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LEISA

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Rebuilding lost soil fertility

LEISA

october 1997 volume 13 no. 3

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FRONT COVER PICTURE

Applying manure before potato planting in Ecuador by Albrecht Benzing

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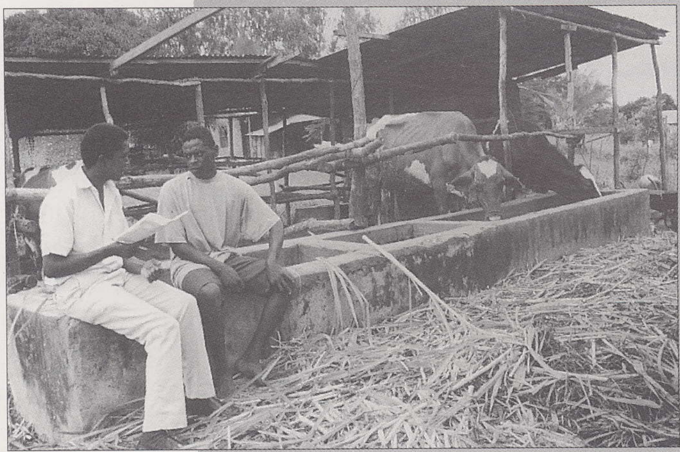
Towards balanced nutrient management



African soils are being mined of nutrients at a rapid rate. In 1995, as part of an effort to secure present productivity and ensure the sustainability of tropical farming systems, a consortium of African and Dutch research institutes established the Nutrient Monitoring Programme (NUTMON). During the first phase of the NUTMON programme a multi-disciplinary scientific tool was developed to assess nutrient balances and economic performance at farm level. This tool would later be integrated with farmer knowledge. The first step in this process, a pilot project carried out in Kenya, is discussed in this issue.

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Achieving sustainability in the use of green manures

Throughout the world wide spread use is made of green manures and particularly in Latin America. For a long time this has gone unnoticed as little attention was given to the extent to which green manure and cover crops were used in traditional systems. Teaching farmers that green manure and cover crops have valuable uses besides maintaining soil fertility can help sustain their wide-spread use and adoption. This article by Roland Bunch provides a useful overview of species and uses and concludes that, with the possible exception of very intensive farming systems, green manure/ cover crop systems probably have the potential to be introduced into many, if not most, small-scale farming systems.

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Dear Readers

At long last, we have found a new lead-editor for the ILEIA Newsletter, Marilyn Minderhoud-Jones. She will have responsibility for the production and editing of the ILEIA Newsletter and other ILEIA publications. We wish her much success with her new job. Together, as an editorial team, we hope to keep up the quality of the ILEIA Newsletter or, better still, to improve it.

Another phase of the ILEIA project comes to an end in December 1998. This will be the end of ILEIA in its present form. To get some idea of the best way to continue ILEIA's activities a 'mandate analysis' will take place in November and December of this year. A selected group of key persons in Asia, Africa, Latin America and Europe will be asked to give their opinion on the institutionalisation of the activities developed by ILEIA. Readers are also invited to contribute to this mandate analysis by sending their opinions to ILEIA before 1 December 1997. If you, our readers in the tropics, feel there is a need to continue documenting and exchanging experiences on the development of LEISA, Participatory Technology Development and Assessment Research by a southern or northern- based organisation or network of regional organisations we would be glad to hear from you. It may well be possible to find funding to continuing ILEIA in a new form. More information on the mandate analysis can be found in ILEIA News (page 35).

This issue of the ILEIA Newsletter describes the experiences of farmers and researchers who are trying to rebuild the soil fertility lost during the drive to increase agricultural production in recent decades. Farmers who shifted to the application of chemical fertilisers as well as those who could not afford these external inputs not only lost precious soil fertility but also their indigenous knowledge of soil fertility management. They are now trying to rediscover the principals of traditional agriculture in order to make natural soil fertility management practices part of their farming systems again. This edition of the Newsletter contains a wide range of articles from 'analysing nutrient balances' and the 'use of green manures and rice straw' to 'recycling organic household waste'. Beside the technical articles there are also articles on 'participatory technology development' and 'learning and communication tools'. On the back page readers will find a short description of the assessment research ILEIA is carrying out in the Philippines.

The editors.

Soil fertility management in irrigated rice fields

Tells the story of how small-scale rice farmers in an agricultural settlement scheme in the 'dry' zone of Sri Lanka cope with dwindling rice yields the result of nutrient mining which has lead to the loss of soil fertility. After some initially successful years, farmers were forced to apply inorganic fertiliser at a level that imperilled profitability. Then, encouraged by government extensionists, farmers began to experiment with adapting their farming system. These experiments - incorporating rice straw into the fields, using green manures and Sesbania rostrata - are reported here. Although some encouraging results have been obtained, much work remains to be done.

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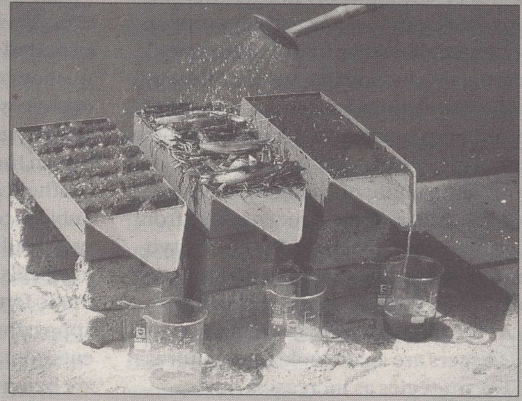
Tools for soil and water conservation



Reports on participatory research and extension in the soil and water conservation measures being taken in southern Zimbabwe. Farmers have many motives for undertaking conservation. The authors argue that high yields are an important factor but farmers also want to minimise off-field damage. For farmers to take the proper farm management decisions, however, it is necessary for them to have an understanding of the dynamics of their environment and the biophysical processes at work in their fields. In order to achieve this, the authors advocate an extension approach in which learning by doing, action learning, experiential learning and discovery learning plays a vital role.

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ILEIA is the Centre for Research and Information on Low-External-Input and Sustainable Agriculture. It is a project implemented by ETC Netherlands and receives funding from the Netherlands Ministry of Development Cooperation. It was established in 1982. ILEIA's mandate includes the collection and exchange of information on the development of Low-External-Input and Sustainable Agriculture (LEISA) as well as collaborative research in partnership with working groups of farmers, development workers and researchers. ILEIA seeks to exchange information on LEISA by publishing a quarterly newsletter, bibliographies, and books. ILEIADOC, the data base of ILEIA's documentation centre, is available on diskette and on ILEIA's Homepage on Internet: http://www.bib.wau.nl/ileia.
ILEIA's Collaborative Research Programme focuses on assessing the viability of LEISA technology systems. This assessment builds on participatory technology development, scientific studies and capacity building. Research is taking place in four areas of contrasting potential in agro-ecological and socioeconomic terms: the dryland savannahs of northern Ghana, the high mountain valleys of Peru, the humid lowlands of the Philippines and on the semi-arid Deccan plateau.

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

Soil fertility management under pressure

photo: K.J.N. Gowtham-Shankar

Editorial

Soil fertility management (SFM) is the basis for sustainability in every agricultural production system. Creating favourable conditions for soil life and plant growth, nutrient application and soil conservation are important aspects of soil fertility management. SFM is a complex issue involving many farming practices. Each farming system has its own unique way of SFM which depends on a combination of factors: the condition of the natural resource base, the land available, labour and capital resources and their relative price, the history of local farming, farmers' knowledge, their motivation, skills and degree of market orientation, the relative prices of inputs and, of course, agricultural policy.

It is possible to identify several broad categories of farming systems each with characteristic SFM practices. These include shifting cultivation and fallow systems based on natural processes of soil fertility regeneration; interactive pastoral and fallow systems based on nutrient harvesting by animals and fallow vegetation; integrated and organic agriculture typified by the recyling of nutrients; and modern agriculture in which synthetic fertilisers and mechanisation control soil fertility management. Within and between these categories are a wide variety of practices.

Practices are changing

SFM is not a static concept, practices are being continually modified as conditions change. Typical is the movement from extensive to intensive soil fertility management when population pressure increases and land becomes scarce. Last June a conference took place on **Indigenous strategies for the intensification of shifting cultivation in South-east Asia** (Cairns 1997). Based on the case studies collected for this conference, Cairns developed a framework of typologies of Indigenous Fallow Management. This framework provides a continuum of indigenous intensification strategies in shifting cultivation. Nijhof (page 10) reports on the intensification process of the Mangyan shifting cultivators in Mindoro in the Philippines. He rightly concludes that shifting cultivation is not a static traditional approach to agriculture neither is it doomed to extinction. The traditional strategies of shifting cultivators as they use natural processes to manage their crops and fallow vegetation still provide options for increasing production in a sustainable way. One of these options is the replacement of slash-and-burn practices by slash-and-mulch practices (Thurston 1997).

Another example of changing SFM practices is the still, relatively recent, shift from SFM using natural means to SFM using synthetic fertilisers. This happened where conditions are favourable for market production. At the moment, however, many of these farmers are again looking for alternative SFM strategies as increasing costs, decreasing yields and indicators of soil degradation convince them that the continuous use of synthetic fertilisers, or at least the way these fertilisers are being used is far from sustainable. Mulleriyawa and Wettasinha (page 18) report on a process of participatory technology development designed to find alternatives to the use of synthetic fertilisers in paddy production in Sri Lanka.

Practices fit specific conditions

Each SFM strategy fits, but also needs, specific conditions, and farmers combine those practices which suit them best. As Subedi (page 16) explains, subsistence farmers in Nepal cannot afford - and sometimes have no access to - synthetic fertilisers and therefore depend on natural means of SFM such as green manures. Roland Bunch (page 12) presents the latest insights into situations where green manures/cover crops can be successful in replacing or complementing synthetic fertilisers or slash-and-burn practices. Where labour is scarce (extensive agriculture), or relatively expensive compared to the cost of synthetic fertiliser (modern agriculture) farmers cannot afford labour intensive recycling of organic waste like that being initiated in Egypt (Zakaria et al. page 24). Benzing (page 14) illustrates this further by showing the relationship between different farming systems/SFM strategies and the varying types of conditions under which farming is carried out in the mountain valleys of Ecuador. He also makes recommendations on how SFM could be improved by optimising the use of natural means of SFM.

Sustainability threatened

Today the ecological sustainability of agriculture and finding ways to increase production are pressing issues. The NUTMON nutrient balance study in Kenya shows that farmers who participated in this programme obtained about 30% of their income from nutrient mining. This confirms earlier findings in Africa (see Vlaming et al. page 6). Elsewhere in the tropics the situation is probably not much better as Mulleriyawa and Wettasinha (page 18) indicate.

This is only one side of the picture, however. There are also places where lost or exported nutrients accumulate: sediments washed out in soil erosion, accumulations of organic waste in city areas, nutrients leached into the ground water and volatilised nutrients in the air. All these cause pollution. Synthetic fertilisers are frequently used in an unbalanced, inefficient and hence polluting way, leading to soil degradation and declining yields. But also, each kilogramme of synthetic fertiliser used corresponds to an approximately equivalent amount of nutrients contained in organic matter and which are being wasted at the moment.

You might wonder how seriously these sustainability problems are being dealt with by researchers and policy makers. There are no broadly-based studies on the many processes involved in agricultural sustainability. For example, it was only in 1995 that the International Rice Research Institute (IRRI) finally initiated a major study -covering eight countries (page 36)- on **Reversing trends of declining productivity in intensive irrigated rice systems**. The study will analyse what is going on and attempt to design alternative strategies to present practices. Probably a much broader study will be needed to analyse the full extent all the problems involved in the use of synthetic fertiliser and their socioeconomic and cultural implications.

No money for synthetic fertiliser

Where farmers cannot produce competitively for the market or are resource poor, the cash income they obtain from farming is too small to allow them to buy external inputs. High transport and credit costs are amongst the factors that make these inputs expensive and risky to use. Where ecological conditions are not particularly favourable for farming or the soil has been degraded, using synthetic fertilisers is relatively inefficient. In these conditions, synthetic fertilisers do not generate enough profit to make them a viable option in compensating nutrient losses. Increasing numbers of farmers are being confronted with these problems as the relative cost of synthetic fertiliser increases and soil degradation accelerates. If these farmers continue to produce for the market and export/loose nutrients in quantities higher than they can afford seen their options for compensation of nutrient losses, further nutrient depletion, soil degradation and yield decline will be unavoidable. At the moment this process can be seen in many regions in Africa and elsewhere in the tropics. Subsistence farming based on ecologically sound practices, therefore, seems to be the only sustainable basis for livelihood within the reach of these farmers. This does not entirely exclude production for the market but must be kept to levels that farmers can afford.

Back to traditional farming strategies?

Many farmers in regions where agricultural conditions are less favourable - and this includes many groups of indigenous people - are trapped in this dilemma. The drive towards modern, market-oriented farming is causing severe ecological degradation and economic marginalisation. Market agriculture, migrant labour and the desire to participate in the consumer culture are sapping the cultural and spiritual basis of traditional society and place a heavy burden on survival strategies (COMPAS 1996).

Reorientation towards traditional farming strategies or urbanisation and the consequent weakening of indigenous culture seem to be the two, far from attractive, development polarities available to indigenous communities and resource-poor farmers. The case studies collected by ICRAF (Cairns 1997; Fuijsaka and Escobar 1997) and the case described by Nijhof (page 10), however, set out evidence that shows traditional farming strategies can still provide a sustainable basis for livelihood. Batterbury (1996), Phillips-Howard and Lyon (1994) and Tiffen et al. (1994) also present examples of how farmers make their way between subsistence farming, market-oriented agriculture, and urban employment and succeed in intensifying land use whilst keeping ecological degradation within bounds. These farmers often complement natural methods of SFM with the judicious use of small amounts of synthetic fertilisers. There are, however, many cases where farmers have been less successful and find themselves trapped in such poverty and ecological degradation that they are forced to migrate to the cities.

One of the problems confronting farmers who reorient their farming towards traditional farming strategies is that conditions for agricultural production have changed during the period they were focusing on a market-oriented agriculture supported by the use of synthetic fertiliser. Population growth, the degradation of soil and natural vegetation mean that traditional farming practices can no longer be applied as in the past and adaptations have to be made. The new 'Kekulam' rice production system described by Upawansa (page 20) is an example of the adaptation of a traditional system with minimal dependence on the use of external inputs of synthetic fertiliser. It would be very interesting to compare the socioeconomic, ecological and cultural performance of such systems with conventional systems.

Ecologically sound market agriculture

The importance of strategies that combine the use of internal and external sources of nutrients in the way best for a given local situation is sometimes called Integrated Nutrient Management (Vlaming et al. page 6) or Integrated Plant Nutrient Systems (FAO). The value of Integrated Nutrient Management (INM) is increasingly being recognised by researchers. Innovative farmers, sometimes alone, sometimes with the support of outsiders, have already developed many INM strategies. The case described by Mulleriyawa and Wettasinha (page 18) is an example of the participatory development of Integrated Nutrient Management. These strategies allow a more efficient, profitable and ecologically sustainable use of synthetic fertilisers and other external inputs in market agriculture which in turn lowers the threshold for farmers working in less favourable conditions to become part of, or remain within the market economy without degrading their system. Resource poor farmers cultivating in areas where conditions are favourable for market production can benefit from these strategies: production costs are lowered and their dependence on usurers and expensive credits is reduced.

Decreasing the cost of transport, marketing, inputs and credit can help farmers to become more competitive in the market. However, where population and the urbanised market economy are growing fast, as in many South and South-east Asian countries, even improving these conditions cannot prevent or halt the process leading to the economic marginalisation of small farmers and their flight in search of urban employment.

Learning to adapt farming

Given changing conditions, needs and insights, farmers have constantly to adapt their soil fertility management practices. However, new practices do not only have to accommodate prevailing natural, economic and cultural conditions but also the way agriculture and society has evolved over time.

Where development workers and researchers try to introduce SFM practices that do not fit the prevailing natural, economic and cultural conditions or where insufficient attention is paid to farmers' own learning process and accumulated knowledge, their efforts are bound to fail. The articles by Hagmann (page 26) and Sharland (page 28) show how such learning processes can be enhanced by learning tools and dialogues that build on traditional practices and insights.

Coen Reijntjes

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photo: Albrecht Benzing

Farmers and researchers on their way to

Kenyan farmers taking part in the NUTMON study know that land productivity had been declining for years. They also know that continuous cropping and manure shortages are to blame. The aim of the NUTMON programme is to build on this consciousness and increase farmer awareness of the role of nutrients in agricultural production and to develop a tool that can assess nutrient balance and economic performance at farm level.

J. Vlaming, J.N. Gitari, and M.S. van Wijk

Research has shown that African soils are being mined of nutrients. (Van der Pol 1993; Smaling and Stoorvogel 1990; Smaling 1991). In 1995 as part of an effort to secure present productivity and ensure the sustainability of tropical farming systems, a consortium of African and Dutch research institutes established the Nutrient Monitoring Programme (NUTMON). During the first phase of the NUTMON programme a multi-disciplinary scientific tool was developed to assess nutrient balances and economic performance at farm level. This tool would later be integrated with farmer knowledge. The first step in this process, a pilot project carried out in Kenya, is discussed below.

