Ministry of Agriculture held a Conference on Sustainable Agriculture and Rural Development in Den Bosch, the Netherlands. It was preceded by a seminar on LEISA, in which NGOs formulated an input into the FAO Conference. With the 'Den Bosch-declaration', it looks like the FAO will move into sustainable agriculture. But...'the proof of the pudding is the eating'. Two NGO-participants report.**

Farmers transplanting rice on an ecological farm in India. Photo: Erik van der Werf.

The Conference sees as the major challenge for agriculture in the coming decades "to feed the growing number of people from a natural resource base which is already seriously threatened by unsustainable farming practices". To meet this challenge a number of fundamental changes are required which include "the active involvement of rural people in the research and development of integrated farm management systems maintaining the essential biological processes; decentralization and enhancing the local communities' management capacity; improving land-use rights, investments in enhancing and conserving natural resources, adjustment of macro-economic and agricultural policies; encouraging demand and promoting production of indigenous crops and animals that can be produced and processed sustainably and of practices that safeguard human health and environmental quality".

## Agenda for action

"The transition towards sustainable agriculture will require new investments and re-allocation of existing financial resources. In this transition phase, the overall production and income of some producers may initially reduce. Therefore parallel action and outside support will be required.

National action will include: accelerating the development of rural organizations with participation of women, small farmers and the landless; human resource development; community based resource management; providing services for the optimum use of on-farm inputs and the minimization of the use of external inputs; enhancing production of renewable energy sources. Diversification of agriculture should be promoted e.g. by promoting traditional food crops, intercropping, agroforestry and aquaculture.

Sustainable agriculture requires redirecting research towards indigenous technologies and towards biological processes developing a diversity of farming systems in which the efficiency of use of external inputs is maximized and their use and environmental impact is minimized. The need was expressed to develop criteria, indicators and methods for assessing farming methods and it was recommended to inventorize and study diverse forms of agriculture, including LEISA and organic farming. International cooperation and action is required for funding, data collection, setting codes of conduct and standards, review of rules for international trade and "debt-for-sustainable-agriculture" swaps." The declaration can be requested from the FAO (Via delle Terme di Caracalla, 00100 Rome, Italy).

## Important step forward

The conclusions and recommendations of the Conference are an important step forward. The atmosphere during the conference was open and the positions and experiences of NGOs were taken serious. However, the proof of the pudding is the eating: it is not the rethorics or semantic upgrading of existing programmes that count. In order to implement the recommendations a major change will be required not only in documents and plans but in the minds, attitudes and activities of people. Adjustments of many ongoing FAO project activities in the field still need to be made, and their implementation needs to be planned carefully.

The conclusions acknowledge the importance of participation of the poor rural population. Yet, in the phrases such as "to strengthen the capacities for agricultural research, technology transfer and adoption by the farmers" a top-down approach is suggested, and nowhere recognition is given to the farmers' own experimental activities. This may lead to strengthening the conventional research and extension approaches, which are in fact part of the problem. Therefore an elaboration of the research and extension approach to be followed is highly necessary for which the experiences in Participatory Technology Development can provide an important basis.

In the proposals for action the possibilities of an approach that aims at regenerating and enhancing the natural resources are hardly mentioned and not elaborated in concrete proposals for action. The tensions between the need for short-term food production and long-term (natural) resource availability can only be overcome by such a regenerative and resource enhancing approach.

The conference gave little attention to the North-South relations and to national pricing policies for farm inputs, farm products and consumer goods. Although the need for macro-economic adjustments has been mentioned, concrete proposals for these adjustments have not been made. The conclusions make reference to the International Code of Conduct on the distribution and use of pesticides. However, no mention has been made of the implementation of this code of conduct nor of the possibilities to establish control mechanisms. Codes of conduct related to issues as trade, fertilizers, biodiversity and farmers' rights with respect to indigenous knowledge and local innovations have not been mentioned.

In conclusion, FAO appears to make an important step towards sustainable agriculture. We look forward to its implementation and to the formulation of next steps as there is still a long way to go. ■

# KEEP ROLLING

## INDIGENOUS KNOWLEDGE

# The spinach tree – a versatile crop for semiarid areas

**Introduced species – particularly ones which enter through informal communication channels – can become so integrated into "traditional" farming that they become part of indigenous knowledge. Ronald Watts discovered that peasants in Zambia have long been growing the spinach tree (Moringa oleifera) to produce leaves for "relish". This encouraged him to find out more about the tree.**

**Ronald Watts/Zambia**

**An impressive orchard of Moringa oleifera at Siatwinda in Zambia in the hot and dry Gwembe Valley. The trees have been pollarded because of the regular use of leaves. Photo: Ronald Watts.**

It was at the southern end of Lake Kariba that I first became aware of the spinach tree. The farmers told me it came across the river from Bulawayo in the days before the dam. Several orchards were probably covered by the rising waters. In over 30 years of working in Africa, it was the first tree I had seen grown by peasants on a substantial scale for its leaves. The farmers said that people with this tree were besieged by neighbours during a drought year because they could not find any "relish" to go with the staple food. Relish is ideally made from a mixture of meat or fish, groundnuts and vegetables but a poor person will sometimes use only spinach leaves. As the leaves of Moringa oleifera are a good substitute for spinach, an appropriate name in Zambia would be "Relish Tree". Other names include Benzoline, Mother's Best Friend, Drumstick Tree and Horseradish Tree (the roots taste of horseradish).