Nutrient mining

Kenya is an example of a country where more nutrients are being extracted from the soil than returned to it. Although the exact relationship between negative nutrient balances and crop yields is not clear, nutrient mining has lead to declining yields. Like many African countries Kenya needs higher production levels to feed its growing population, a situation which will become increasingly difficult in future as the critical indicators of nutrient output/input and per capita food production show. Stoorvogel and Smaling (1990) found that nutrient outputs exceed inputs by 42 kg N, 3 kg P and 29 kg K ha^{1} year^{1} and studies show that per capita food production had been steadily declining since the late 1980s. (De Jager et al. 1997)

Nutmon-Nutrient Management

The NUTMON concept (see Figure 1) integrates different knowledge systems (farmers' knowledge and scientific knowledge) and sciences (biophysics and economics) to assess nutrient balances and economic performance at farm level and to develop Integrated Nutrient Management (INM). Integrated Nutrient Management is defined as the best possible combination of available nutrient management practices, that is they are biophysically powerful, economically attractive and socially acceptable. The interdisciplinary approach was a necessary response to the fact that farmers' goals are not only economic but cultural, social and ecological as well.

Four Kenya districts, in different ecological areas (Kisii, Kakamega, Embu, Kilifi), were chosen and land-use zones (LUZ) were identified during discussions with local experts and with the help of satellite image interpretation. The objective of this phase of the NUTMON programme was to develop a methodology that would help farmers manage nutrient balance in their fields.

Multi-disciplinary teams of agronomists, soil scientists, livestock specialists, sociologists and economists from the Kenyan Agricultural Research Institute's (KARI) regional research centres made Participatory Rural Appraisals (PRA) in each of the land-use zones. It was the first time that these research teams had made PRAs. They conducted interviews with a cross-section of key individual and group informants including farmers, administrators and extension workers.

Farmer awareness

Interviews confirmed that the farmers interviewed had been aware of the gradual decline in land productivity for several years. They attributed this decline to continuous cropping on the same fields, steadily diminishing supplies of manure as livestock number declined, overgrazing and soil erosion. However, they were not aware of the key role played by nutrients in these processes or how this affected soil productivity.

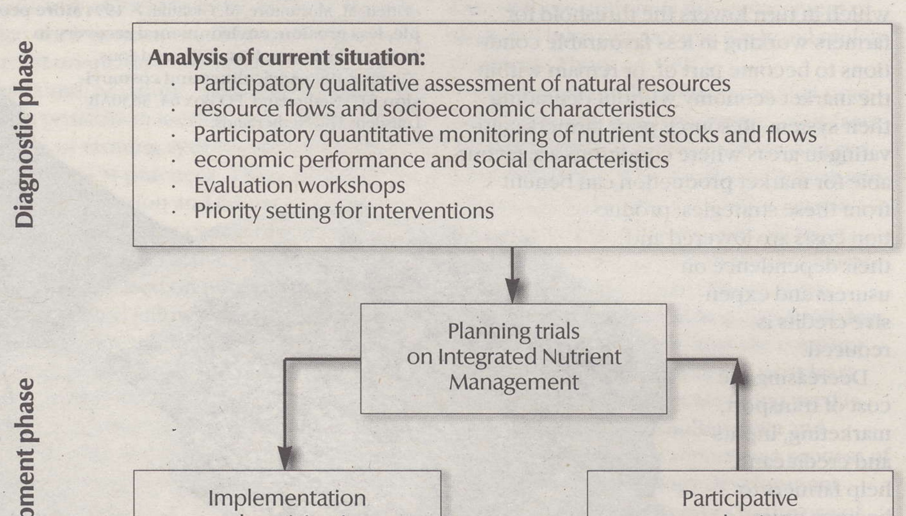
In group interviews farmers ranked the factors they felt constrained farming in their district. The most frequently mentioned and ranked constraint (31% of all number one constraints) was the high cost of fertiliser and the fact that it was often unavailable. Low maize yields (15%) and lack of seed (15%) were also seen as major problems. The constraints most often ranked as number two were the high price of fertiliser (23%), striga (15%) and low soil fertility (8%).

Farms were selected for the NUTMON programme on the basis of information provided by Participatory Rapid Appraisal. Criteria for selecting two or three farm households in each land-use zone included a willingness to participate in the monitoring programme, cropping pattern, livestock activities, farm size, farm management practices, product marketing and off-farm income activities.

Nutrient monitoring

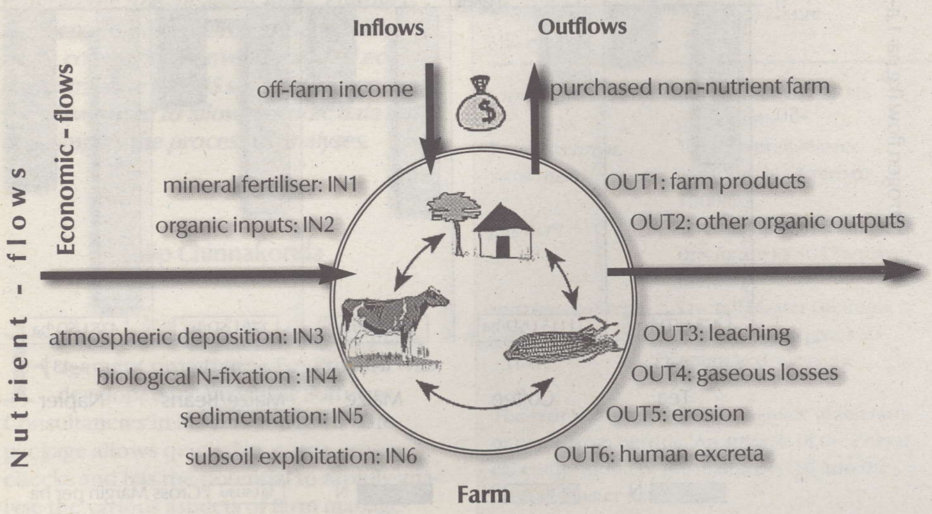
An initial inventory of household composition, farm and field layout, agricultural

Figure 1: NUTMON methodology



Integrated Nutrient Management

Figure 2: Nutrient flows



activities and nutrient stocks was completed for each farm. This inventory was followed by a monthly monitoring of those on-farm agricultural activities that affect nutrient flows. In addition to the monitoring of nutrient management, the activities of the farm family, their cash income and the allocation of labour were also studied.

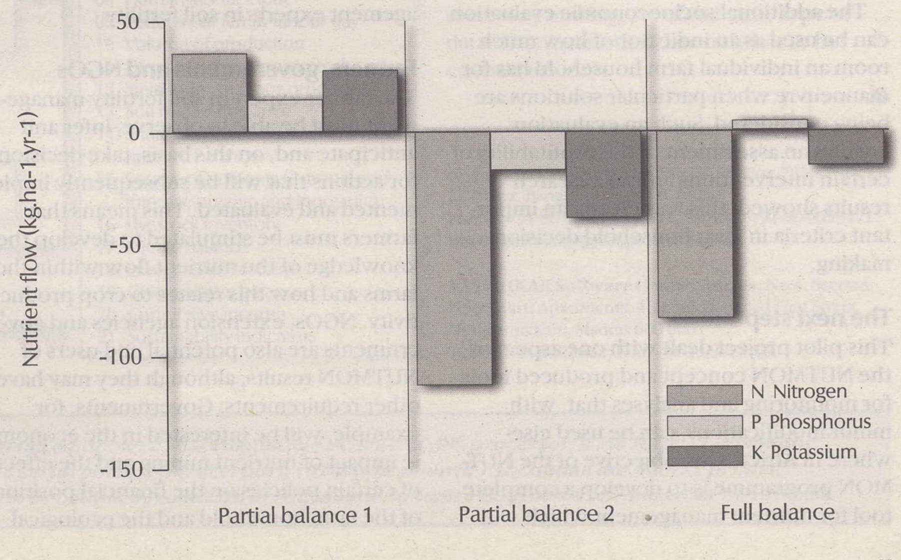
The nutrient balance - the product of nutrient inputs and nutrient outputs - was calculated for both the farm as a unit and for its field(s). Nutrient output included harvested crop products and residues, nutrients leached out below the root zone, gaseous losses from the top soil, erosion, and human excreta lost because it ends up in deep pit latrines far below the root zone. Nutrient inputs into the system were mineral fertilisers, organic inputs (manure, imported crop residues and feeds), airborne deposition, biological N-fixation by plants, sedimentation and nutrients extracted from the sub-soil by deep-rooting crops and trees (see Figure 2).

Economic performance indicators were calculated at both activity (crop, livestock and off-farm activities) and farm household level. In addition a number of general farm household characteristics such as household size, labour and consumer units were also determined. The main indicators at activity level were gross margins (gross return minus variable costs) and net cash flows (cash receipts minus cash payments) per unit area. At farm household level net farm income (total gross margin minus fixed costs) and family earnings (net farm income plus off-farm income) were the most important indicators.

Results of nutrient flow analysis

The analysis of the nutrient flows and balances showed that the average nutrient balance of 26 farms was negative for nitrogen (N) and potassium (K) and slightly positive for phosphorus (P) as is shown in Figure 3. The total nutrient balance can be disaggregated into two partial balances. Partial Balance 1 (IN1+IN2-OUT1-OUT2) in Figure 2 consists of direct nutrient inputs and outputs, such as fertilisers and crop harvests. Partial Balance 2 (IN3+IN4+IN5+IN6-OUT3-OUT4-OUT5-OUT6) is made up of biophysical flows such as the fixation of nitrogen and erosion. This desegregation of the overall balances into two partial balances shows that Partial Balance 1 turns positive for the three macro nutrients, which means that, in general, the farmers are compensating for the losses made by harvested products. It is basically the loss processes of Partial Balance 2 that cause overall nutrient depletion.

Figure 3: Average partial nutrient balances



Results of economic analysis

The economic analyses at activity level showed that cash crops, as compared to food crops, were far more profitable and at the same time had less negative nutrient balances because more inputs were invested in them (Figure 4). However, at farm level a higher nutrient loss was calculated for the more market-oriented farms. This seeming contradiction was caused by the way the households managed their livestock. The market-oriented farms had zero grazing units and despite the fact that they recycled more material within the farm, relatively large losses of nutrients (leaching, gaseous losses) occurred during storage and when manure was being applied. The subsistence farms, however, usually had herds of free ranging cattle which resulted in a net import of nutrients into the farm when cattle were grazed outside the farm during the day time and were tethered within the farm boundaries at night. In this analysis the common grazing grounds from which the nutrients are extracted are not included as part of the farm.

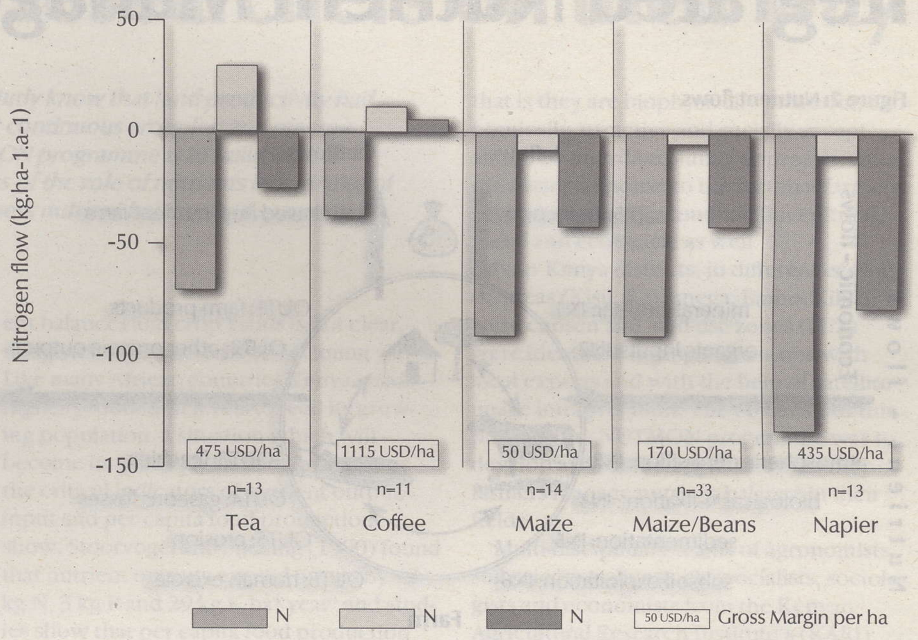
Assessing sustainability

The following indicators were calculated to assess the overall ecological and economic sustainability of this sample. On average 32% of the net farm income was based on nutrient mining. In other words, the farm income would be reduced by 32% if the depleted nutrients were actually replaced. About 54% of the farms generate returns from agriculture that are insufficient to meet basic food and non-food requirements. Farms in this category were already dependant on off-farm income for their survival.

Changes in perception and practice

NUTMON monitoring results showed that although farmers were not familiar with nutrient flows and their role in soil productivity, in general they were balancing crop harvest nutrient outputs with inputs such as manure and fertilisers. During the process of monitoring it was clear from the changes farmers made in their farming system that they were becoming more aware of the importance of assessing nutrient balances. One woman farmer bought three bags of fertiliser for her tea plot instead of one because, as she said "I'm taking more from the land than I'm giving to it". NUTMON farmers in an Embu land zone changed their manuring practice: instead of waiting to use their old livestock corral as a location for planting crops until a new corral had been established, they began to move corral manure to their various fields. This resulted in more efficient nutrient applications. The quality of the manure also improved because farmers began to protect it from the effects of the sun. Although it is not yet clear how NUTMON farmers used the economic performance indicators of their various activities, they were very keen to know whether they were making a profit or loss.

Figure 4: Nutrient balances for different crops



Evaluating the role

The results of the pilot project showed that determining nutrient balances provides an insight into the flow patterns within and in and out of the farming system. As such the concept of nutrient balance is an important learning and evaluation tool in optimising nutrient management. The partial balances derived for the NUTMON farms indicated that in most cases it was more worthwhile to conserve nutrients by taking measures against leaching and erosion than it was to make further fertiliser applications which, in any case, often lead to higher losses. These nutrient flows can be analysed and linked to economic data so that the most important nutrient outflows can be reduced by taking cost-effective measures. Partial nutrient balance can also be used to classify farms in order to design more specific and effective policy measures and extension services.

The additional socioeconomic evaluation can be used as an indicator of how much room an individual farm household has for manoeuvre when particular solutions are being considered. Such an evaluation enables an assessment of the profitability of certain interventions and, as research results showed, this was clearly an important criteria in farm household decision making.

The next step

This pilot project dealt with one aspect of the NUTMON concept and produced tools for monitoring and analyses that, with minor modifications, can be used elsewhere in Africa. One objective of the NUTMON programme is to develop a complete tool for nutrient management which will include surveys, manuals, data entry and analysis software capable of assessing economic and environmental sustainability at farm level. It is hoped that this will become available before July 1998.

The next step, however, is to employ the analyses tool in a more participatory context using results to set up and evaluate interventions. There are two NUTMON projects presently involved in developing monitoring and analytical tools: the LEINUTS project in Kenya and Uganda and the VARINUTS project in Burkina Faso. Both focus on the intervention phase and are being managed locally by NGOs and national agricultural research stations. Both projects make use of the monitoring and analysis tools already developed including resource flow mapping techniques to identify farmers' knowledge and to explain the NUTMON concept. The long-term objective is to link quantitative flows and balance figures with farmers' indicators. This should eventually create a situation where farmers themselves become management experts in soil fertility.

Farmers, governments and NGOs

The farmer-expert in soil fertility management must be able to observe, infer and anticipate and, on this basis, take decisions for actions that will be subsequently implemented and evaluated. This means that farmers must be stimulated to develop their knowledge of the nutrient flow within their farms and how this relates to crop productivity. NGOs, extension agencies and governments are also potential end-users of NUTMON results, although they may have other requirements. Governments, for example, will be interested in the economic impact of nutrient mining and the effect of certain policies on the financial position of the farm household and the ecological sustainability of its farming system. To meet such demands, representative farm samples have to be selected and linkages between nutrient balances and yields have to be quantified. NGOs, on the other hand, will be more concerned with practical applications such as the economic and ecological effect of certain soil conservation measures and less interested in setting up intensive monitoring systems. This means that simplified and less data-demanding tools will have to be developed.

Although there is still much to be done, an integrated science package is being developed which, when combined with farmers' knowledge can be used in a joint effort to reduce nutrient mining and encourage the development of more sustainable farming systems. ■

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FARMS: monitoring farm performance

The Agriculture Man and Ecology (AME) Programme in Bangalore, India, conducts agro-economic research in Tamil Nadu, India, comparing conventional and ecological farms. The FARMS software programme was developed to allow periodic data entry and simplify the process of analyses.