**Better than Leucaena**

We have all heard of multipurpose "miracle" trees that could revolutionise farming, e.g. Leucaena. Where Leucaena is difficult to grow, Moringa can serve many of the same purposes. It seems to have excellent prospects as a fodder tree. Its main advantage over Leucaena is that it can be propagated from cuttings and, if a large cutting (ca 2 m) is planted, the tree is immediately out of reach of free-roaming animals. Another problem with Leucaena is that termites attack the young seedlings in the dry season. Termite attack seems to be less of a problem in Moringa. In any case, cuttings are less vulnerable than seedlings because of their size.

Moringa can also be grown from seed. Germination takes place very quickly and early growth is phenomenal. According to Roy Danforth in Zaire (Echo Technical Note A-5), one 3-month-old tree grew to almost 3 m. Another tree grew to about 5 m in 9 months. The trees I saw in Zambia had obviously been regularly cut at about 2 m high to provide relish.

**Suitable natural conditions**

Moringa is grown throughout the tropics, most notably in the Philippines, Haiti and Hawaii. In Africa it is grown along the Nile in Sudan and in Uganda, Zaire, Cote d'Ivoire and several other countries. According to the ICRAF database, the tree grows well in the following conditions:

Mean annual rainfall: 366-1177 (!) mm
Annual mean minimum temperature: 18-20°C
Annual mean maximum temperature: 31-34°C
Absolute minimum temperature: 6-8°C
Altitude: 0-660 m

Moringa also grows at higher altitudes, as a specimen tree has grown for many years in the Harare Botanical Garden (1470 m). Echo reports that it grows in Nepal. In the Dominican Republic, it is said to withstand frost and even frozen soil.

According to ICRAF, Moringa likes light sandy and medium loamy soils with a minimum depth of 50 cm and no waterlogging. It will stand some acidity. Beth Mayhood (Echo) reports that it also stands alkalinity and a high salt content. In dry areas Moringa needs a reasonably high groundwater table.

The tree can be propagated in several ways. According to ICRAF, it will grow from stumps, seedlings, natural regeneration, coppicing, air layering, direct sowing and cuttings. Zambian farmers said that the best time for planting cuttings was in the late dry season, but this may depend on soil type and termite challenge. A nursery at Magoye in Zambia's Southern Province reported problems with termites when cuttings were grown in plastic pots, but achieved some control by planting with the plastic sleeve as protection. The tree can be grown as a hedge. When it is used mainly for the roots, it is grown from seed in beds like a vegetable.

**Dung beetles will be rolling up the themes again. When we publish a Newsletter on a certain theme, we hope that readers will digest it so that new ideas can emerge. In this section "Keep rolling", you have a chance to present further information about themes highlighted in previous issues, thus giving still more food for thought and action.**

**Wide range of uses**

Moringa can be used in a multitude of ways. Its main deficiency compared with many leguminous trees is that it does not fix nitrogen. As it is deep-rooting, it could also be tried in alley cropping.

!CRAF also lists the use of Moringa for cosmetics, insecticides, fibres and aromatic essences. Maydell (1986) reports a wide range of medical applications.

**Many management possibilities**

The farmers near Lake Kariba plant Moringa in and near their compounds, so the leaves are readily accessible for cooking and the trees provide shade. Since branches and leaves are constantly being removed, pruning is automatic, but would need to be done anyway to prevent lanky growth and breaking branches during high winds. The height of cutting would depend on access of domestic animals, particularly goats. Spacing depends very much on use, the widest spacing being in woodlots and the closest when Moringa is used as a root vegetable. The range would thus be from 4 m to 20 cm.

| USE | NOTES | REFERENCE |
|---|---|---|
| **1. Leaves as vegetable**<br>Pick young, remove stems, steam for few minutes; | high in Ca, Fe and vitamin A | Martin |
| **2. Edible roots**<br>Grind taproot of young plant, add vinegar and salt to make horseradish sauce | | Echo |
| **3. Edible pods**<br>Cut in short lengths, boil 10 minutes; makes mock asparagus soup, | add milk and season to taste | Alicia Ray (Echo) |
| **4. Edible nuts and seeds**<br>Cook seeds before they start to turn yellow; dry seeds have bitter coat which limits use | | Maydell |
| **5. Edible oils and fats**<br>High oil content (38%), remove oil with press, used for cooking or lubricating, also used as soap | | Alicia Ray (Echo); Brandis |
| **6. Seeds to purify water**<br>Suspension of seed as primary coagulant to remove turbidity and bacteria, | doses up to 250 mg/l | Jahn et al |
| **7. Flowers**<br>Eaten and used to make a tea; used as a cold cure; source of pollen and nectar in apiculture | | Alicia Ray (Echo); Okafor; Singh |
| **8. Livestock feed**<br>Fruit, pods and seeds used as fodder; shoots and leaves highly palatable, can be fed as supplement, young leaves contain vitamin C | | Singh; Price; Maydell |
| **9. Fencing**<br>Makes good live fencepost for wire; plant closely from seed or cuttings for living fence/hedge | | Okafor |
| **10. Pulpwood**<br>Wood very soft | | Singh |
| **11. Fuelwood**<br>Exceptionally quick growing, acceptable firewood, | not suited for charcoal | Singh; Price |
| **12. Shade/ornamental**<br>Grown in compound; feathery, fern-like leaves makes it attractive | | Okafor |
| **13. Soil conservation**<br>Quick growth and natural regeneration | | Okafor |
| **14. Magic rites**<br>Used against witchcraft and hyenas | | Maydell |

**Potential in Africa**

For a peasant farmer to grow 20-30 Moringa trees on his own initiative around his compound must mean that the tree has considerable potential. Much research is needed to find out how its obvious qualities can be used more widely. Farmers could gradually extend tree cultivation, starting with a few around the house and could then expanding to a plot for feeding livestock in dry periods, and later planting it all over the farm along contours to prevent erosion or for alley cropping between annual crops. The area in Zambia where I first saw Moringa has a mean annual rainfall of about 700 mm but a very severe 7-month dry season. In such an area, the main factor which might limit the spread of Moringa would be the presence of groundwater at a reasonable depth.