Inputs Farmer A 3 tonnes per acre of farmyard manure 300 rupees		**Output Farmer A** 1 tonne of paddy plus 1 tonne of paddy straw containing a given quantity of nutrients	
Inputs	Data source in FARMS programme	*Output*	Data source in FARMS programme
3 tonnes farm yard manure	Visits Overall Master (relating this figure to 1000kg)	*1 tonne paddy*	Visits Overall Master (relating this figure to 1000kg)
per acre	Overall Master (relating this figure to 4047 square meters)	*nutrient content paddy*	Overall Master (Percentage of N, P, K, Zn etc per kilogramme dry weight of paddy[1]
nutrient content farm yard manure	Overall Master (defining N, P, K, Zn etc per kilogramme dry weight	*1 tonne paddy straw*	Overall Master (entered or calculated from the grain/stalk ratio)
The farmyard manure may originate in the farm or come from outside. An analysis of the chemical composition of the manure is fed into the Overall Master database		*nutrient content paddy straw*	Overall Master (definition of percentage N, P, K, Ca, Mg, S, Zn, Mn etc.)[2]

[1] Defined in Overall Master either on the bases of chemical analysis or on literature data entered into Overall Master
[2] Results of chemical analysis or data obtained from literature entered into the Overall Masters by user.

Dilip Chinnakonda

FARMS is based on the database management programme FoxPro and was developed by Aavishkar Software Consultancies in Madras and AME. The package allows quick data entry, cross-checks and has the potential to rapidly analyse the various aspects of farm management including the results of financial performance, labour requirements, nutrient, energy and groundwater balances and to provide sustainability indicators at plot, crop, enterprise and farm level.

Masters databases

Using menus in a DOS environment, FARMS provides a user-friendly interface. Most data entries can be taken from 'picklists' that the user can create to describe the farming system being studied. Enterprises (crops, animals, etc.), inputs, units of measurement used, farming systems practices (cropping systems, sericulture, etc.) have to be described and quantified before calculations can be carried out. The database relationships and reports which contain the output data needed in calculations are described in Figure 1.

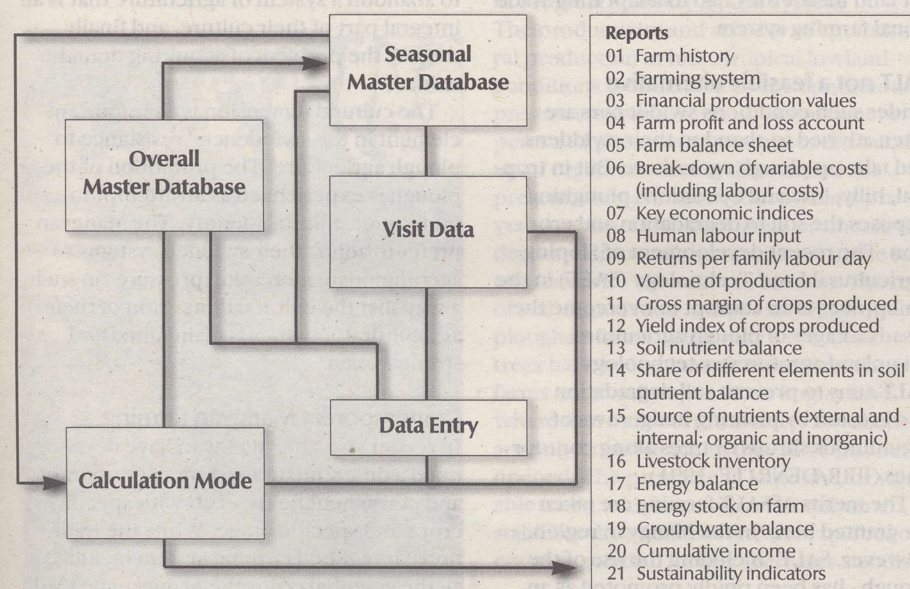
Data are arranged in such a way that all entries or values that are common to all farms or that do not change from farm to farm such as data on crops, trees, livestock have been put in data files. This is known as the Overall Master database and can be defined by the user beforehand. Data that is fairly constant over a period of time are entered into a set of data files called the Seasonal Master database. The user can also define this data which covers information on plots cultivated, the value of these plots and the crops grown.

Data entry and calculations

After a farm has been visited, data on quantities and the price of resources used are entered into a set of files called the Visits database. These are then combined with data from the earlier defined Overall and Seasonal Master files in the Calculation Module. Calculations can then be carried out and made visible by using the Report functions. At the moment there are 21 Report functions.

The example given above shows how a nutrient balance can be calculated. All other balances can be calculated in the same way making use of the same type of data. This means that data only has to be entered once. ■

Figure 1: Database Relationships & Reports



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Running the FARMS programme requires the following equipment: IBM compatible PC with 80386 processor; 4 Mb RAM, VGA monitor; 240 Mb hard disk drive; 1.44 Mb floppy disk drive; 2 serial ports, 1 parallel port; 101-key keyboard; 132-column dot matrix printer; DOS version 6.0 or later. The FARMS programme can be obtained from AME or Aavishkar Software Consultancies and costs US$ 180.00.

Swidden agriculture is often seen as unsustainable and not adapted to present day needs. Whilst it is true that traditional swidden systems are vulnerable to pressures from contemporary society, it is surprising how little effort has been made to improve these systems by building on indigenous insights and initiatives in order to increase the economic and ecological sustainability of swidden agriculture. This article describes the innovativeness of the Mangyan swidden farmers, the indigenous inhabitants of the island of Mindoro in the Philippines, and demonstrates their ability to adapt their farming to changing needs and conditions.

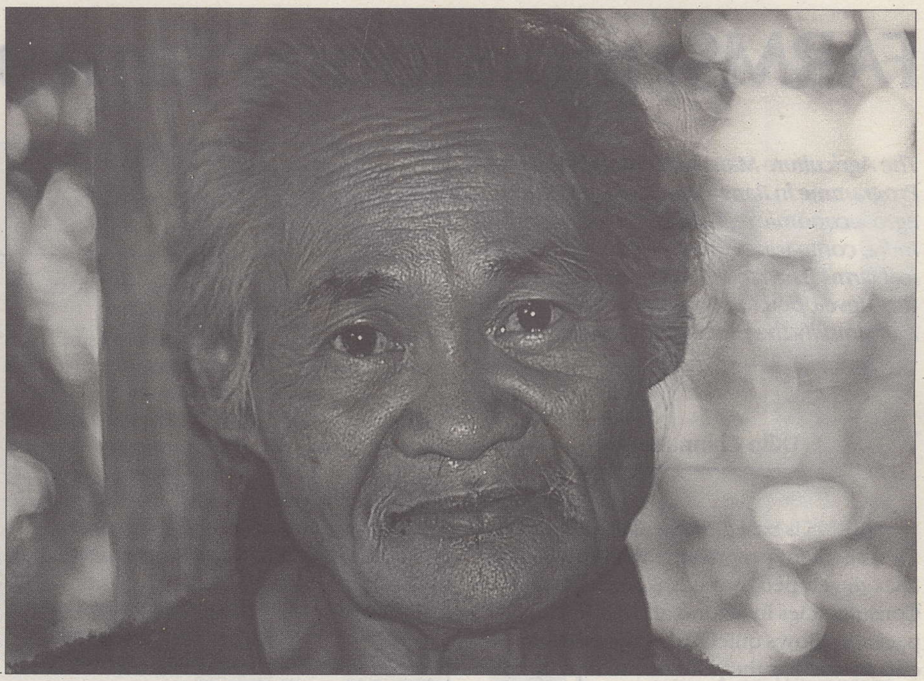

photo: Liesbeth Dorema

Indigenous intensification by Mangyan swiddeners

Klaas Nijhof

Mangyan swidden agriculture was one of the first swidden systems to be fully researched. Conklin (1957) classified it as an established integral system. In such a system few crops are raised outside the swiddens and farms are usually located in secondary forests, as the clearing of primary forest is avoided. A long fallow period during which the forest recovers, completes the swidden cycle. The fallow ensures the sustainability of swidden agriculture by regenerating soil fertility and preventing high levels of yield loss through weeds, pests and diseases. Such swidden farming systems allow an efficient and ecologically sound exploitation of the hilly, wet, tropical lowlands. The stability of swidden systems is partly due to the fact that crop production is in conformity with the natural regenerative processes that takes place on the cleared swidden. Crop choice, crop management and crop succession reflect the process of forest recovery. Competent swiddeners have a deep understanding of the dynamics of natural processes and use this knowledge to manage their swiddens. In this aspect swidden farming differs essentially from other agricultural systems where natural processes are usually controlled to allow crop growth.

No forests left

Since the late 1950s the population of Mindoro has increased sharply as thousands of immigrants settled on the island. Mangyan land was taken by the settlers and as a result the Mangyan had to retreat into the hills. More recently, commercial loggers devastated most of Mindoro's extensive forest reserves. After logging kogun grass (*Imperata cylindrica*) took over the land in many areas and hampered forest recovery. The Mangyan continued their swidden-based life style but the lack of forest land meant they had to adapt their traditional farming system.

SALT not a feasible alternative

Under such conditions swiddeners are often advised to abandon their swiddens and take up plough agriculture. But in tropical, hilly, lowland conditions ploughing exposes the soil to degradation and erosion. The recent development of Sloping Agricultural Land Technology (SALT) in the Philippines is an attempt to overcome the disadvantages of plough agriculture. An upland agroforestry technology, SALT aims to prevent soil degradation and erosion by planting hedgerows of leguminous shrubs or trees along contour lines (IIRR/DENR/ FF, 1991).

The merits of SALT farming are taken for granted here. In the Mangyan region, however, SALT - including the use of the plough - has been rigidly promoted as an alternative to swidden farming. Moreover, SALT has been presented as a sustainable blueprint for agriculture rather than a source of technologies that can be adjusted to local conditions and needs. The rigid promotion of SALT is likely to have little impact on the Mangyan for several reasons. First, if one or more of its elements are incorrectly implemented, ecological stability will be undermined and soil erosion will be increased rather than prevented. Second, as Schlege (1981) demonstrated in the Southern Philippines, plough agriculture demands more labour than swidden cultivation and SALT is particularly labour intensive. Third, the Mangyan are unlikely to abandon a system of agriculture that is an integral part of their culture, and finally there is the problem of acquiring draught animals.

The cultural dimension is an important element in the swiddeners' resistance to plough agriculture. The promotion of the plough is experienced as an attempt to undermine cultural identity. The Mangyan prefer to adjust their swidden systems to accommodate increasing pressures in such a way that the cultural dimension of their agricultural activities is maintained and strengthened.

Contemporary Mangyan farming

In recent years the Mangyan have developed a differentiated system of temporary and permanent fields, each with specific crops and specific usage. While the traditional integrated farming system included all the essential crops the Mangyan needed for subsistence, various farming subsystems are now required to raise the necessary crops. Farmers initially avoided kogun-infested land mainly because the rhizomes of this grass survive burning. But as forest fallow land became increasingly scarce, new fields had to be opened on kogun land. This type of land was abundant and, to prepare it, Mangyan farmers use fire, the plough and sometimes the hoe. Both plough and hoe have only recently been adopted by the Mangyan and plough agriculture has not replace swidden farming, but complements it by allowing the exploitation of otherwise unexploited areas. The various farming sub-systems found in the Mangyan crop production system today include:

- *Ploughed fields* usually planted with a mixture of annual crops and some perennials. These fields are typically located on deforested, kogun-infested land. They are permanent with a relatively short fallow period.
- *Swidden fields* planted with mixed annual crops and bananas. Perennials, if considered valuable, are left unburned. Compared with the traditional system, the swiddens have a strongly reduced fallow, are used for shorter periods and the emphasis is on grain crops.
- *Fields with minimal clearing and tillage* used for the extensive production of root crops such as cassava and yams.
- *Fields with no tillage and limited clearing* used for fruit trees and bananas.
- *Forest* reserve and fallowed land with secondary forest vegetation.

Swidden fields are usually combined with fields that require minimal clearance and tillage, perennial crops are raised and there is also some extensive root crop production. Some farmers are wholly dependent on their swidden farms, the most, however, include many (sometimes all) sub-systems in their individual farming system.

The knowledge of older farmers such as Hamulat is essential in rediscovering the principals of traditional swidden cultivation.

Table 1. An estimation of the ecological stability of the subsystems used in Mangyan agriculture

subsystem	presence of permanent plant cover	intensity of tillage	ecological stability
ploughed farms	few (fruit) trees/ bananas	intensive	very low
short-cycled swiddens	some (fruit) trees/ (wild) bananas	extensive	low (during first year)
extensive farms	weeds/scattered trees	extensive	medium
perennial crop farms	many (fruit)trees/ bananas	extensive	high
forest reserve	natural	none	very high

Farming unsustainable

This differentiation has not neutralised the negative effects of the increasing pressures on the farming system. The newly developed farming system compares unfavorable with the traditional swidden system. Almost all Mangyan in Tinis-an stated that yields have fallen considerably in recent decades. The yield/labour ratio has also dropped. Weed control is considered to have become more troublesome and many traditional crops have disappeared from the area. Soil erosion is no longer uncommon and landslides occur during typhoons. Mangyan farmers could no longer maintain their practice of fitting crop production harmoniously into natural processes on ploughed fields. However, the other types of fields still reflect the Mangyan's profound understanding of the best way to fit crop production into the dynamics of natural processes.

Ecological stability of the system

The productivity and stability of agricultural production in hilly, tropical lowland conditions is enhanced by the continuous presence of plant cover. A permanent or perennial plant cover stimulates the build-up of organic matter in the soil and the presence of permanent root systems prevent erosion. Intensive tillage promotes the decomposition of organic matter in the soil and leaves it vulnerable to erosion. The risk of soil degradation is especially high on ploughed farms, often only a few (fruit) trees have been planted. Moreover, these farms are usually opened on kogun land, where there are very few trees. Swiddens are only unstable when they have just been opened. The presence of large and/or valuable trees, which are often left unburned, stabilises the swiddens and the rapid recovery of vegetation further increases stability.

Mangyan innovation

The Mangyan of Tinis-an are acutely aware of the fragility of their agro-ecosystem and the need to increase food production. Further shortening of the fallow period in the ploughed and short-cycle swidden systems is impossible without chemical fertiliser. However, as Mangyan farming is still essentially a subsistence agriculture, the use of chemical fertiliser is risky and not very profitable. Purchasing external inputs is therefore far from feasible. In fact, an increase in the level of food security can only come from further developing the remaining three sub-systems: extensive farms, perennial crop farms and forest reserves. The Mangyan are, therefore, shifting crop production towards these more stable subsystems. The most recent development is a renewed interest in root crops such as yam and red tannia. Both yam and red tannia were important crops in the traditional swidden cycle, but their importance diminished as farming became more differentiated. Both yam and red tannia provide food during periods when other food is scare and are generally produced in the ecologically more stable extensive farm sub-system. In this way, the Mangyan raise their food security level and at the same time improve ecological stability.

Conclusion

It is not uncommon for outsiders to consider swidden agriculture as a static type of agriculture, dominated by tradition and in danger of disappearing. Recent developments in the Mangyan swidden system, however, shows that swiddeners are trying to sustain and improve their swidden agriculture. The trend towards ploughed fields and shortened fallow periods which lead to ecological degradation has been halted with an intensification of the ecologically more stable agroforestry sub-systems. To achieve this transformation swiddeners have fallen back on traditional practices. Based on the potential of traditional swidden agriculture to use land in a sustainable way and recent experiences with fallow intensification, it is expected that these indigenous innovations will create opportunities for sustaining a growing population.

The recent adaptation of the Mangyan swidden system shows the importance of

Yam (*Dioscorea* spp.)is particularly useful for developing the extensive production of food if grown like the forest yams of this area. It can give good yields and only requires the farmer to dig a planting hole and carry out some initial weeding. With its preference for stalking, yam is an excellent woodland (inter)crop and flourishes amongst fruit tree stands, reforested areas and secondary forest as well as on marginal and fallow land. Trees can be left undisturbed to develop into a yam/ bush agroforestry system. Although yam is usually raised as an annual crop, it is a perennial and can be left in the field during years of plentiful food supply to provide a reserve for years when food supplies are scarce.

Red tannia (*Xanthosoma violaceum*) is not a climbing crop, but is larger, sturdier and more perennial-like than the normal white tannia. Both types of tannia can be planted on swiddens and ploughed farms, but red tannia also produces well on extensive farms. It requires little attention apart from the digging of a planting hole and some ring weeding. Erni (1989) observed that red tannia, once established, yields continually for many years and needs only little additional care. Although not as flexible as yam, red tannia can also serve as a food reserve.

Mangyan traditions as a source of knowledge for innovation. Both yam and red tannia were traditionally important crops which have now been rehabilitated in order to overcome contemporary problems. Thus, even though the Mangyan no longer practice the original traditional swidden cycle, knowledge of this cycle is still very relevant as they develop new agricultural strategies. These adjustments, unlike introduced agricultural technologies such as plough farming and SALT, also strengthen the cultural identity of the swiddeners. Hopefully, the flexibility and the potentials of swidden agriculture will be recognised by the agriculturalists and policy makers responsible for the uplands and forests inhabited by swiddeners. ■

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Achieving sustainability


photo: Roland Bunch

Teaching farmers that green manure and cover crops have valuable uses besides maintaining soil fertility can help sustain the widespread use and adoption of green manuring practices

Roland Bunch

Today, well over 125,000 farmers are using green manure and cover crops in Santa Catarina, Brazil. Green manure and cover crops are equally popular in neighbouring Parana and Rio Grande do Sul. In Central America and Mexico, an estimated 200,000 farmers are using 20 traditional systems involving some 14 different species of green manure and cover crops and organisations from Central Mexico to Nicaragua are promoting their use in at least 25 additional systems. Across the ocean in West Africa more than 50,000 farmers have adopted *Mucuna* spp. or *Dolichos lablab* as green manures in the last eight years

The present widespread use and rapid adoption of green manure and cover crops has taken many people by surprise. To some extent this is because little attention has been given to the extent to which green manures and cover crops have always been used in traditional systems. Gene Wilken, for example, in his otherwise excellent book, **Good farmers: traditional agricultural resource management in Mexico and Central America**, stated that "cover cropping is not widespread in traditional Middle America," (Wilken 1987). Many scientists believed the technology inappropriate for village farmers. As late as 1989, Anthony Young in the classic **Agroforestry for soil conservation** dismissed green manuring as "a form of non-productive improved fallow which has rarely found favour with farmers". (Young 1989)

Sustainability

For more than a decade it has been accepted that green manures and cover crops would only be accepted by small farmers if they could be grown on land that had no opportunity cost, could be intercropped with other produce, grown under tree crops or on fallow land and be cultivated in periods of expected drought or extreme cold. They would also be favoured if they involved no extra labour or out-of-pocket cash expense (Bunch 1995).

Whilst these assumptions have proved correct, recent experience has shown that the sustainability of green manure and cover crops is more likely to be guaranteed when they provide farmers with some other benefit besides fertile soil. This condition is consistent with the observation that village farmers generally prefer multiple use technologies.

Experiences worldwide

Experience from many parts of the world confirms the value farmers' attribute to green manures and cover crops that have multiple uses. In most known, traditional systems legumes are appreciated not only because they maintain soil fertility, but because the seeds or pods can also be eaten. Examples include the *Vigna* spp. which is intercropped in Southern Honduras, El Salvador and South-east Mexico and the high-altitude scarlet runner bean (*Phaseolus coccineus*), which is widely used from upstate New York (Seneca bean) to Mexico (ayocote) and from Guatemala (piloy) to Honduras (chinapopo) and Northern Chile. The velvet bean (*Mucuna* spp) is easily the most popular of

in the use of green manures

all the green manures/cover crops used today and was initially used and spread by farmers along the southern border of the Himalayas in Nagaland partly because it was such a valued source of food (Young 1989). In Central Honduras, where World Neighbors and COSECHA have taught farmers to intercrop velvet bean with maize, there has been a disappointing failure (35%+) to continue this technology except in those villages where it is consumed as a major component of coffee, hot chocolate, bread and tortillas. In fact, the value of green manures and cover crops as human food seems to be the strongest factor motivating their sustained adoption.

Perhaps the second most common use of green manures and cover crops is weed control. In South-east Asia, a perennial species of the velvet bean is used to improve fallow and to control weeds. More modern practices include using jack bean (*Canavalia ensiformis*), tropical kudzu (*Pueraria phaseoloides*) and perennial peanuts (*Arachis pintoi*) under a variety of plantation crops, including coffee, citrus, and African oil palm. The velvet bean is also used to control imperata grass (*Imperata* spp.) and this practice is spreading rapidly throughout Benin, Togo, and Columbia. Velvet bean and jack bean are used to control paja blanca (*Saccharum* spp.) in Panama and to combat nutgrass in several other countries.

A third practice, which is now more widespread but which is still under-appreciated, is the use of green manures and cover crops to stabilise swidden agriculture. Since decreased fertility and weed infestation are the two most important reasons why farmers abandon their fields today, and since green manures and cover crops can, to some extent, often solve both these problems they have proved to be an effective way of stabilising shifting cultivation in many countries.

One dramatic example can be drawn from the work of the Centro Maya in Guatemala's northern Peten region. In this humid forest area, farmers could only grow maize for one or two years and then the ground had to be left to regenerate. Now hundreds of farmers are growing velvet bean intercropped with maize on the same fields year after year. Those who initially adopted this system have been growing maize on the same land for eleven consecutive years and productivity has **improve**d over time. Another interesting example is that of Central Ghana, where village farmers are inventing their own ways of stabilising their agriculture, including one system in which 30,000 leucaena trees (*Leucaena* spp.) on one hectare are intercropped with maize and burned very lightly each year. This practice has allowed maize to be planted on the same land for 20 years in succession.

A fourth potential benefit and one that will probably acquire more significance as experience increases, is the use of green manures as animal feed. Most green manures and cover crop species, with the major exception of *Melilotus albus* cannot be grazed well, but many can be used for cutting and carrying even after months of drought. The most notable examples of this type are *Lathyrus nigrivalvis* and lablab bean (*Dolichos lablab*). Seeds also provide fodder. One good example is the seed of the velvet bean which in Campeche, Mexico is cooked for a half hour, mixed with an equivalent amount of maize and then ground into pig feed. The University of Yucatan calculated that this velvet bean feed cost less than commercial feeds per unit of weight gained.

Green manure and cover crops can be used in other ways as well. Two years after Alter-Vida stopped working in El Naranjito, Paraguay, farmers abandoned using velvet beans as a green manure, but continued to use them when they wanted to prepare their land for tobacco. In Southern Brazil, hundreds of thousands of farmers regularly use some 25 different species of green manure and cover crops for soil improvement partly because this allows them to increase the amount of organic matter in their soil to the point where tilling is no longer necessary. The financial as well as ecological advantages of zero-till systems are tremendously attractive.

Conclusions

A number of conclusions can be drawn from the examples given above. First, the variety of sustainable green manure and crop cover systems already established in traditional as well as more recently introduced agricultural system is remarkably diverse. Green manures and cover crops have been adopted on a wide scale despite the seemingly prohibitive conditions mentioned earlier in this article. The fact that virtually every system we have refered to has some elements of these conditions confirms their predictive value. Thus, programmes to introduce new green manure and cover crop systems should teach farmers not only how these species can be used to improve their soil but that they have other uses as well. Tremendous potential still exists for the development of new green manure and cover crop systems. Scores of potential systems for using green manure and cover crops still need to be investigated, most notably the major possibilities of using them for animal feed; the potential latent in new as yet untried species, including trees and non-legumes, and the value of combining of green manures and cover crops rather than using individual species. Experience leads us to believe that, with the possible exception of very intensive farming systems such as irrigated vegetable and rice, green manure and cover crops systems can probably be introduced into many, if not most of the world's, small-scale farming systems. ■

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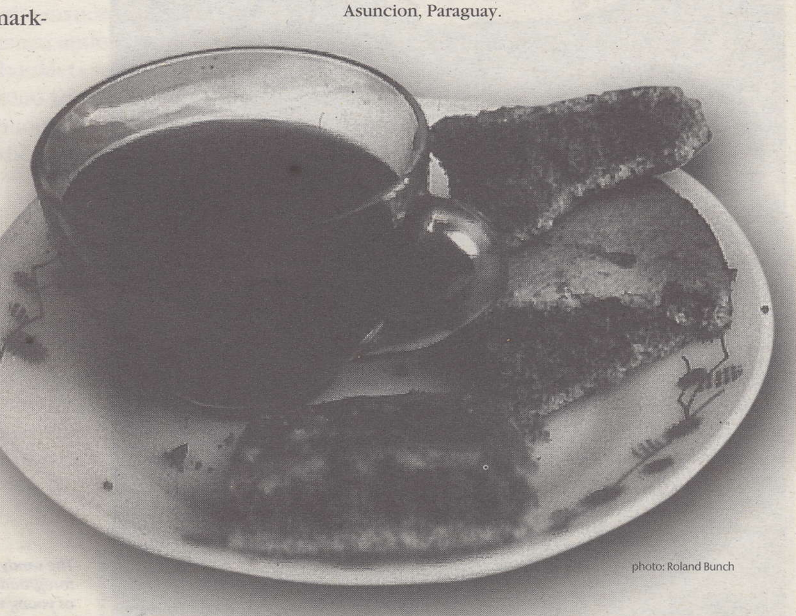
photo: Roland Bunch

In Central Honduras where velvet beans are also consumed as a major component of coffee, bread or tortillas its introduction as a green manure has been successful.

Poor soils need organic matter

The author, who has a great deal of experience in organic farming and is building up his own organic vegetable farm, describes the main farming systems in the valleys of the Ecuadorian Andes. Using practical examples, he gives some suggestions on how these farming systems could be improved using an 'organic' approach. There are, however, still many questions that farmers and researchers have to work on

Albrecht Benzing

In the valleys of the Ecuadorian Andes most of the soils farmers cultivate originate from the volcanic ash ejected during the last quaternary. What geologists and soil scientists call volcanic ash, to the farmers is nothing more than infertile sand. How long it will be before this sand becomes fertile soil depends on precipitation. In the rainy mountain regions the soils are heavily weathered, a process that is accompanied by the accumulation of organic matter. In these *páramos* there is soil with between 5 and more than 30 % organic matter. However, in the valleys located in the rain shadow of Andean Cordilleras, there has been very little weathering. The soil consists mainly of sand and coarse silt and often has less than 1 % organic matter. Low precipitation usually coincides with an extremely poor soil water-holding capacity. In addition, there is very little nitrogen in these soils and although volcanic ash has relatively large amounts of phosphorus, this is often not available to the plants.

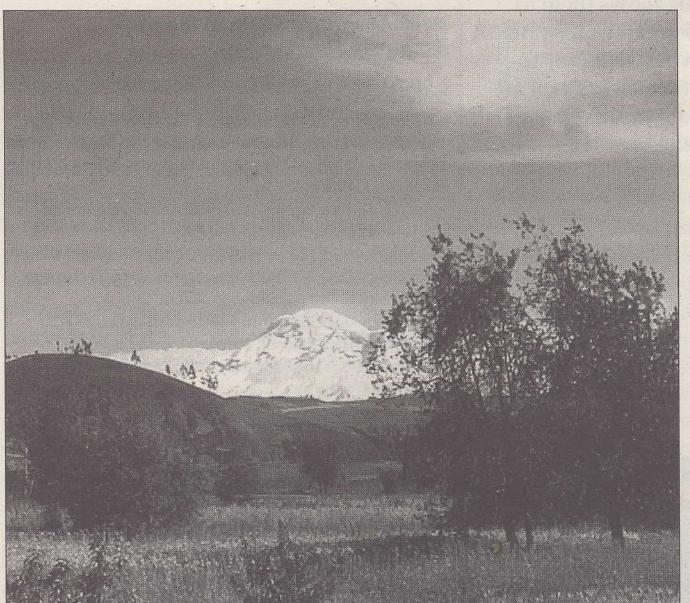

photo: Albrecht Benzing

The sandy soils in the foreground are made up of young volcanic ash which originates from 'Father' Chimborazo seen in the background.

Main farming systems

There are many farming systems in these valleys and I have analysed the effects a few of them have on long-term soil fertility.

- *Rainfed farming.* Where there are no irrigation facilities or irrigation water is scarce, peasants often grow corn and in some regions this is part of a complex mixed cropping system. Very few external inputs are bought. The soil is often fertilised by leaving animals on the field the night before planting. This effects some nutrient transfer from the natural pastures and waysides where the cattle have been grazing during the day but the external input is far less, and particularly less energy intensive than in irrigated farming, for example. Usually the straw from corn and associated legumes is conserved carefully and returned to fields by feeding it to cattle during the dry season. Nobody has yet studied whether this system leads to an increase in the organic matter content of soils. Nevertheless, where the crop mix is sufficiently diversified and farmers care for nutrient-recycling, this seems to have been a stable system for many centuries.

- *Irrigated farming.* Where irrigation is available, small farmers often engage in intensive vegetable growing and follow a high-input strategy. In addition to large quantities of water, they also use considerable amounts of chicken manure, biocides and, increasingly, chemical fertilisers. The chicken manure comes from chicken or egg 'factories', most of which are located on the Pacific Coast Plain. Many surveys have shown that this manure has the ability to increase production. Nevertheless, there is always the risk of antibiotic, hormone and insecticide residues and, therefore, it cannot really be considered an 'organic' fertiliser. In the sandy soils of the Andean valleys where there is good airing, the mineralisation of these manures with a close C/N ratio is so fast that their effect is similar to chemical fertilisers. The extremely intensive tillage and mechanical weeding employed in vegetable production accelerates this process. One of the most positive elements in these systems is alfalfa which is used as a component of many crop rotations. Alfafa remains on the fields for up to five years.

- *Market-oriented organic farming.* These farms take a step towards organic agriculture by composting organic materials before applying them to the soil. This may lead to more stable organic complexes although, as yet, there is no clear scientific evidence for this. Some people make earthworm compost (*lombricultura*), which is perhaps even better in this respect. But even organic vegetable growers often buy enormous quantities of chicken and cattle manure, sometimes from very far away. Thus, no real recycling takes place because the organic matter is transferred from one system to an other. In strict organic terms the farm itself is seen as an organism and a high percentage of nutrients should be recycled within the farm itself. The attempts of organic growers to solve the phosphorus problem by using raw phosphate or bone meal does not seem to be very promising, since these forms of phosphorus are easily fixed as calcium phosphate in neutral soils.

- *Ranging.* Landlords in the Andean valleys often raise cattle in extensive systems. Their most important external input is water and nitrogen with an increasing tendency to use herbicide. There is a considerable accumulation of organic matter under pasture cover which can be very beneficial to other crops.
- *Peri-urban farming.* In the vicinity of the larger towns, peasants have found their own way to recycle nutrients: they pay a little *propina* to municipal refuse collectors who, in return, dump urban waste on their fields. After they have manured their properties in this way a couple of times, it is difficult to distinguish corn fields from the nearby refuse tips. It is a common misconception that there is less toxic waste in the urban refuse of poor countries than in the waste produced by more industrialised communities. The opposite is probably nearer the truth: batteries, medicines and syringes are just some items regularly found in this kind of 'manure'.

Nutrient transfer from poor to rich

The main challenge in developing sustainable systems on the type of soils described here lies in increasing the organic content of the soil whilst keeping nutrient imports to the minimum. Manure is scare and its price is increasing continually. Better-off farmers buy manure from poorer smallholders. It is questionable whether this type of soil fertility transfer is sustainable.

Promising organic approaches

The integration of elements found in the farming systems described above combined with new insights could offer a solution to the problem of sustainability. Very little advantage is being taken of this potential at the moment and it should be explored. First, the integration of agriculture and animal husbandry is part of peasant farming systems in the region. This can be considerably intensified by reducing grazing on natural pastures, growing fodder shrubs and undersowing main crops with fodder legumes. Second, in intensive irrigated systems, an alfalfa-grass-ley combination would help build up the level of organic matter in the soil more effectively that the traditional system of growing alfalfa as a row crop and hoeing it in after every harvest. This would let humus build up in the soil. However, care should be taken that *kikuyu* (*Pennisetum clandestinum*) is not allowed to invade the fields too much. Two years seem to be a reasonable time. Third, mixed cropping, as practised by small corn growers, mostly in dryland farming appears to be a good way of conserving soil fertility, especially when one or more legumes are included. Ways of covering the soil as soon as possible after planting and keeping it

photo: Albrecht Benzing

A traditional corn-bean-cucumber mixed cropping system in the Ecuadorian Andes. Soil covering helps to conserve fertility.

covered during the period when no main crop is being grown should be investigated. Mulching appears to be one of the most promising approaches. Material for mulching can be grown in the margins of the fields using low-input-grasses or shrubs, for example.

There are many simple ways in which nutrient losses from organic fertilisers can be reduced. Earthworm compost might be one of these although this still requires research. Manure heaps can be covered very simply, thus reducing the leaching of nitrogen and basic cations. When cattle are left in the fields overnight in order to fertilise the land, the manure they produce should be turned under as quickly as possible. Some booklets written for farmers' still recommend adding lime to compost heaps. This should be avoided, however, as it increases the amount of nitrogen lost and the pH of many young volcanic soils is more often too high than too low.

Recycling of nutrients from urban waste is desirable, but involves many difficulties. Attempts have been made to collect organic household waste separately, but was unsuccessful because there was little awareness amongst the general public of why this was necessary.

Basic questions unresolved

In spite of the many projects aimed at improving soil fertility, a number of basic questions remained unresolved. Which cover and fodder crops are most suitable for irrigated farms? Which drought-resistant legumes and low-input grasses could be used to increase the amount of pasture and cover soil available throughout the year? What is the best way of including these within the existing system in such a way that they do not make heavy and competitive demands of the water and nutrients available? How can the amount of phosphorous available to the plants be increased? How can biological nitrogen-fixation be optimised? How can manure be best used for the various crops and systems?

There are many solutions that can be drawn from farmers' experiences. Some of these experiences need to be developed and complemented by research. Solutions to the problems of achieving and maintaining an optimal amount of organic matter in poor soils is a task for farmers and researchers working together. ■

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photo: Albrecht Benzing

Cabbage growing with vetch-undersowing (Vicia villosa) in an organic farm in Riobamba, Ecuador.