In this area of Zambia, a detailed study of the food economy of the Tonga people was made from 1957 to 1971 (Scudder 1971). Moringa oleifera was mentioned as an introduced species in Mwemba villages, and given the local name Zakalanda. The study focused on the 131 wild plants eaten by the Tonga. While there is nothing wrong with eating wild plants, these must increasingly be supplemented by cultivated crops. The population of the area has risen greatly since 1957 and has been concentrated on higher ground after the flooding of the Zambezi Valley by the Kariba Dam in the early 1960s. The fact that these farmers have adopted Moringa without encouragement from extensionists is a good omen. It opens up the possibilities for agroforestry in a semi-subsistence economy. This would have tremendous benefits in ensuring more ground cover, reducing erosion and, at the same time, providing both humans and livestock with a better and more reliable diet. ■

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**Ronald Watts**,
Dept of Community Medicine
PO Box A178,
Harare, Zimbabwe

# NETWORKING

**NEW ECONOMICS FOUNDATION**. A growing number of people are working out new ideas the change the prevailing and polluting market economic system. The emerging New Economics is humane, just, sustainable and culturally appropriate, based on people's needs. Current projects and initiatives of the New Economic Foundation (NEF) include formulating alternative economic indicators, investigating community enterprise, energy conservation spreading economic alternatives for Eastern Europe, researching links between economics, trade and the environment, linking faith and ethics to economics, understanding social investment and sustainable development. NEF is thus far mainly based in Europe and North America, but they want top learn from Southern experiences. NEF organizes conferences, publishes a quarterly Newsletter and books on environment, society and economics; local economic development; trade and self-reliance; sustainable development; 1992 and the EC internal market. Write to: NEF, 88-94 Wentworth Street, 2nd Floor, London E1 7SA, England.

**LOCAL SEED SUPPLY SYSTEMS**. A team of the Development Research Institute (IVO) in Tilburg, the Netherlands and 3 teams in Costa Rica, Honduras and Nicaragua started a project on 'Local seed supply systems'. The project will analyse the socio-economic importance and potential of local seed systems for national food security. Information on practices of small farmers to produce, obtain, store, select and use seed; the type of genetic material in used; their criteria for crop and variety choice, etc. will be collected. The project will pay special attention to the role of women and ecological aspects. Case studies will be carried out in the above mentioned countries to actively search in the field for information and farmers' knowledge. A final report will be published with recommendations on seed policies of governments and how to develop institutes in order to strengthen and improve local seed systems. All information collected will be compiled in a literature study and bibliography. Part of the literature will be from projects, NGOs, etc. the so-called 'grey' literature. Send interesting information and papers on the topic to:
IVO-Project local seed systems, Attn. Conny Almekinders, P.O. Box 90153, 5000 LE Tilburg, the Netherlands.

**SOUTH-NORTH NETWORK ON CULTURES AND 'DEVELOPMENT'**. The phrase "cultural dimensions of development" is decidedly misleading. Culture is not a "dimension", it cannot be reduced to a simple facet of development. It is culture that gives meaning to and makes sense of economic activities, of policy decisions, of community life, social struggle, technical means, etc. Without culture, development becomes quite meaningless. People at the base show remarkable dynamism and creativity to determine their own path of development. The network is not pushing for romantic purism, reactionary indigenism or a backward-looking religious fundamentalism. Instead, it draws on the deep intuitions of the local religion for the energy and dynamism that are necessary for new approaches that genuinely respect humankind and nature. It is presently engaged in a three-year research programme on local culture dynamics. The network is open to all those who struggle for justice and the right of peoples to be different. The activities include a regular liaison bulletin, meeting, advocacy, training seminars in cultural analysis. The network coordinators are in Belgium: Mrs. Edith Sizoo, rue Joseph II 172, 1040 Brussels; Asia: Mr. Siddharta, c/o INODEP-Asia, Indiranagar 1, Stage 902, 560 033 Bangalore, India; Latin America: Mr. Ruben Cesar Fernandes, c/o ISER, CP 16011, 2221 Rio de Janeiro, RJ, Brasil; Africa: Mr. Emmanuel Seyni Ndione, c/o ENDA GRAF, Hamo 2, B.P. 13069, Grand Yoff, Dakar, Senegal and Mr. Chenjarai Hoive, Box 6050, Harare, Zimbabwe.

**TRADITIONAL ANIMAL HUSBANDRY SYSTEMS**. Domesticated animals have long provided valuable products and services (e.g. meat, milk, wool, transportation) to farmers and nomads. To manage these production systems, a number of methods have been used to breed and care for animals, feed and maintain animal health, manage animal groups, and collect and handle final products. Tracy Slaybaugh is compiling an annotated bibliography for CIKARD (Center for Indigenous Knowledge for Agriculture and Rural development) and invites persons with experience or information to contribute this. Topics include: decision making related to breeding and mating; criteria for stock removal; forages and their nutritional value; methods of feeding and the seasonality of feeding; cost-effectiveness and sustainability.
Contact: Tracy Slaybaugh, CIKARD, 324 Curtiss Hall, Iowa State University, Ames, Iowa 50011, USA.