Farmers' local knowledge agrees with

photo: K.D. Subedi

Carrying Asuro leaves for green manuring

The extent to which farmers' preference for particular green manure species agrees with the scientifically demonstrated value of these plants is discussed in this article of on hill farming in Nepal

K.D. Subedi

Agricultural practices in the hills of Nepal are based on traditional knowledge and maintaining soil fertility is almost entirely dependent on locally available resources. The recycling of organic matter from farm and forest is the major source of plant nutrients in the traditional system. Farmyard manure/compost and green leaf manure are the traditional sources of plant nutrients. Traditionally, farmers in the Nepalese hills cut and carry leaves and twigs (Photo) from a variety of plants found on their farms, in the forests and on marginal lands and either incorporate them into the soil as green manure or use them as green mulch. These practices are most common in the foothills and middle mountain regions of the country where they are mainly used in wet-bed rice (*Oryza sativa*) and vegetable nurseries, and in rice fields.

Fallen leaves from various plants are also used as compost. These leaves are collected in the Spring, used as animal bedding and ultimately become compost. Farmers have identified the leguminous and non-leguminous trees, shrubs and annual plants that have good manuring value. This local knowledge has developed over centuries of farmer experimentation and the importance of these composts and manures is widely recognised. There are several plant species commonly used as green manure but the ten most preferred species are listed in Table 1. Usually these plants species have little or no value as fodder and become green manure by default. Many of them are multipurpose and locally available, and many of them are perennials. Farmers have a preference ranking for different species based on their value as manure, their availability and their multifunctionality. The degree to which local farmer preference ranking agrees with formal experimental results and the prospect for these green manures in the subsistence farming system of the Nepalese hills are discussed below.

Verification of farmers' knowledge

The knowledge farmers had about the traditional green-leaf manuring plant species to be found in the western hills of Nepal was gathered together in various formal and informal ways. In order to understand and verify the farmers' indigenous knowledge as far as these species were concerned, plant tissues (leaves) were analysed for their nutritive values (nitrogen, phosphorus and potassium) and, in formal field experiments, the manuring performance of many of the species were tested on rice crops.

Asuro, siplikan, titepati, ankhitare, bakino, rice bean and padke were among the species most preferred by farmers. When their nutrient values were analysed, asuro came in first place. The other species were also found to be quite rich in major plant nutrients (Table 1). It was clear that farmer preference agreed well with the nutritive values of the plants studied.

Plant species that were less preferred included jhuse til which although it had good nutritive values, caused itching during puddling and rice transplantation Chilaune (*Schima wallichii*), sajiwan (*Jatropha curcas*) and tuni (*Toona ciliata*) were also used only when the more preferred species were unavailable. The nutritive values of these species were found to be comparatively poor. When green leaf manure from asuro and chemical fertiliser (at 60:30:30 NPK kg/ha) were applied in rice field experiments and their effects compared, asuro consistently out-yielded the chemical fertiliser over several seasons and locations (Sthapit et al. 1989; Subedi 1993a). Similarly, rice yields from experimental plots treated with titepati, khirro, rice bean and siris were consistently better than yields from those plots where chemical fertilisers had been used. This proved that farmers, by experimenting over the generation, had been able to select species with superior qualities.

Another example of farmer ingenuity in green manuring can be found in relay planting. Here rice bean and niger are planted as green manure under the summer-planted maize crop (*Zea mays*). These green manure crops were dug into the soil after the maize harvest and before the rice was transplanted in a rice-wheat-maize rotation. Farmers in the western Nepalese hills developed this procedure when they realised that an intensive cropping system placed heavy demands on plant nutrients and that growing a green manure such as *Sesbania* would mean relinquishing a food crop, something no subsistence farmer could afford. Relay planting on two sites was studied in a three-year long field experiment. The plots manured with relay planted rice bean as a green manure produced rice yields equivalent to a plot treated with chemical fertiliser applied at 60:30:30 NPK kg/ha with no negative effect on the grain yield of the maize crops (Subedi et al. 1995). From these examples it can be concluded that Nepalese farmers make efficient use of their natural resources in providing for the necessities of their subsistence way of life.

h formal experimental results

Prospects

Low and declining soil fertility is a major production constraint in the hills of Nepal and it is becoming increasingly critical to secure sustainable soil productivity. Intensification of crop production, deforestation and soil erosion are the main factors involved in declining soil fertility. Chemical fertilisers have been seen as a way of sustaining soil productivity. However, the extent to which farmers can depend on this input is constrained by the inaccessibility of the remote mountain regions, lack of technical know-how, the low purchasing power of the majority of hill farmers and the difficulty of making the right type of chemical fertiliser available in the right amount at the right time. Farmers themselves are becoming increasingly concerned about the deteriorating physical properties of the soil as the volume of chemical fertiliser increases and the amount of organic manure declines.

Most of the indigenous green manure species can be used for many purposes. Asuro, for example, is used as a live fence, a hedge plant, an insect repellent and as an excellent green manure. Khirro has insecticide properties and when used as a green mulch is said to control such pests as white grubs. It is also frequently used to control crabs in rice fields. The tender twigs and leaves of the siplikan plant are used as a pickle after it has been boiled and farmers attribute it with medicinal properties. In the same way, Siris, Bakaino and Padke which are commonly grown in terrace risers, as fences and along streams provide not only timber, firewood and foliage but also produce good green leaf manure as well. Moreover, these species help conserve soil and are said to cause minimal shade problems to food crops.

Whilst growing such plant species in marginal lands, as fences and along river banks causes no harm, there are limitations to the scale on which green manure can be used. If green manures were to be employed on a large scale, a major gap would develop between demand and availability. Therefore, one should not expect the total nutrient supply to come from green manure alone. Moreover green manure involves considerable human labour because the green biomass has to be cut and carried. Some plant species such as ankhitare and siplikan are beginning to disappear very quickly because of over exploitation. Attention must be given to the conservation and proper utilisation of these important plant species.

Traditional knowledge is often neglected in agricultural research and development and the price paid for this omission is that new technologies are often adopted with little enthusiasm and resolve. Despite the many efforts being made to introduce exotic green manures such as *Sesbania* sp, their use is far from widespread in Nepal because of altitude constraints, the fact that they compete with arable crops during the growing season and because seeds are often unavailable and difficult to germinate. Using indigenous green manure is a traditional practice. Therefore, it is less likely to encounter the same adoption problems and communication barriers that confront new technologies. Identification, conservation, and utilisation of locally available green manure will contribute significantly to meeting the total nutrient demand of local crops without creating environmental problems or placing cash demands on subsistence farmers. These examples reinforce my belief that agricultural research, especially in the case of subsistence farming, should be based on local knowledge. ■

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Table 1. List of the top ten indigenous green manure species found in the western Nepalese hills with farmers' preference rankings and the comparative nutrient content of plant leaves.

Local name	Common name	Botanical Name	Plant type	Altitude range (approx. m)	Farmers' preference ranking	Nutrient content (%) on dry matter basis		
						N	P	K
Asuro	Malbar nut	*Adhatoda vasica*	shrub	200-1300	1	4.30	0.88	4.49
Ankhetare	-	*Walsura trijuga*	tree	400-1200	4	2.77	0.49	2.40
Bakaino	Persian lilac	*Melia azedarach*	tree	100-1500	5	3.24	0.19	1.76
Khirro	Tallow tree	*Sapium insigne*	tree	200-1200	8	2.70	0.79	2.89
Jhuse til	Niger	*Guizotia abyssinica*	annual oil seed crop	100-1700	10	4.45	0.36	3.44
Padke	-	*Albizzia* spp	tree	300-800	6	3.62	0.26	0.94
Siltung/Masyange	Rice bean	*Vigna umbellata*	annual grain legume	<1500	7	2.91	0.28	1.84
Kalo siris	Albizia	*Albizzia leebek*	tree	100-1500	9	2.89	0.65	2.59
Siplikan	Garlic pear	*Crataeva unilocularis*	tree	200-1200	2	3.69	0.36	2.27
Titepati	Indian worm wood fleabane	*Artemisia vulgaris*	herb	>2000	3	2.40	0.41	4.90

Source: Subedi (1993b)

Soil fertility management in

Ranjit Mulleriyawa
and Chesha Wettasinha

Mahaweli System-C is an agricultural settlement scheme in the 'dry' zone of Sri Lanka. Prior to 1980 most of the land in this region was covered by forest. Between 1980 and 1990 almost 70,000 hectares of this forest was cleared to make way for an irrigated agricultural settlement of some 22,000 farmer families. Each family was provided with one hectare of irrigable rice land and 0.1 hectare of 'highland' for use as a homestead. Since rice is the staple diet of the Sri Lankan people, and with an ample supply of irrigation water assured for growing two crops of rice on the same land each year, rice monoculture tends to be standard practice for most farmers in Mahaweli System-C.

During the first three to four years (six to eight seasons) of cultivation, the new, high-yielding rice varieties spawned by the Green Revolution performed exceptionally well and yielded between five to six tonnes of rice per hectare without any fertiliser. Thereafter, rice yields began to fall drastically and farmers were compelled to apply inorganic fertilisers to maintain yields at around four and half to five tonnes per hectare. As the price of imported inorganic fertiliser increased, the profitability of rice farming began to decline. And when the Sri Lankan Government, yielding to pressure from the World Bank, removed the subsidy on fertilisers, rice farmers found themselves in dire straits.

Sesbania rostrata produces modules capable of N-fixation on its stem.

photo: Chesha Wettasinha

Nutrient mining

One of the important reasons for yield decline in irrigated rice is nutrient mining. Total nutrient removal per hectare by a rice crop of five tons amounts to about 100 kg of N, 16 kg of P and 128 kg of K. Farmers compensate this loss by applying about 375 kg of inorganic fertilisers which contribute 117 kg N, 23 kg of P and 42 kg of K.

Traditionally most farmers burn their rice straw on the threshing floor and do not return the ashes to the fields. Thus, whilst the grain is consumed as food, the straw is wasted by burning. The net result being the nutrient mining of the soil. Little wonder then that rice yields fall in the absence of adequate nutrient replenishment. As rice straw (5000 kg/ha) contains approximately 36 kg N, 4.5 kg P and 112 kg K, recycling straw might be a good way of balancing the negative nutrient balance.

Farmer education

Extensionists employed by Sri Lanka's Mahaweli Authority began to educate farmers by confronting them with the hard facts of conventional rice farming practices. Farmers were quick to recognise the value of incorporating rice straw into their fields during preparatory tillage rather than burning it on the threshing floor. However, many of them experienced practical problems when trying to incorporate rice straw into their fields. Some complained that the straw became entangled in the mould board plough. Others maintained that rice seedlings began to yellow shortly after the straw had been incorporated. Extensionists sought the assistance of researchers in trying to solve these practical problems.

Before long, farmers, extensionists and researchers were fully involved in many on-farm experiments designed to find the most practical way of incorporating rice straw into the field whilst minimising the negative impact on rice seedling growth. In less than two seasons of trial and error suitable solutions were found.

Incorporation of straw feasible

Farmer experimentation revealed that rice straw could be effectively ploughed back into the field if the following steps were taken :

- Spreading the straw out in small heaps (weighing 4-5 kg) spaced 2 to 2.5 meters apart over the entire rice field shortly after threshing.
- Impounding enough water in the field to allow the heaps of straw to become thoroughly wet.
- Ploughing the field with a mould board plough (first ploughing) taking care to avoid the heaps of straw and then spreading the straw uniformly over the field.
- Cross-ploughing two weeks after the first ploughing. The straw breaks down readily into smaller pieces at this stage enabling it to be incorporated into the soil.
- Puddling, levelling and broadcasting pre-germinated rice seed about three weeks later.

Researchers were quick to point out that the yellowing of rice seedlings observed by farmers was a result of the temporary immobilisation of soil nitrogen by soil bacteria because rice had been sown broadcast immediately after the straw had been incorporated. These negative effects could be avoided if rice was sown at least three weeks after the straw had been incorporated or by applying about 20 kg of urea fertiliser per hectare of rice field when the straw was ploughed in.

irrigated rice fields

photo: Chesha Wettasinha

Dingiri Banda claims that ploughing in Sesbania improves the fertility of his land.

Benefits of straw application

Farmers reported the following benefits from applying straw to their rice fields:

- Healthy, robust rice plants which are more resistant to insect pest and disease attacks.
- Potassium fertiliser no longer required (rice straw is rich in potassium).
- Slightly less nitrogen fertiliser required (20-25 kg per hectare).
- Yield increases of around 400-500 kg per hectare of rice after three to four consecutive seasons of straw application.
- Improved water retention of soil.

Despite the many benefits and considerable saving of hard cash made possible by straw application, the high nitrogen requirements of better yielding, improved rice varieties still make heavy demands on inorganic nitrogen fertilisers which are mostly in the form of urea. Acutely aware of the problem faced by rice farmers who had to find the money to buy the 60-80 kg of nitrogen fertiliser (130-175 kg of urea) needed for each hectare of rice field, researchers at the Department of Agriculture's Regional Research Station in Girandurukotte, Mahaweli System-C, began looking for cheaper sources of nitrogen in the form of green manures.

Green manures

Cyril Bandara, the main researcher at the Agricultural Department's Regional Research Station in Girandurukotte, began screening a number of leguminous green manure crops such as *Sesbania rostrata, Sesbania sesban, Sesbania aculeata, Crotalaria juncea and Crotalaria caricia* for bio-mass production and N-content. *Sesbania rostrata* proved to be most promising. Research showed that at a seedling density of 60 plants per square meter, *S. rostrata* was capable of providing 4000 kg of dry matter and 100 kg of nitrogen per hectare in just 45 days of growth. Unlike most other legumes, *S. rostrata* was also unique in that it produced nodules capable of N-fixation on its stem (Photo 1).This remarkable plant from Senegal was also able to grow well in water logged soil unlike the many species of *Crotalaria*.

Sesbania rostra fits the system

Research also showed that *Sesbania rostrata* could be grown in situ in a rice field, and that it could be easily fitted into the turn-around period of the rice-rice cropping pattern of the region. The best time for ploughing in *Sesbania rostrata* proved to be 40-50 days after germination. Thus, it was possible to grow *S. rostrata* in a rice field during the 'fallow period' following one rice crop and the beginning of another (second) crop. *S. rostrata*'s potential as a green manure crop for rice was considerable. It was now necessary to introduce it to rice farmers, to determine its performance in farmers' fields and find out whether farmers would accept it.

A firm believer - but no seeds

Dingiri Banda is a rice farmer in the Divulapelessa Unit of Mahaweli System-C. He is an innovative farmer always looking for new things to try out. He applied straw routinely and many of his neighbours have been motivated to do the same. He strongly believed that soil fertility should be improved through the use of organic matter. As a regular visitor to the Agricultural Research Station in Girandurukotte, he had observed a patch of yellow flowering *Sesbania rostrata* growing in a rice field. When he was told of *Sesbania*'s potential benefits as far as improving soil fertility was concerned, he immediately asked the researchers for some *S. rostrata* seeds to try in his own field. The researchers obliged. That was about two years ago.

When we visited Mr. Banda in July this year, he proudly showed us his rice fields. He claims he ploughs in *Sesbania* regularly and says it has improved the fertility of his land considerably. He finds the rice plants are much healthier and that they give a better yield. Another advantage he noticed was that *S. rostrata* kept soil-based pests at bay, probably due to the slight bitterness of the plant.

Although Mr. Banda is aware of the benefits of *S. rostrata*, he is unable to produce sufficient seed to maintain the required plant density over the entire one hectare area during any given season. Therefore, he resorts to a rotation of manuring. Lack of seed is also the reason why his neighbours have been slow to follow his example.

Farmer-researcher collaboration

As mentioned earlier the link between the farmer and the researcher was bridged by the extensionist in traditional extension. It was the latter who brought the farmers' problems to the notice of the researcher, and returned their advice to the farmers. Direct interaction between researchers and farmers had been minimal. PMHE recognises the need for strengthening collaboration between all actors, namely researchers, extensionists and farmers and hopes to use farmer experiments to this end. This Maha (October 1997-February 1998) researchers such as Mr Cyril Bandara and the Mahaweli extensionists will be linked to farmers trying out *S. rostrata* on their fields so that experiences and knowledge can be exchanged. ■

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New Kekulam rice cultivation: a practical and scientific ecological approach

photo: G.K. Upawansa

Paddy farmers in Sri Lanka face serious problems. In conventional rice cultivation inputs are expensive and yields are low. Although new improved rice varieties have a potential return of over three tons per acre, in reality they often yield less than one and half tons. This production level reflects a history of indiscriminate agro chemical application and the effects of soil erosion caused by inappropriate land preparation techniques. This article explores a way of mitigating the potentially disastrous consequences of this process.

G.K. Upawansa

After a detailed study of the problems associated with conventional rice cultivation, the Eco-Conservation Organisation (ECO) developed the new Kekulam method of rice growing.