**REAPER**, the Euro-African network for small ruminants, wants to give impetus to research work on small ruminants. Reaper cannot finance research work, but it can give advice and scientific support to institutions requesting assistance such as: analysis and evaluation of on-going work; preparation of research or training programmes; etc.. In the medium term, Reaper wants to co-organize workshops in various ecological environments of Africa and encourage national and regional cooperation. There are no membership fees for Reaper. You may simply join by applying to the network's secretariat. Contact address: REAPER, c/o GTZ, Division 422, Postfach 5180, D-6236 Eschborn, Germany.

**AGROCECOLOGY IN THE SOUTH CONE OF LATIN AMERICA**. A Master on Agroecology for the South Cone will start this year at the MFAL (Multiversidad Franciscana de America Latina) in Montevideo, Uruguay. This project is oriented to train people interested in developing organic agricultural systems in the subtropical and temperate regions of South Brazil, Argentina, Uruguay and Paraguay. Although there is some research on alternative agriculture for the tropics and the Andean regions, this is not the case in our region. We greatly appreciate the help of other institutions working on the same issues. The MFAL is open to consider institutional agreements that includes exchange of faculty and students, research opportunities and literature.
Please contact: Mr. Fernando Perez Miles, Agroecology Program, MFAL, Canelones 1164, 11100 Montevideo, Uruguay. Fax: 5982-985959.

**LA PROTECTION NATURELLE DES VEGETAUX, ATELIER REGIONAL**. 12-23 Novembre 1991, Sénégal. L'Atelier a pour objectif de permettre une réflexion approfondie et un échange d'expériences dans la recherche et l'application d'alternatives aux méthodes chimiques coûteuses et parfois dangereuses de protection des végétaux. Le programme sera axé, entre autres, sur les thèmes suivants: l'accumulation des connaissances paysannes en matière de protection; les bases de la protection naturelle des végétaux, possibilités de l'agriculture écologique en Afrique, problèmes de production et de commercialisation des produits biologiques en Afrique. La date limite des inscriptions est fixée au 30 juillet 1991 et le nombre des participants se limitera à 40 personnes en provenance de l'Afrique Occidentale.
Pour tous renseignements contacter: Simon Anaby Thiaw ou Abou Thiam, Enda/Pronat – BP 3370, Dakar, Sénégal. Telex 51 456 ENDA TM SG

**EXTERNAL PROGRAMME ON AGRICULTURAL DEVELOPMENT**. This programme offers 'state of the art' postgraduate courses in the economics, planning, and management of agricultural development to suitably qualified students anywhere in the world, through the medium of distance education. As well as MSc and Postgraduate Diploma registration with the University of London, the Programme also provides an opportunity for registration as an Affiliated student of Wye College to take individual courses. Course available in 1991 are Core Course (Agricultural economic for development; Project planning, monitoring and evaluation; Economic and social survey methods and data analysis; and Policy analysis for the agricultural sector) and Specialised Courses (Business management of agricultural enterprises; Economics of water resources; Livestock development; Managing Agricultural development; Environmental management in agricultural devel-

opment; and Gender relations and agrarian change).
**Request prospectus from**: The External Programme, Wye College, University of London, Ashford, Kent, TN25 5AH, England.

## Wanted

For botanical preparations in animal husbandry, farmers in this area of south-east Sri Lanka use a preparation of Neem leaves and/or Psidium guajava leaves (guava) with curcuma domestica rhyzome (Turmeric) in equal proportions by weight, ground to paste in coconut oil as a local external application for infestations of ticks in cattle. Does anyone out there know of this or similar remedies for common ailments with livestock? Peter Wise, Forests for people, 35/32 St. Rita's Road, Mount Lavina, Sarvodaya Road, Tanamalwila, Sri Lanka.

We work on sustainable agriculture in Guatemala, training agricultural promoters. On a small demonstration plot we cultivate local crops. Lentils were grown in the region until about 15 years ago. People stopped growing them because of fungus diseases. We planted lentils again, using seeds sold for consumption in a grocery store in Germany. The crop is growing, but produces only one seed per pod. We tried to get information about lentils in Guatemala, but have not been successful. Also non of the organic growers from the USA offer lentil seeds, Who can help us with information or with seeds? In peace,
Castra Neuenroth, Comite Central Mennonita, Aparatado Postal 1779, Ciudad Guatemala, Guatemala.

**TRAINING PTD**
ILEIA has been assisting ETC, her mother organisation, in a programme to collect and develop training modules for PTD. A workshop was held in November 1990 with 18 individuals and representatives of organisations experienced in PTD and/or training. The main conclusions of this workshop in the ILEIA Newsletter of September 1991. The action has resulted in a draft training guide 'Learning for Participatory Technology Development' which contains the main concepts and methods, an outline of a training methodology and a set of possible learning activities for each part of the PTD process (e.g. diagnosis, supporting farmers' experimentation, sharing the results). This draft will be further developed and modified in the field by present partners in the programme as well as other interested parties. Interested readers can obtain a copy of the guide free of charge by writing to ETC, Attn. Henk de Zeeuw or Laurens van Veldhuizen. They should be prepared to use the materials, modify and add to them, and be committed to share their experience with ETC.

# NEW IN PRINT

Basant, R. and Subrahmamian, K.K. 1990. **Agro-mechanical diffusion in a backward region.** IT Publications, 103-105 Southampton Row, London WC1B 4HH, England, English pounds 4.95.
Studies on the generation and use of agricultural technology at village level have paid until recently only limited attention to the specific problems related to agricultural mechanization. The book by Basalt and Subrahmamian makes an effort to fill this gap which gives a merit on its own. It reports the findings of a detailed micro-study in 4 poor Indian villages on the use of agricultural tools. It traces the origins of various innovations and analyzes factors that have impeded the wider adoption of others.