'Kekulam' means the sowing of paddy seed that has not been pre-germinated and the new approach seeks to combine farmers' experiences with concepts drawn from modern farming such as mulching wetland rice, using weeds as crop protection agents, and carefully avoiding normal weed control measures and agro-chemicals.

Mulch in the new Kekulam system reduces erosion to near zero and has the added benefit of improving soil properties and reducing both the incidence of weeds and the amount of tillage required. Farmers, supported by ECO, found that the system was 75% cheaper, more time efficient than conventional rice cultivation and achieved water savings of up to 50%. This helped to offset the negative effects of climatic irregularities. In ecological terms the system leads to a substantial improvement in fauna and flora bio-diversity. In the earliest stages of cultivation, rice grown by the new Kekulam method requires no pest or disease management measures and whilst yields may be 10% less than conventionally cultivated rice in the first one or two seasons, they subsequently rise to a similar level.

Weeds on bunds

In conventional rice cultivation, weeds are normally removed from bunds and thrown into the fields. In Kekulam cultivation, however, weeds are left on the bunds to harbour predators. Whilst there may be some harmful insects amongst these predators, their numbers are relatively small and can be kept under control. Weeds that grow on bunds are slashed and laid on the bunds when they become taller than the rice crop itself.

Not puddling but mulching

In Kekulam cultivation, the soil is loosened with a country plough, a mommoty (flat-bladed hoe) or a tractor-drawn tyne cultivator. Ploughing and other forms of soil turning are avoided. A rotovator can be used if no tyne cultivator is available but should never be used to cultivate below a depth of five centimetres. Kekulam cultivation requires a cloddy soil and not the fine surface usually associated with conventional rice cultivation. If rains are expected within a few days of sowing, mommoties are used to construct shallow drains to carry away excess water. This is all the land preparation required.

Experience has shown that rice varieties that mature within four or more months are the most suitable for Kekulam cultivation. Seed is broadcast on dry land if rain has fallen or the land is wet from irrigation. Sprouted seeds are sown broadcast. Once the field has been sown, it is covered with a mulch made either from rice straw gathered the previous season or, if this is not available, with green leaves, dried grass or branches and twigs. It is not necessary to apply fertiliser if the fertility level of the land has been built up to an appropriate level.

A manure-fertiliser-neem mixture

Only very small amounts of nitrogen fertiliser are applied. A manure-fertiliser-neem mixture provides the basis for soil fertility management. It can be prepared in the following way. Powder 1-2 kg neem seeds and add them to 7 kg urea. Powder this mixture again, mixing it well with at least 50 kg of well-rotted, fine compost. Whenever possible, use more than 50 kg of compost. The mixture of neem seeds, urea and compost should be gathered into a heap, covered with polythene or sacks, and kept for no longer than 12 hours before being spread on the fields. Preferably the mixture should be made in the morning and applied at sunset, thus allowing the insect repellent and manuring properties of the neem seed to be used to full advantage. The manure-fertiliser-neem mixture should be applied 10 to 12 days after the seedlings emerge and a second application should be made 10 days later. Before any subsequent application is made, the crop should be observed carefully. If there are yellow leaves indicating nitrogen deficiency, a third application should be made fifteen days later. Normally a fourth application is only necessary when soils are very infertile or when varieties that take longer to mature are grown. The number of fertiliser applications needed decrease when the Kekulam system has been in use for several seasons.

Effective micro-organisms (EM)

Direct feeding to soil microbes rather than the rice itself will fix sufficient nitrogen and make other essential nutrients available once microbes are established. In Sri Lanka experience has shown that it is possible to bring the soil into balance again within four to five seasons by using composts and neem seeds. In infertile soils, the extraction of soil nitrogen by microbes decomposing mulch and other organic matter causes seedlings to yellow in the early stages of growth. An EM (Effective Micro-organism) solution or home-made liquid manure (see Box) can be applied to overcome adverse effects and retarded crop growth. It can also be applied when a thicker than normal layer of mulch is being used. The EM solution is a combination of different beneficial and coexisting soil micro-organisms and was developed in Japan by Professor Higa. It is currently being used in many countries.

No weeding

In Kekulam cultivation, mulch is used to keep the weed population to a minimum and it becomes unnecessary to remove the few weeds that do appear because these will act as host plants to predators. The weeds of the *Echinochloa* species, however, must be removed and this can be done by hand because of the small numbers involved. There are two or three varieties of weeds - members of the grass family - that germinate with the rice and absorb nutrients faster than the rice plant itself. Kekulam farmers sow rice at higher densities than in conventional cultivation in order to smother weeds. The mulch, the manure-fertiliser-neem seed mixture and a high seed density keep weed populations at a level that favours bio-diversity in both fauna and flora.

No pesticide application

In conventional agriculture, weeds, harmful insects and diseases are treated as pests. In ecological farming and Kekulam cultivation, they are treated as a natural resource. No chemical pesticides are used and plant-based pesticides are only applied during the initial stages of conversion when harmful insects, disease-causing organisms and pernicious weeds still dominate. Kekulam farmers try to establish a balance between all organisms as quickly as possible by improving bio-diversity and avoiding activities that might harm any form of visible or invisible life. The proportion of harmful organisms can gradually be reduced over time if there is a balanced natural supply of plant nutrients from organic matter, host plants are provided for predators, and the diversity of soil microbes is increased as a result of protective measures. Avoiding the use of excessively nitrogenous fertiliser also helps reduce the incidence of pests and diseases. Climate changes, variable weather and mistakes by farmers can cause an upsurge of pests and disease. In such situations a kem (a traditional rite) which does not damage the eco-system, is carried out. Sometimes a plant extract from neem seed preparation or *Derris* scandence stems is used. Kekulam farmers, however, never use chemical insecticide.

One might think that a Kekulam farm, surrounded by conventional, high-external-input farms, would be vulnerable to diseases and pests. This is not the case. I have personally observed two small beds on a conventional farm being cultivated using Kekulam farming techniques: these beds remained free of pests and disease even though the rest of the farm was affected.

Mulching

Kekulam cultivation had been practised in the past but, with the emphasis on irrigated rice cultivation, its significance declined. The most significant difference between the two systems is mulch and the way it is used. Mulching allows straw to be recycled very simply. The mulch protects the soil from erosion and improves its physical, chemical and biological properties. The effect of mulch is something that has to be experienced: it cannot be explained. Improvements to fertility exceed expectations probably because of the combined effect of soil conservation, nutrient enrichment, enhancement of biological activities and the improvement of moisture-retention capacity. Weed suppression also contributes to yield improvement. Mulching increases the soil's moisture retention capacity at the beginning of cultivation providing cover for seeds and helping to ensure uniform germination. In conventional rice cultivation intensive land preparation is an essential factor: it keeps fields weed free and encourages a good plant stand. Perfect levelling ensures a uniform depth of water which checks weed germination and growth. In the Kekulam system, mulch helps keep weeds down to an optimum level, encourages moisture retention without perfect levelling, and protects nutrients from being leached out. The Kekulam farmer does not have to till his or her fields so intensively and can keep manure and fertiliser use to the minimum.

Maximising water use

At the national level, using Kekulam cultivation can reduce the amount of irrigation water required by as much as 50% - a great leap forward in improving irrigation efficiency. At present farmers are often restricted to planting small areas because there is not enough water in the reservoirs to allow them to cultivate more extensively. Using the new Kekulam method it may sometimes be possible to cultivate all the land available and still use only half the amount of water normally required. At the moment cultivation takes place when there is sufficient water in the reservoirs. Quite often the season is delayed and this can lead to pest damage. These delays can be avoided if the Kekulam method is used and water is saved. The increase in the area available for potential cultivation can be of tremendous national significance. A 25% extension can have the same effect as constructing reservoirs with 25% of the capacity of those currently in use. The Kekulam method is particularly important because often the number of suitable reservoir sites is limited and water is always in short supply.

Lower inputs, savings in labour and reasonably high yields even with a limited supply of water mean higher profits and demonstrate that the new Kekulam method is not only viable but also economically sound, environmentally friendly and gives sustainable yields. It is a valuable, alternative, cultivation method and as such warrants further research and popularisation.

■

Upawansa, GK ECO, 46, Jaya Mawatha,
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Home-made liquid manure

Liquid manure acts not only as a manure but also as a foliar spray, mild fungicide and mild insecticide. It has the properties of plant-growth hormones and enhances soil life. In addition to all these effects it appears that crops treated with this liquid manure also develop resistance to viral diseases. As a nutrient source the liquid manure is complete and balances macro, micro and organic compounds. It can also be used as a catalyst to promote growth. When used regularly in sufficient quantities no other manures are required. The use of liquid manure is a way of maximising the utilisation of available nutrients. Crops respond well to liquid manure even on soils poisoned and inactivated by excessive use or agrochemicals. When applied to starved crops, the visual effect of application is clear within 24 hours.

Preparation

To prepare the liquid manure, sheep, goat, pig or cattle dung should be mixed with water and fresh leaves of the Gliricidia or any leguminous trees. An equivalent to 10% of the wet weight of the dung required should be added to the mixture. The fresh dung should be mixed with water in a tank or a barrel and the fresh leaves dipped in the dung mixture. The leaves selected ought to be those that dissolve when dipped. Leguminous leaves are preferred because of their high nitrogen content. In Sri Lanka the best species were found to be 'keppitiya' (*Croton lactifer*) and 'hinguru' (*Lantana camara*). The mixture should be churned daily. After about eight days a pungent odour will develop so it is better to keep the tank or barrel well away from dwellings. The vessel should also be covered to avoid mosquito breeding. Gas bubbles will appear as decomposition begins. After about three weeks the manure is ready and a layer of foam appears on the surface of the mixture.

Use

When using this manure add one volume of the concentrated liquid to 3 to 4 volumes of water. High value crops are sprayed at a rate of about one litre per square meter, depending on the crop and growth stage. The liquid manure can also be applied to the soil. When paddy is being cultivated, the manure can be mixed with the irrigation water. If the treatment is carried out weekly, excellent results can be expected.

Recycling household waste to

The traditional way: manure waiting to be carried to the fields.

photo: Peter Laban

CEOSS, a Coptic NGO in Egypt, is making important steps in a process of change towards enhancing the self reliance of its target communities. In a pilot project in Sharoona and Nassareya, PTD is creating wonders in focusing LEISA synergy on the problems of garbage and reducing the high cost of chemical fertilisers. Women, in a participatory decision process, adopted innovative measures that would lead to cleaner stables and living space. By concentrating organic household waste, manure and urine in a pit in their in-house stable, they were able to produce an organic fertiliser that probably has a much higher nitrogen content than traditional manure. Further experiments may well lead to making an improved compost which will help farmers to decrease their inputs of chemical fertiliser by experimenting with different fertiliser combinations. The recycling of garbage through improved stables has resulted in time savings for women, improved health conditions as well as providing income earning opportunities. Participatory Technology Development (PTD) is a major trigger in this process.

Gamal Zakaria and team members and Peter Laban

The people of the Nile valley have sustained production on their precious valley soils since the time of the Pharaohs. These soils are very rich and, before the building of the Assouan dam, were regularly 'fertilised' by new sediments washed down the Nile as the river, swollen with the water from the summer rains in the Southern Sudan, Ethiopia and Uganda, flooded the 50 kilometre wide valley. This natural process came to an abrupt end when the dam was built in 1962.

After the dam had been constructed, farmers were able to grow two or three irrigated crops a year. Most grew wheat, maize, alfalfa, and vegetables in a two-year crop rotation. Sugar cane and cotton are also important crops. In 1953, land reform curtailed land ownership to 50 feddan (1 feddan = 1 acre) and today most farmers in the Nile Valley do not own more than 2 to 5 feddan. People live in two or three storey houses, densely packed into the narrow streets of the small towns found throughout the valley. Cattle are kept inside the home, and there is little or no organised collection or disposal of manure, stable or household waste. Each day low quality manure is carried to the fields and household waste is dumped beside the river or along the irrigation and drainage canals.

A pilot project

In 1997, the Coptic Evangelic Organisation for Social Services (CEOSS) started a pilot project in Sharoona (pop. 35,000) and Nassareya (pop. 16,000), two small towns on the eastern banks of the Nile. CEOSS is an important NGO in Egypt and has high credibility at government level because of its non-partial approach to both Islamic and Christian as well as rural and urban communities. Established in 1952, it has expanded over the past four decades from organising literacy programmes to running complementary economic, health and agricultural development programmes that follow a social-service-delivery type approach. At present it is implementing development programmes in about 75 communities.

The pilot project area is relatively inaccessible and undeveloped. The present objective is to improve the living conditions of the population and increase the ability of farmers and women to develop solutions to the problems they face in everyday life. A second objective is to strengthen the capacity of CEOSS to implement more participatory, integrated, and ecology-oriented development programmes. The project strategy draws heavily on the Participatory Technology Development (PTD) approach and focuses on the recycling of garbage by women and the improved use of fertilisers by farmers.

First results

Some 30 farmers work together in farmer-experiment groups. After only nine months they are eager to continue systematically experimenting with different crop practices and indicate that they are prepared to continue this approach with or without CEOSS support. Other farmers have expressed interest in joining these experiment groups and in starting experiments themselves. The initial results of these fertiliser experiments have been encouraging and have shown that it is possible to maintain yields and reduce cost despite decreased applications of chemical fertilisers. In the first experiments organic and/or bio-fertilisers partially replaced chemical fertilisers.

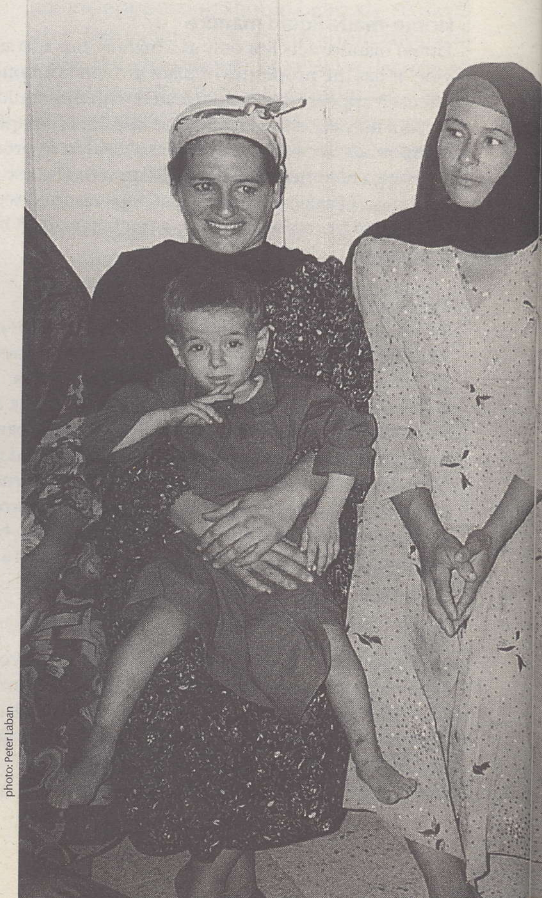


photo: Peter Laban

improve soil fertility

The impact of the pilot project at the household level was more profound. After a careful and participatory process of workshops and discussions amongst six different women's groups, it was decided to see whether it was possible to collect manure, straw and urine from the stable and combine it with organic waste and kitchen ash in a pit prepared in the stable itself. This innovation proved highly successful. Not only did it produce a much richer organic fertiliser, it saved the women a great deal of time. They no longer had to bring soil in from the fields every day to dry the stable or carry household waste to the garbage dumps near the river. The stables were cleaner so animals did not have to be cleaned in the river every day. Moreover, cleaner stables and animals made it possible to collect much cleaner milk which benefits both animal and human health. Men also profited from these innovations: they no longer have to carry manure to their fields everyday and they are coming to realise that they are getting a much richer manure. In the long run garbage recycling may well reduce pollution of the canals and the other waterways. The initial six groups involving 60 women have grown to about 100 participants and 50 other women have asked to join the project.

How did this happen?

CEOSS, wanting to incorporate a more ecological dimension into its agricultural and rural development activities, asked its funding agencies for support. Preparatory work was carried out in two villages to prioritise problem areas and assess gender roles. Soumaya Ibrahim, a social development and gender specialist from Cairo played an important role in this process. A PRA was carried out in March 1996 amongst 75 households in the two towns and demonstrated very clearly that the disposal of household waste water and garbage were by far the most important problems facing women, while male farmers gave priority to reducing the cost of chemical fertilisers. The outcome of the PRA guided the subsequent project proposal formulated by the CEOSS team. A PTD approach was chosen in which the farmer and women groups selected would still have the freedom to select other priority problems when implementing the pilot project. This open-ended project approach was approved at the end of 1996 by NOVIB and ICCO.

Implementation started in January 1997 with a PTD Training Workshop for CEOSS staff, which included a PTD design workshop (see Box 1) with one of the three selected farmer groups.

The CEOSS team repeated the design workshops with two farmers' groups and six women's groups from the two towns. Farmers grasped the process and decision making aspects very quickly and CEOSS's role was thus limited to advice, facilitation and making contacts with experts such as Dr. Sayed Arafat, a soil fertility expert attached to the National Research Centre (NRC) in Cairo.

Box 1. Looking for things to try: a PTD module for designing experiments with farmers.