Although the use of concepts like technology development versus technology diffusion may be a cause for some confusion, the authors arrive at the interesting conclusion that the development of tools in these villages is almost exclusively done by farmers together with local artisans, whereas the role of extension officers and agents of 2 commercial enterprises is neglectable. There is scope for outsiders to assist these villages in agricultural mechanization only if they aim at improving this indigenous capacity of artisans and farmers to develop incremental improvements to the implements they already have, rather than introducing completely new ones (Laurens van Veldhuizen).

CARE and Buck, L. E. 1989. **Agroforestry Extension Training Sourcebook.** This is a very useful CARE-Kenya publication, consisting of 10 modules bookform as 'Extension Training Sourcebook' and a huge filer labeled as 'Sourcebook support materials' with background reading, reprints, training ideas and session, references and botanical information. It is nicely illustrated and deals a.o. with agroforestry background; project approach to agroforestry extension; extension communication; landuse diagnosis; agroforestry design; planning, monitoring and evaluating agroforestry extension activities; seed supply, nursery management and tree planting, protection and management. Try to contact CARE Kenya, P.O. Box 606, Siaya, Kenya how to obtain a copy, or: ICRAF, P.O. Box 30677, Nairobi, Kenya or FAO/SIDA Forest, Trees and People, Swedish University of Agricultural Science, Box 7005, S-75007 Uppsala, Sweden.

Friedman, Y. and Schaur, E. 1990. **Environment and self-reliance.** Human Resource Development Foundation, 74-Vigyan Lok, Near Anand Vihar, Delhi 110 092, India. 155 pp, Rs. 30.00
To communicate the available scientific knowledge to the common man is transposing it into cartoons supported by appropriate captions. These picture-scripts form the basis for manuals and ▶

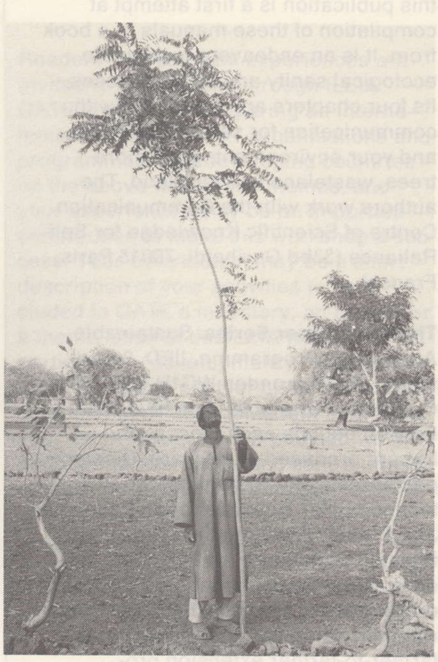
Photo: Mark Edwards.

## Protecting trees from livestock

A common reason why farmers in India do not plant economic trees in their fields or on bunds is because the young trees are grazed by free-roaming livestock. But there are many simple ways to prevent this. One effective check is community action. For example, households in a Sannuhas (Jalahalli) village have agreed that each pay a small amount and employ a local person to tend the grazing animals and keep them away from the fruit trees.
Another method is to collect droppings of goats and/or sheep and mix them with an equal amount of water. The slurry is swabbed on the young tree's leaves with a tablespoon of soap powder per litre of slurry. This repels stray animals from the leaves. Using dung to repel animals from crops is a common indigenous practice in many parts of the world.
Another method to protect young trees is to erect a "wall" of morning glory (*Ipomoea cornea*). This is done by taking 5-foot long stalks about 1 inch in diameter and planting them around the trees. The cuttings root quickly and create a solid fortress. Such low-cost techniques allow low-risk integration of fruit trees, a source of important additional income, into the traditional farming systems.

**Prabhanjan Rao**, Panchajanya 70, New Santosh Nagar Colony, Hyderabad 500 659, India this publication is a first attempt at compilation of these manuals in a book from. It is an endeavour to promote ecological sanity among the masses. Its four chapters are concerned with: communication for self-reliance, you and your environment, grow more trees, wasteland into farmland. The authors work with the Communication Centre of Scientific Knowledge for Self-Reliance (33bd Garibaldi, 70015 Paris, France).

**The Gatekeeper Series.** Sustainable Agriculture Programme, IIED, 3 Endsleigh Street, London WC1H ODD, UK. Copies are available from IIED, 2.50 English pounds each, (inc. p. and p.). Papers produced in 1990 are 'Displaced pastoralists and transferred wheat technology in Tanzania' by C. Lane and J.N. Pretty; 'Teaching threatens sustainable agriculture' by R.I. Ison; 'Microenvironments unobserved' by Robert Chambers and 'Low input soil restoration in Honduras: the Cantarranas farmer-to-farmer extension programme' by Roland Bunch.

GTZ (German Agency for Technical Cooperation). 1989/90. **Agricultural Extension.** Rural Development Series. Sonderpublikation der GTZ No. 238. Vol.1: Basic Concepts and Methods (276 pp., DM 28); Vol.2: Examples and Background Material (446 pp., DM 36). Eschborn: GTZ/BMZ/CTA. TZ-Verlag, P.O. Box 1164, D-6101 Rossdorf, Germany; or GTZ-Unit 02, P.O. Box 5180, D-6236 Eschborn, Germany; or CTA, P.O. Box 380, 6700 AJ Wageningen, The Netherlands.
The second, revised edition of the German handbooks on agricultural extension written by Harmut Albrecht and his colleagues have now been translated into English. They were meant originally as a practical tool for development project workers but are also being used as textbooks in faculties of agriculture. The more theoretical first volume is given concrete support by the accounts in the second volume of how the concepts are being put into practice, e.g. evolution of a peasants' newspaper in Peru, GRAAP's approach to self-development in Burkina Faso. A French translation of the first volume of Vulgarisation agricole is also available.

Inckel, M., de Smet, P., Tersmette, T. & Veldkamp, T. 1990. **The preparation and use of compost.** AGRODOK 8. 25 pp. AGROMISA, P.O. Box 41, 6700 AA Wageningen, The Netherlands. DFL 7.50. (Inhabitants of African, Caribbean and Pacific countries can obtain it free of charge from: CTA, P.O. Box 380, 6700 AJ Wageningen, The Netherlands).
This small booklet gives a simple description of the processes taking place in the soil during composting, and makes practical suggestions for constructing a compost heap. The advantages and disadvantages of using compost are discussed. This is a revised edition of the 1983 version of AGRODOK 8.

Rehm, S. and Espig, G. 1991. **The cultivated plants of the Tropics and subtropics.** ISBN 3-8236-1169-0, DM 49,- Verlag Josef Margraf, P.O. Box 105, D-6992 Weikersheim, Germany.
This books serves a dual purpose: a handbook covering the whole range of plants cultivated in the tropics and subtropics, and a textbook for students of agriculture, botany, geography, economies and other disciplines. It deals with more than 1000 crop species in 21 chapters. Apart from starch-, sugar-, oil- and protein providing plants, also medicinal plants, tanning materials, dyes, pesticides, waxes, forage and pasture plants, green manure-, ground cover -, soil stabilizing-, windbreak-, fencing plants and shade trees are described, including production, botany, ecology, diseases and pests, harvesting, processing and uses.
An essential part of the book is the list of more than 2000 references, giving each access to information which could not be given in this book.

Singh, V. 1991. **Ecological impact of apple cultivation in the Himalaya.** International Book Distributions, 9/3, Rajpur Road, P.O. Box 4, Dehradun 248 001, India. 152 pp, ISBN 81-7089-114-0, Rs 125.00.
Apple cultivation is leading to the alteration or replacement of the temperate forests at such a rate, that it has aroused much concern among the ecologists, social workers, environmental campaigners and the local community. Of special importance is the effect on biological productivity, soil, hydrological cycle, atmosphere, biodiversity and on the life-supporting base. This book synthesizes the ecological effects of apple cultivation in the Himalaya.

Wageningen Agricultural University (Ed.), 1990. **Design of sustainable farmer-managed irrigation schemes in subSaharan Africa.** Proceedings of a workshop. DFL. 85,- Dept. of Irrigation and Soil and Soil and Water Conservation, attn. Ms. J. Heynekamp, Nieuwe Kanaal 11, 6709 PA Wageningen, the Netherlands. In two volumes, 6 analytical introductions and 33 case-studies are presented, giving a multi-facetted view of recent experiences. Field workers and policy makers attended the workshop and technical as well as social profession were represented. The English version of the document contains 7 articles in French and in the French version, about half of the contributions appears in English. Please indicate your choice between English or French.

World Neighbours, Yaysan Tananua and Studio Dryia Media, 1990. **The practical guide to dryland farming series.** Four booklets of around 40 pages each on Soil and water conservation; Contour farming; Integrated farm management and Planting tree crops. English versions are available from World Neighbours, 5116 N. Portland Ave., Oklahoma City, OK 73112, USA; US$ 4.50 per copy plus postage. Indonesian language versions available from Studio Dryia Media, Jl. Tubagus Ismail Raya 15, Bandung, West Java 40143, Indonesia; Rp. 1,500 per copy plus postage.
These booklets were designed to be used together with farmers, extension agents or programme personnel who are already somewhat familiar with the practices described. The practices discussed may be specifically applicable to the conditions found in semi-arid regions of southeastern Indonesia, but the principles may be applicable for other upland areas as well. The booklets are the result of a collaborative effort of different Indonesian NGOs with additional input of several other grassroots organization working throughout the region. They mainly contain drawings, picturing the rural life and the practices that have been developed by and with farmers. Colouring the drawings is a nice exercise (not only for children!) to understand soil degrading and soil building processes.

Amanor, K. 1990. **Analytical abstracts on farmer participatory research.** 7,95 English pounds.
Farrington, J. and Mathema, S.B. 1991. **Managing Agricultural Research for fragile environments: Amazon and Himalayan case studies.** 6,95 English pounds.
Moris, J. 1990 **Extension alternatives in tropical Africa.** 9,95 English pounds.
Obtainable from Overseas Development Institute, Regent's College, Inner Circle, Regent's Park, London NW1 4NS, U.K. or via booksellers

IFOAM-Australia. **Organic Agriculture: A dream or an economic imperative?** 1990. Proceedings of a regional conference. It includes: keynote papers, submitted papers and field visits guidebook. Costs: Australian $ 40,- plus $ 20 postage and handling. The conference dealt with: long term viability of farming practices; sustainable farming practices; integrated pest management; social challenges and export potential.

IIRR/SEASAN, 1990. **Resource book on sustainable agriculture for the uplands.** This valuable book brings together experiences from many NGOs in South-east Asia on sustainable upland farming. They are linked through the SEASAN, the South-East Asia Sustainable Agriculture Network. It describes both techniques like soil and water conservation, agroforestry, seed technology and also experiences on working with farmers.
More information: IIRR, Silang, Cavite, Philippines.