Objective: Agreements on what to find out and what to try out

Tools: Resource flow diagrams; Problem tree; PRA ranking tools

Procedures:

Community meeting for commitment and endorsement of experiments

Drawing resource flows for farm enterprises *(Flow diagrams)*

Identifying problems and options to solve them *(Pair-wise Ranking)*

More detailed problem analysis *(Problem Tree)*

Orienting the farmer experiments *(Ranking)*

Agreeing on the detailed design of the experiments (treatments; experiment lay-out; monitoring; etc.)

Conclusions are laid out in project idea-sheets

This module corresponds to Step 2 (partly) and Step 3 of the PTD process. Such a module should be preceded by a PRA problem identification and priority setting at the community level.

Adapted from: Diop and Laban (1997).

Farmers wanted an analysis made of the soil in the fields where they would carry out the experiments to help guide different treatments - combinations of a more balanced amount of chemical fertilisers, biofertilisers and/or traditional manure. Smaller groups of farmers were formed on the basis of the field conditions in which they worked and progress, difficulties and results were discussed in these groups.

Women showed great interest

It was not surprising that setting up workshops and further discussions with women took more time. The projected changes had important cultural, social and gender implications for the age-old system of dealing with cattle, waste and manure. CEOSS staff took as much time as was necessary to make sure that the decisions made were really owned by the women's groups. Visits were organised to Minya, Cairo and Alexandria to discuss other experiences and projects. This was in itself an important event for most of the women had never left their village before and now, for the first time in their lives, were being exposed to other situations and ideas. CEOSS credited the PTD process with making this possible.

The experience and advice of Prof. Dr. Nader Ragheb Mitry of the NRC, an expert in rural waste technology, proved to be invaluable in helping the women develop the proposed innovations. ▶

A women's group in the small town of Nassareya

Costs involved

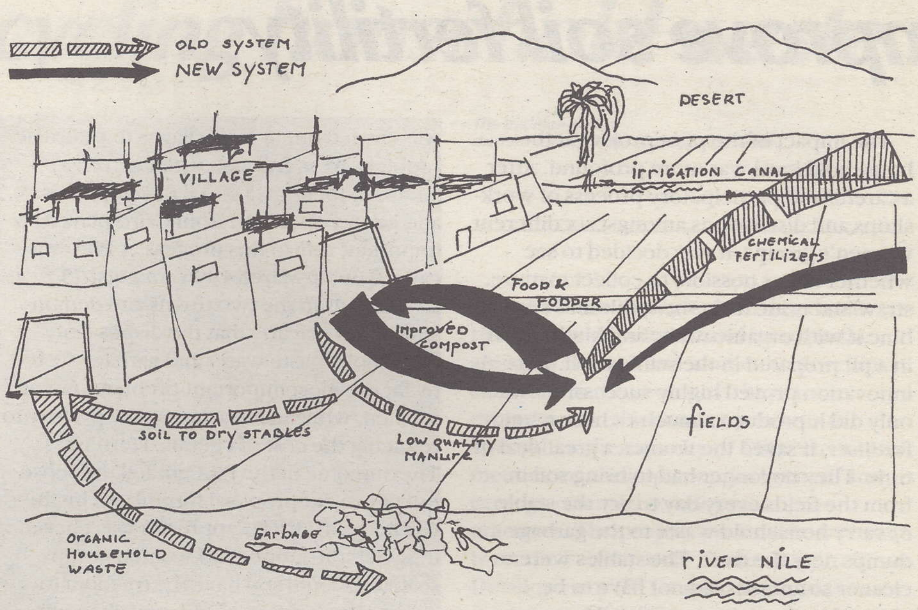
In May the final decision was made to experiment with solutions to the garbage/manure disposal problem. The most successful solution has already been described above. Another solution, developed for families without cattle, involved a large blue plastic container (200 litre) with holes in the bottom and a small door on the lower side for removing composted materials. The containers were second-hand and bought relatively cheaply (120 EL (3.5 EL=1 USD) At the moment the construction cost of in-house stable pits is about 280 EL, but these costs can be reduced when people provide the necessary bricks and labour themselves. When making decisions on the solutions to be tried out it was agreed that CEOSS would pay 75 % of the expense involved. Later it became clear that this contribution needs to be drastically revised.

Challenges ahead to increase impact

Although this pilot project has made a promising start, important issues need further attention. The advice of scientists from NRC have contributed to the positive results achieved. However, it became very clear that it is important that researchers are committed to the PTD process to avoid their opinions becoming too dominant.

The fertiliser experiments were too complex and it will not be possible immediately to differentiate between the effects of a balanced application of chemical fertiliser and those results achieved by applying organic and bio-fertilisers. There is still the risk that researchers will be inclined to follow their own research agendas and CEOSS staff have an important role to play in this respect.

Further work is needed to ensure that farmer experiments continue to improve and that the results are shared within farmer groups and the village community. Strengthening and increasing the number of farmer-experiment groups could be the next step in the PTD process. The early results of this pilot project are encouraging. They invite further action to develop on the successes of the participatory process especially as it has improved living conditions and affects the work women do in the household. Two important steps that could be taken are strengthening the way the women's development groups function, and finding ways to market the organic fertilisers produced at home, especially by families who have no cattle and no fields.



drawing: Melitta Steenhuis

Figure 1: A nutrient flow diagram of a Nile Valley farm household system

Challenges to CEOSS

CEOSS as a development organisation also faces a number of important questions. How can its policies be adapted to up-scale and increase the impact of the pilot project by strengthening and institutionalising the PTD approach? What will this mean for the further development of staff capacity? How should the important issue of financial contributions be dealt with, where it is clear that it cannot respond to a massive demand for improved stables? What form should new programme proposals - the follow-up to this pilot project - take? How can the contradiction between this participatory process of empowerment and more individually-focused development programmes be reconciled? And, finally, how should this information be recorded and documented so that it can be exchanged and shared with others both inside and outside CEOSS?

When this article has been translated into Arabic it may form an important part of the process of advocating more participatory- and ecology-oriented development programmes in Egypt. ■

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Key factors for success

- Farmers and women eager to change their situation;
- A participatory process from problem identification to an open-ended project approach;
- The PTD process: people really feeling that outsiders are listening to them and taking their concerns seriously: handing back decision making and the ownership of innovations and experiments;
- Gender sensitivity and differentiation;
- Practical procedures for farmer/women design workshops (Box 1);
- Extensive use of PRA tools including drawings of resource flows;
- Participatory development of a major innovation in the household system with multiple positive effects (cleaner houses, time savings for both women and men, improved health and fertilisers);
- The open learning attitude of CEOSS development staff;
- A process embedded in an organisation with long experience in community development that has the trust of rural communities.


photo: Peter Laban

An improved stable with a manure pit ready for use

Biomass transfer: harvesting free fertiliser

Many examples can be given of biologically orientated working strategies that aim to increase farm soil fertility. One strategy with considerable biomass transfer potential is the gathering of green plant material from farm boundaries or outside the farm to add to the cropped area.

Stella Wanjau, John Mukalama and Rik Thijssen

Most of the plants used for green manure, improved fallows, and even for improved animal manure production are leguminous species. Under favourable conditions, they can provide a practical way of securing nitrogen supply via biological nitrogen fixation and are, therefore, genuine nitrogen suppliers on farms.

There is, however, evidence that several non-leguminous plants accumulate as much nitrogen in their leaves as legumes and that these also have very high levels of phosphorus. This is most probably because these, often indigenous, species are better adapted to the area, have a greater root volume and a special ability to recover scarce nutrients from the soil. When their biomass is transferred from where it has been produced to where it can be used it provides extra nutrient input of great benefit to crop producers.

New options needed

The western Kenyan highlands are densely populated. Farms have been divided and subdivided until today average farm size is less than two hectares. These small fields are in almost continuous food production. The majority of farmers cannot afford the amounts of inorganic fertilisers necessary to maintain soil fertility, and this results in seriously depleted soils, a situation complicated by soil erosion during the rainy seasons. Farmers would normally leave land fallow to counter these problems, but with no new land to cultivate, this is no longer an option.

Researchers from the Maseno Agroforestry Research Centre and from the Tropical Soil Biology and Fertility Programme (TSBF) have been collaborating with the development-oriented Kenya Woodfuel and Agroforestry Programme (KWAP) to develop options that farmers could use to restore and sustain soil fertility. One method involves the cutting and spreading of green leaves and twigs from selected common shrubs found on farm boundaries, in bushland and along roads and streams.

Common shrubs and trees are effective

Since 1994, a number of locally available species of shrubs and trees have been used in these experiments including *Senna spectabilis, Lantana camara, Tithonia diversifolia, Psidium guajava*, and *Grevillea robusta*. In other experiments, the effects of the green manure from some of these species on the staple crop maize has been compared with the applications of inorganic fertiliser.

In a research managed on-farm experiment, green manure from tithonia and lantana was applied to the cropping area at rates of 5, 10, and 20 tonnes per hectare. Other plots were treated with a commercial fertiliser (TSP) at 12.5, 25 and 50 kilogramme per hectare. Control plots received neither fertiliser or green manure. The increase in maize yields where tithonia or lantana had been applied was startling and exciting. Plots fertilised with TSP had maize yields only 250-300 kilogramme per hectare higher than the control plot. But where tithonia or lantana had been applied maize yields were more than 1000 kilogramme per hectare higher than the control plot. Another exiting conclusion was that after it had been applied, the residual or lasting effect of this biomass transfer appears to increase yields into the third cropping season after application.

Farmers prefer tithonia

The question was now what would happen when farmers tried this biomass transfer technology on their fields? Many farmers in the area of Maseno ARC and in localities in the Busia District where KWAP is active, agreed to try applying five tonnes of tithonia green manure to each hectare of their maize fields. Although most of them were unable to immediately gather the amount needed for a hectare of maize, they did try using biomass transfer in smaller fields and found that in comparison with other areas of the farm where no green manure had been applied, yields were indeed higher. Most of the farmers reported that they preferred tithonia because it led to greater increases in yields and was easier to handle.

Tithonia (*Tithonia diversifolia*), originated in South America and is found as a roadside weed and common farm hedge species throughout tropical Africa (Palm et al. 1997) and South-east Asia (Najarajah et al. 1982). It provides a particularly good example of biomass transfer. The plant is easy to establish through cuttings and grows fast even under unfavourable circumstances. It can produce up to 275 tonnes of green material (about 55 tonnes of dry material) per hectare per year. It is very hardy and can withstand being pruned to soil level and being burned. The species is, however, not invasive and, given that it does not grow more than about 2.5 metres, it does not become an unmanageable nuisance when planted on farms. According to farmers tithonia is the only one of a total of 31 species that has a positive effect on crops grown adjacent to live fences containing this plant (Thijssen et al. 1993). Prunings are often fed to zero-grazing cattle but, because of its very bitter taste, animals generally only nibble it reluctantly.

According to farmers, however, even this has benefits. Tithonia is believed to kill intestinal worms in cattle and the bitter leftovers from tithonia reportedly assist in breaking down the fibrous materials used as animal bedding, a process that increases the quantity and quality of farm yard manure.

Confirmed by laboratory analysis

Laboratory analysis has shown that fresh tithonia consist of about 20% dry matter (DM) and has nitrogen content of 4.6% DM (Thijssen et al. 1993). Tithonia has unusually high concentrations of phosphorus (0.27-0.38% P) in its leaves (Gachengo, 1996). These levels are higher than those found in legumes commonly used in agroforestry which are somewhere in the order of 0.15-0.20% phosphorus (Palm 1995). Further, tithonia had the highest ash content out of a total of 20 commonly found shrubs and small trees: 13.7% DM, almost double the average content of these 20 different plants (Thijssen et al. 1993). This might indicate that tithonia green manure could also be a good source of other essential plant nutrients.

Conclusion

The main reason for using a plant such as tithonia in biomass transfer is that it has all the necessary attributes to rapidly store 'lost nutrients' in its biomass. Sturdy and fast growing plants, including certain grasses for example, can arrest the nutrients seeping out of the farming system. This means a lot of free fertiliser if farmers and labourers can be mobilised.

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From teaching to learning

Tools for learning about soil and water conservation

Experiment-based participation research in Southern Zimbabwe has shown that land literacy leads to land conservation. Farmers who understand the dynamics of their environment are more effective in their soil preservation and water management strategies. Regional studies in Masvingo, a dry zone to the south of Harare, have shown that conventional contour ridging had little positive effect in two-thirds of the fields studied. Small, site-specific measures, however, revealed considerable potential but to use them effectively farmers need to understand the bio-physical processes at work in their fields. Whilst teaching and demonstrating standardised techniques - practices central to conventional extension work - perpetuate farmer dependence on 'knowledgeable outsiders', land literacy stimulates their capacity to generate creative land husbandry solutions.

Jürgen Hagmann, Edward Chuma and Oliver Gundani

For many years conventional extension practices in Zimbabwe emphasised oral communication at the expense of visual stimuli - farmers were frequently assumed to be illiterate - and little attention was paid to women farmers who often felt inhibited in male-dominated groups. The authorities used promises of higher yields, material benefits and coercion to motivate farmers to carry out technical interventions in the interest of halting soil degradation. The fact that farmers adopted techniques such as contour ridging in more than 90% of their fields seemed promising. A less favourable picture emerges, however, if the impact of soil conservation measures rather than the extent to which farmers adopted soil conservation techniques are taken as the critical indicators. Recent research shows that in two-thirds of the fields studied contour ridging did not stop erosion but often accelerated it (Hagmann 1996).

The effectiveness of taking small, site-specific measures such as building check dams in rills, leaving grass strips and creating small barriers to prevent concentrated flow from anthills and depressions was demonstrated by these studies. However, if farmers are to benefit from the superior soil and water conservation potential of these techniques, they need to be able to "read their land". By exploring the causes and effects of soil erosion and monitoring them in their own fields, farmers come to an understanding of bio-physical processes. They must also have access to a variety of ideas and technical options so that they can experiment with and identify the strategies most suitable for their specific site and situation.

The principal of understanding processes through discovery and learning about technologies for site and situation specific soil management applies to all aspects of farming and extension: conservation is just one example. It is a method that enhances farmers' creativity and their capacity to use technical principles and ideas to arrive at a solution appropriate to their situation. If they do not develop this understanding farmers remain dependent on the 'knowledgeable outsider' and their motivation to adopt standard techniques will remain low because invariably they will fail to meet the specific requirements of these designs.

Farmers have many motives for undertaking conservation. In our studies we found that high yields were an important factor but farmers also wanted to minimise other off-field damage such as dams silting up and wells and rivers drying out. We discovered that farmers and their communities valued their environment highly. However, before these values can become criteria they must be identified and discussed: only then can they actively influence farmers' decision making.

How to raise farmers' capacity

The most effective, pedagogic way to come to an understanding of complex issues is 'learning by doing', 'action learning', 'experiential learning' and 'discovery learning'. All these principles stress the need to get involved in action and debate in order to build up experiences, share these with other people and learn more in an iterative process of action, reflection, self-evaluation and new action. Instead of being taught extension techniques, farmers are inspired to analyse their situation together, to put forward and try out their own ideas and known technical options. These experiences and lessons are then shared with other farmers and the larger community.

This extension approach is being practised in Southern Zimbabwe and contains an individual and a social learning component: the platform on which learning is based is one of experimentation and sharing (see Hagmann, Chuma and Murwira 1997). In putting ideas developed in this way into practice we use a variety of 'learning tools' by which farmer awareness is increased and processes are discovered.

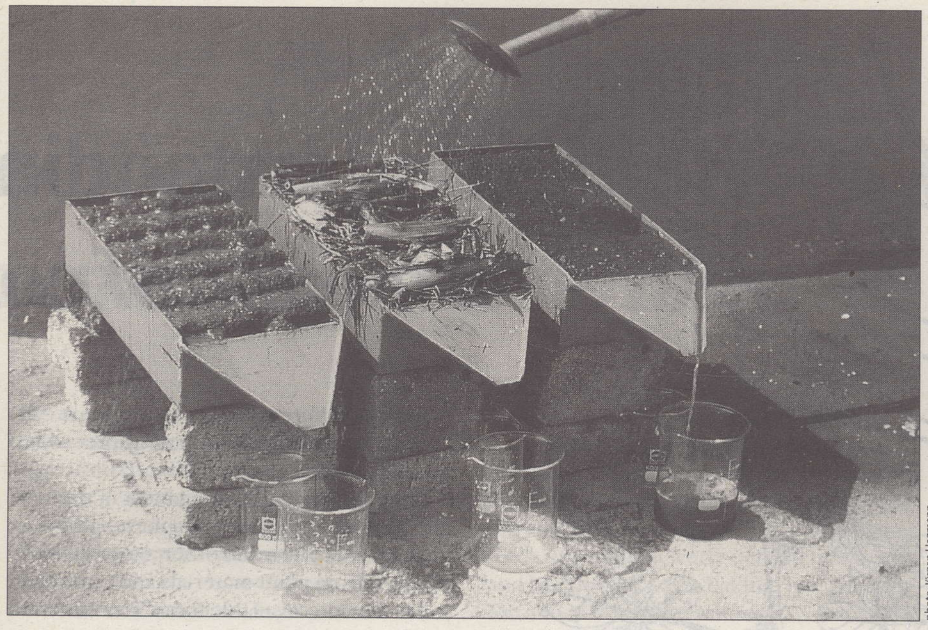
Tapping visions and values

We initiate this learning process in community workshops by stimulating debates on people's visions of development. With questions such as "If you came back as a spirit in 100 years' time, what would you like to see in your village?" people were stimulated to think about non-material values. The subsequent discussions often reflected the farmers' concern for environmental issues.