# ILEIA NEWS

**STOP! OUT OF PRINT!**
So many requests have come in for ILEIA publications that we are running out of them. We regret to inform you that the Proceedings of the ILEIA Workshop on PTD (held in 1988, published in 1989) is now out of print. Also the booklet by Johan van der Kamp and Peter Schuthof about PTD concepts and techniques is no longer available. And all 5000 copies of the ILEIA Newsletter on "Local Knowledge" (March 1990) have been gobbled up by avid readers. That seems to be a popular theme. If you joined the ILEIA network after that issue appeared, maybe you can borrow it from another reader. See ILEIA Newsletter 6/4 (Dec. 1990) to find the address of the one nearest you!

**JOINING FARMERS' EXPERIMENTS**
This is the title of a reader on Participatory Technology Development (PTD) compiled by ILEIA staff members past and present: Bertus Haverkort, Johan van der Kamp (now working in Guinea Bissau) and Ann Waters-Bayer. It contains reports from research and development agents who have tried to support the efforts of farmers in that huge research operation commonly known as "small-scale farming in diverse and risk-prone areas". Many researchers have found that smallholders are often far ahead of them when it comes to developing appropriate technologies for rainfed farming under difficult conditions. The book includes experiences of NGOs, development projects, and national and international research centres in Latin America, Africa and Asia. It also brings a bibliography of recent publications about collaboration between farmers and researchers and/or extensionists in PTD for sustainable agriculture.
The 280-page reader is fresh off the press and can be obtained from Intermediate Technology Publications, 103-105 Southampton Row, London WC1B 4HH, UK, for 9.95 UK pounds plus postage and handling.

**UPCOMING ISSUES**
After this double issue of the Newsletter, the third issue for 1991 will focus on training or, better yet, learning for sustainable agriculture. This will include reports on approaches to and experiences in training/learning for LEISA and PTD. We also plan to include the addresses of some groups and organisations which offer courses in ecologically-oriented agriculture and/or PTD, or at least indicate where information about such courses in different regions of the world can be obtained. We also want to refer to useful training materials, both written and audiovisual (films, slides, radio etc) and where to get them. Please send us any relevant information, to be included in the next issue and/or a data base on LEISA/PTD training programmes and courses, by 15 August 1991.
The fourth issue in 1991 will focus on synergy, the combined action of two or more organisms to achieve an effect of which each is individually incapable. Deadline for contributions is 15 October 1991.
Themes planned for 1992 include gardening, health and water, energy and labour, and strategies for promoting LEISA (particularly networking).

**PTD AND AT – CALL FOR EXPERIENCES**
The AT organisations ITDG, TOOL (Netherlands), ATOL (Belgium) and GATE (Germany), and ILEIA agreed to inventorize participatory approaches in appropriate technology and mechanisation programmes. Though many AT programmes follow participatory approaches, quite a few other programmes concentrate on designing technology purely within an workshop institutional setting. There is little direct interaction with end users to find needs and design criteria, and involve them in the development process, including experimentation with and further promotion of the technology. Unfortunately, we know of very little documentation on those AT programmes that succeeded in using a participatory approach. Readers with relevant experiences are invited to share these through ILEIA.
GATE is currently preparing an international workshop for AT organisations and programmes from developing countries on the above-mentioned themes, and your experiences may be an important contribution to make this workshop a success. Your contribution may be a short description of your activities to be included in GATE's inventory; an article for a theme issue of the ILEIA Newsletter on participatory development of appropriate tools and equipment for LEISA; or a more detailed paper describing and analysing your experiences for the planned workshop. Send your ideas and contributions to ILEIA, Attn. Laurens van Veldhuizen. ■

**The ILEIA workshop 1990 was a process of assessing LEISA. Apart from those who have corresponded with ILEIA and sent valuable comments and documents, there was also a meeting from 11th to 13th December 1990. It was a fruitful meeting and the success has to be attributed to all those who have been involved.**

<u>Kneeling from left to right:</u> Meine van Noordwijk (Institute of Soil Fertility, the Netherlands); Coen Reijntjes (ILEIA); Bram Huijsman (Royal Tropical Institute, the Netherlands); Bart van Kats (student Wageningen Agricultural University, the Netherlands); David Gibbon (part-time farmer and University of Norwich, United Kingdom); Bertus Haverkort (ILEIA).

<u>Sitting front from left to right:</u> Narayana Reddy (farmer, India); Christine Karuru, farmer, Kenya); Helle Munk-Ravnborg (Centre for Development Research, Denmark/Tanzania); Angie Ibus (International Institute for Rural Reconstruction, Philippines); Bola Okuneye (Department of Agricultural Economics and Farm Management, Univ. of Abeokuta, Nigeria).

<u>Standing from left to right:</u> Rohana Ulluwishewa (Department of Geography, Univ. of Sri Jayewardenepura, Sri Lanka); Gil Ducommun (AGRECOL, Switzerland); Hilario Padilla (AGTALON, Philippines); Ken MacKay (ICLARM, Philippines); Jose Benites (FAO, Italy); Marijke Kater (ILEIA); Anna de Boer (ILEIA); Carine Alders (ILEIA); Henk Kieft (ETC); Kurniatun Hairiah (Doctoral student Groningen University, the Netherlands); Lies Joosten (student University of Utrecht, the Netherlands); Wim Hiemstra (ILEIA); Roland Bunch (World Neighbors, Honduras); Ann Waters-Bayer (ILEIA); David Yaw Owusu (Ghana Rural Reconstruction Movement, Ghana).

# READERS

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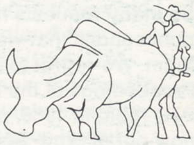

## Resource-use efficiency

*Dear ILEIA,*

*After receiving the papers of the ILEIA workshop 1990, I want to share some thoughts with you. We seem to be talking about techniques as opposed to a total system. This reductionist approach provided the rationale and logic behind the chemical farming and the current state of affairs in agriculture. Only a holistic approach can bring in the seeds of sustainability. Survival was observation based. Most current observation and documentation fails to even identify the whole host of factors in any given situation and their interplay. We would be able to develop baskets of technologies, from which farmers can choose, in order to strengthen their experimentation. Yet, experimentation is not a recent phenomena. The history of centuries of men-nature interaction resulted in a stunning array of farming systems, genetic diversity and life-styles. As for 'yardsticks of comparison', one would suggest looking at 'resource-use-efficiency', or different systems through an input-output analysis, keeping in mind the qualitative aspects of the input and its implications. In other words, the inputs involved per unit of output, inclusive of all the backward linkages, including extraction, processing, packaging, distribution and marketing till the final input stage. Since modern systems are promoted on the myth of 'efficiency', such an approach can expose the hollowness of the claims made. Arguments against this would be about the quantum of total production, i.e. the demand, vis-a-vis population pressures etc.. That would raise issues related to the pattern of use of land-related resources, diet systems, food processing, agro-industry connection, etc. for which some data is available: a given acreage can feed twenty times as many people eating a pure vegetarian diet-style as it could people eating the standard American diet-style. Our reasoning and logic must encompass the total system, in order that it becomes as alternative system rather than remain at the level of alternative techniques.*

Korah Mathen, Association for Propagation of Indigenous Genetic Resources, D-1 Aurobindo Society, Vastrapur Talavadi, Ahmedabad 380 015, India.

## Natural Farming

*We would like to share some conclusions of the National Seminar on Natural Farming (NSNF), held 18-20 February 1991 in Udaipur, in which scientists and workers met. It was a joint venture of Rajasthan Agricultural University, Udaipur and Department of Agriculture (Rajasthan). The NSNF felt that the time was ripe in the country to consider more effective alternatives to the use of agrochemicals. Productivity has to be maintained or increased without causing any decline in the capital stock of natural resources of soils, water, environment, and genetic diversity. Basically, these systems of agriculture work with nature and not against it. Both the Central and State Governments should put higher efforts in this neglected area. There is a need for extensive controlled comparative field trials all over the country for judging both yields and pest control. An action plan and a steering committee need to be drawn up. The NSNF would like to receive concrete information, evidence and results of experiences with alternatives. The NSNF also felt that there is a clear need for launching an information and advocacy campaign towards achieving above objectives.*

NSNF, c/o Mr. J.E. David, Data Centre for Natural Resources, 104 Spencer Road, Fraser Town, Bangalore, India.

**ILEIA** stands for Information Centre for Low-External-Input and Sustainable Agriculture. ILEIA was established in 1982 by the ETC Foundation and has been funded mainly by the Netherlands Ministry of Development Co-operation. The present programme funds are assured till 1994.

**ILEIA's** long-term objective is to contribute to a situation in which Low-External-Input and Sustainable Agriculture (LEISA) is:

- widely accepted and adopted as a valid approach to agricultural development, complementary to high-external-input agriculture,
- recognized as a means to balance locally available resources and local knowledge with modern technologies requiring inputs from elsewhere,
- valued as a useful perspective in planning and implementing agricultural research, education and extension,
- developing and consolidating its stock of knowledge and scientific basis.

**Low-External-Input and Sustainable Agriculture** is agriculture which makes optimal use of locally available natural and human resources (such as climate, landscape, soil, water, vegetation, local crops and animals, labour, local skills and indigenous knowledge) and which is economically feasible, ecologically sound, culturally adapted and socially just. The use of external inputs such as mineral fertilizers, pesticides, hybrid seeds and machinery is not excluded but is seen as complementary to the use of local resources and has to meet the above- mentioned criteria of sustainability.

**ILEIA** is reaching these objectives by the establishment of a documentation centre, the publication of a quarterly newsletter, publication of bibliographies and a register of organizations, international workshops and support to regional networks in Third World countries.

**BACK COPIES**
of the ILEIA Newsletter are available:
(US$ 5.00) Vol.3/No.1: Integrated nutrient supply
Vol.3/No.2: Diversity
Vol.3/No.3: Microclimate management
Vol.3/No.4: Livestock as part of the agroecosystem
Vol.4/No.1: Mountain agriculture
Vol.4/No.2: Towards sustainable agriculture
Vol.4/No.3: Participatory technology development
Vol.4/No.4: Enhancing dryland agriculture
Vol.5/No.1: Discussion on sustaining agriculture
Vol.5/No.2: Intensifying agriculture in humid areas
Vol.5/No.3: Farmers' hands on alternatives to chemical pesticides
Vol.5/No.4: Local varieties are our source of health and strength
Vol.6/No.2: Trees and farmers
Vol.6/No.3: Complementary use of external inputs
Vol.6/No.4: Networking towards LEISA

The opinions expressed in the articles do not necessarily reflect the views of ILEIA. The reader is encouraged to reproduce articles with acknowledgement.

# WRITE

**ILEIA,
P.O. Box 64,
3830 AB Leusden,
The Netherlands**