Debates were guided towards retrospection (for example, mapping) and to exploring the reasons for environmental and social change. Raising awareness through discussion and the joint analysis of change in combination with social learning gives form to values and creates an interest in working with concrete learning tools to realise the visions formulated in the group.

photo: Jürgen Hagmann

The 'two soils' in action during an awareness field day.



The rainfall simulator

photo: Jürgen Hagmann

Tools for learning

There are a variety of tools that can be used to stimulate the process of group exploration, discovery and learning. Some of these are described below.

Comparing soils

Two simulated soil profiles contained in glass boxes with an outlet at the bottom are compared. One profile is eroded and as a result has a shallow topsoil. The other profile simulates well-managed, non-eroded soil. An equal amount of water is poured into the two soil columns. The shallow, eroded soil has a lower water retention capacity and half of the water immediately flows away. The non-eroded profile is able to hold water. Having observed this simple experiment, the farmers learning process is facilitated by such questions as "What happened?", "Why did it happen?", "What effect has this on plants growing on these soils?", "Have you seen this happen in your fields?", "What is the effect in your field and has this changed over the last few decades?". In this way farmers discover and analyse bio-physical principles and relate them to their situation. The analysis reveals the link between the (man-made) drought and soil erosion.

The rainfall simulator

Three fields - one ploughed, one ridged and one mulched - are compared during a 'rainstorm' induced by a watering can. In reality these fields are boxes measuring 0.3 m x 0.5 m x 0.1 m with an outlet in the bottom and a chute in the top. Runoff, soil loss and groundwater outflow are collected in glass beakers from the three 'fields'. High runoff and soil loss occurs on the ploughed field, whereas on the mulched and ridged fields runoff and soil losses were low and groundwater outflow was high. Questions similar to those mentioned above were asked to encourage farmers to analyse these observations and relate them to their own environment and practices. (tool/learning aid adapted from Elwell 1986).

Metaphors and codes

Discussions encouraged the use of imaginative language derived from the farmers' life world. For example, a farmer compared the dynamics of water in the soil to the workings of blood in the body: a gully becomes a wound which allows blood to drain away. Such metaphors together with songs, stories, proverbs and dances are used to relate environmental processes to the farmers' everyday reality. Pictures of degraded landscape, for example, with people struggling to get firewood or games such as the nuts game which simulate the use of common resources are also important. Role play depicting situations in play form help rural people to analyse their own situation from a distance. These codes provide an entry for a debate on farmers' perceptions. The type of facilitation that takes place, however, is extremely important. First, questions on the situation depicted in the picture/game/role play are asked and these are then developed into questions that create links with the 'real-life' situation. The farmers then discuss the various answers generated by the group. The facilitator function is restricted to summarising the discussions and guiding the process.

Think tanks

Think tanks, where numerous technical options are explored, are used to expose representatives selected by communities to the technical options open in land husbandry. In our case the source of these innovations are creative farmers, training centres and research stations. Visits to think tanks have become so popular that farmers hire and pay for buses to visit these locations themselves on their own initiative .

Comparison

Conventional practice and new ideas are compared by placing them side by side in one field. The possibility of making comparisons in this way allows farmers to continually monitor and analyse what they see.

Competitions for the best ideas

Such competitions help revive the farmers' own knowledge and generate a willingness to try out new things. In many communities trying out has become a new, positive social norm and the idea that an experiment or an idea can fail is largely ignored. This spirit has replaced the tendency to wait for outsiders' solutions and has re-valued farmers' knowledge. To avoid innovators being victimised by fellow villages, a two-way competition has been introduced: individuals in a community compete, but different communities compete against each other. In this way innovators are accorded more respect by their community, whilst it is also in their interest - if they are to win - that as many 'ordinary' farmers copy their ideas as possible.

Sharing know-how and experiences

Sharing and debating know-how and experience gained during field days, farmer evaluations, exposure visits and workshops, for example, are extremely important tools in facilitating group/social learning. They also ensure that most community members have equal access to knowledge. The presentation of a farmer's own experiments and experiences to others can strengthen his or her confidence and pride.

Conclusion

These are some learning tools used in the process of experimentation-based participatory extension and research. More are available and many more should be developed. They can be highly effective in enhancing farmers' self-analysis and learning for land literacy and land husbandry. This leads ultimately to effective soil and water conservation. Farmers call this capacity building process *Chikoro chi Kuturaya* - the school of trying. ■

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The methodology was developed in the framework of the AGRITEX/GTZ Conservation Tillage Project in Masvingo, Zimbabwe. Specifications on the tools can be obtained from the authors.

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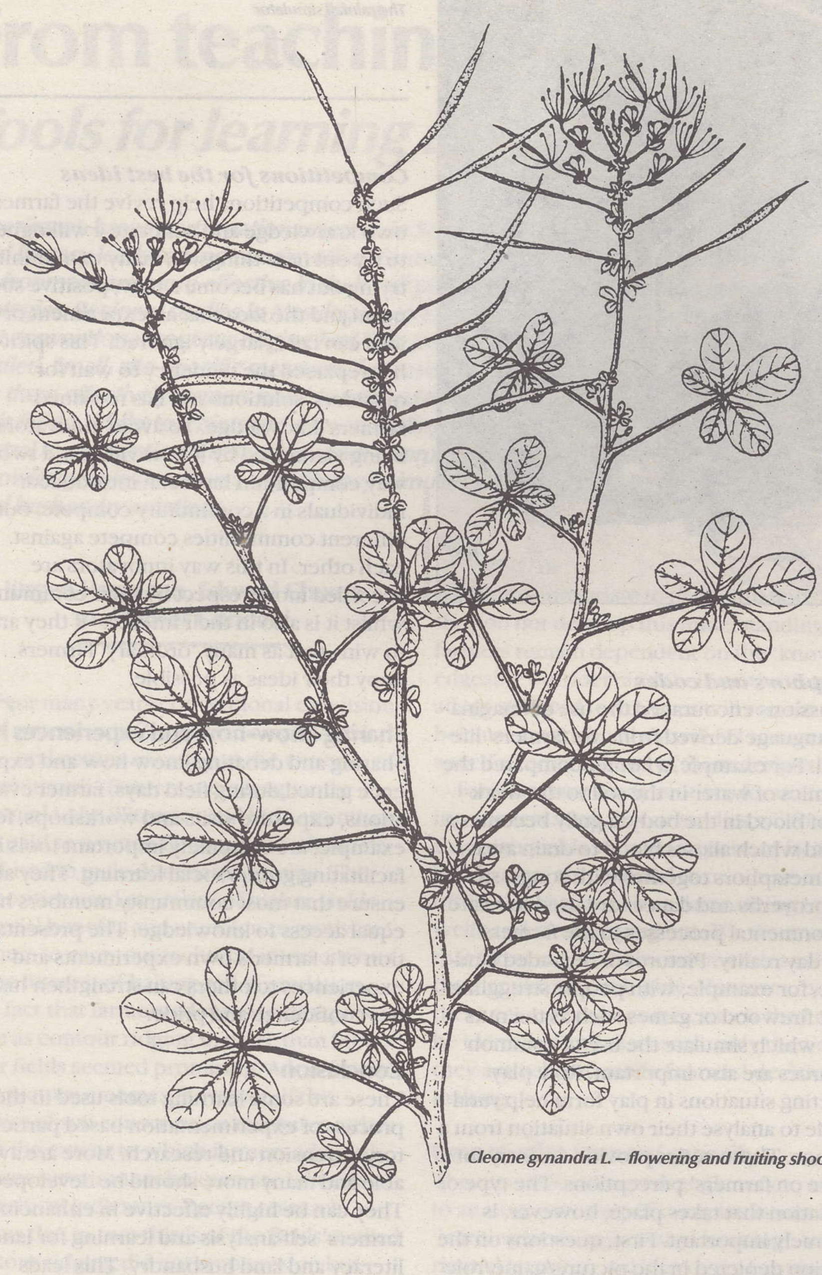
Understanding
a means of com



*Cleome gynandra L. – flowering and fruiting shoot**

Indigenous knowledge has both strengths and weaknesses. It is strong in what can be observed and weaker at understanding what is not visible. Concepts such as soil fertility and nutrients are difficult to see, but with understanding can be explained in terms acceptable to the farmer. The Moru of the Southern Sudan recognise that accumulations of wood ash provide valuable sites for cultivating ecologically specialised plants. This article demonstrates how traditional perceptions of soil and fertility were developed to teach notions of soil husbandry which the Moru, traditional shifting cultivators, could use in conditions of agricultural intensification. Understanding what the Moru already knew helped bridge the communication gap.

Roger W. Sharland

The Moru live in Mundri county, where land is plentiful, external inputs are scarce and shifting cultivation continues to be the main way of restoring soil fertility. As more people are drawn to population centres and adapt their cultivation to their new circumstances farmers need to have a better understanding of the role soil nutrients play in cultivation. Soils in the area are largely acid, so potassium soon becomes a limiting factor once land is cleared. With no synthetic fertilisers available, wood ash has a clear and significant effect on the growth and yield of many crops.

In Mundri county, ash obtain from burning trees and bush is recognised as a way of improving soil fertility and is an important reason for using fire to clear land. Areas with particularly high concentrations of ash such as those where a large tree or mound of rubbish has been burnt, are regarded as ecologically significant and suitable for ecologically specialised crops. Ash from domestic household fires, however, is seen in rather a different way even though it can provide depleted soils with an appreciable amount of nutrients.

Although during burning most of the nitrogen is lost to the atmosphere, phosphorus, potassium and other minerals are released from plant materials and enter the soil in a readily available form. The mineral composition of the ash is very similar to that of its source materials, each of which has its own nutrition pattern and specific assortment of minerals. The type of plant burnt determines the types of mineral salts released. This difference has long been recognised by Moru housewives who know that some plants are a particularly good source of the lye they use in cooking and which they make by burning certain favoured plants.

Burning in the garden

When clearing new land for cultivation, the Moru make extensive use of burning and the ash produced is highly valued. Wood ash temporarily raises soil alkalinity making potassium and phosphate more available to the crop. Two main methods are used to clear new land and both leave a significant amount of ash. First, on second year and older land, crop residues and one-year-old coppiced tree and shrub growth are collected together into piles, left to dry and then burned. Sometimes this rubble is collected together towards the end of the growing season, left to dry and burned before the rains start. The ash area created in this way is then used to cultivate ecologically specialised crops. In this procedure, ash is deliberately generated and concentrated into one place.

Second, fire is used to kill large trees and remove fallen trunks that would otherwise hinder crop growth. Firewood is plentiful in Mundri so, although smaller branches may be broken off and used as household firewood, the trees themselves are set alight and left to burn slowly in the field for several days. The result is a concentrated area of wood ash which is subsequently used to cultivate ecologically specialised crops. In a fertile area such concentrations of wood ash are avoided when sorghum is being planted for farmers know from experience that ash stimulates over-vigorous growth and lodging.

Farmers also understand that ecologically specialised crops such as finger millet, maize, pumpkin, okra and spider flower

traditional perceptions of wood ash:

municating soil fertility

(*Cleome* spp) as well as banana and papaya thrive where there are dead trees, rotting vegetation (bunds of last seasons' weeds, heaps of groundnut haulms) termite mounds and wood ash. This recognition shows that farmers understand their environment, but they do not know why these differences affect their crops.

Ash from the hearth

Hearth ash is not used in the same way. The Moru, living in an area where there is no scarcity of wood, generate an appreciable amount of ash in the course of their household activities. This ash is swept up into a pile: it is not spread on the land or taken to nearby gardens. The ash heap has a special status. It has taken time to develop and a large heap shows that a woman has been in the compound for a long time and enjoys a stable marriage. Even today when there is considerably less virtue in having a large pile of ash, the habit of heaping it up in one place still persists.

Kumbo: ash for lye

There are other domestic uses for ash. One use not directly related to agriculture is the making of kumbo, a local salt. The way the Moru make salt reflects their environmental understanding and provides an excellent parallel with processes basic to soil fertility. In the Moru situation, salt making has all the right elements for creating a teaching tool.

When the women of the village make kumbo, they carefully choose particular plants. These include crop residues, wild plants and some exotics. Once these have been selected they are cut, added to brushwood when they are still green and burnt in a well-swept area. The ash generated is collected and stored in a pot or similar container. It is recognised that if this ash is to retain its saltiness it must be kept dry. When salt is needed, the ash is put into a perforated bowl and a small amount of water is added allowing the soluble salts to leach out in the form of lye. This lye is then added to cooking water when salt is needed.

Significance of wood ash

The importance of potassium in the soil is difficult to teach, but the effect of wood ash is easy to see. Teaching, however, must be situation orientated. Burning has often been condemned. However, as long as the Moru maintain the tradition of clearing land and using it for a period of two to four years, farmers continue to see that burning is an efficient (ash gives quick results) and effective way of saving labour. However, change has brought agricultural intensification and with it new problems and learning needs. Burning is clearly detrimental to old land because it causes baking, low percolation and low water retention.

In the past, farmers were taught that all burning was bad. They rejected this teaching because they saw the beneficial effects ash had on their traditional shifting agriculture. Once this position has been understood it becomes possible to relate it to the issue of burning in the areas where it causes the most damage. In this way teaching can be situated in the context of late hot burning, the changes associated with a more intensive land use and the need for more soil husbandry because old land is being kept in production.

Not only does burning destroy organic matter and soil texture, it also damages the nutrient supply. Compost or cruder rotted vegetation contain nutrients similar to those found in wood ash but releases them at a less dramatic rate. Since the Moru recognise wood ash and decomposed plant material sites as places suitable for cultivating ecologically specialised crops, established farming practices can be used as a basis for further learning.

Traditionally, ecological niches are used in an opportunistic way and rarely involve the deliberate creation of specialised conditions. As land use practices change amongst the Moru and new crops and vegetables are grown for market, household ash becomes an important resource for maintaining soil fertility.

Many farmers find the idea of nutrients difficult to understand. They do not know why some soils are good and some are poor or why wood ash, for example, is beneficial. The community's familiarity with preparing kumbo provides a way of helping farmers understand what nutrients are, how they become available and how they work. The following learning steps proved useful when discussing the subject of soil fertility with several Moru womens' groups and helped them see the soil in a new light.

Kumbo from ash: nutrients from soil

- Kumbo is salty, it is useful in cooking.
- The saltiness is in the plant. It becomes available when the plant is burnt to ash.
- The saltiness is drawn out by adding water to the ash. The salt is then washed out.
- This saltiness is what plants have taken from the soil as nutrients.
- Plants take their food from the soil dissolved in water. If there is not enough water, plants do not get their food either.
- When ash is added to the soil, nutrients pass quickly to the water and become readily available to the plant bringing quick results.
- Nutrients can also come from compost. They are like the salt already in the plant. Burning is not necessary. In compost, nutrients pass slowly into the water. The effects of compost are not as immediate as those of ash, but the same amount of nutrient is present.
- When kumbo gets wet the salt is washed out. In the same way salt is washed from wood ash. So ash must be put on the garden while still dry.
- In the same way that ash is washed to give salt, the soil can also be washed by floods or heavy rain. When this happens salt is lost (leaching).

Kumbo provides a useful tool for learning about nutrients. Unless farm families understand the basic processes taking place in the soil they will not take an interest in soil husbandry. This is a specific example of how indigenous traditional knowledge can sometimes be used in unusual or unexpected ways. It is one example - others need to be investigated. The farm family's understanding of the ecological setting of marginal areas is an essential element in its survival for the only resources readily available are those in the soil and the bush. As we have seen the Moru have a detailed and rational understanding of their environments and this in itself provides a sound basis for grafting new learning. ■

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*) Chayamarit K. 1993. *Cleome gynandra* L. In: Siemonsma, J.S. & Kasem Piluk (Editors): Plant Resources of South-East Asia: No 8. Vegetables. Pudoc Scientific Publishers, Wageningen, The Netherlands. pp. 148-150, Figure p.149.

Barometer of sustainability: what it's for and how to use it *by R Prescott-Allen. 1996. World Conservation Union (IUCN), Rue Mauverney 28, CH-1196 Gland, Switzerland. 25 p. PADATA, 627 Aquarius Road, RR2, Victoria, British Columbia, Canada V9B 5B4. (Strategies for Sustainability series).*
This paper, commissioned by IUCN, is an interesting attempt to come to grips with a very complex subject. The exact status of the study is not known, for this reviewer only had access to a photocopy. For more information, please contact the author. A Barometer of Sustainability is proposed. This is a tool for measurement and assessment, that also serves to communicate a society's overall well-being and the progress being made towards sustainability and will eventually lead to an index of sustainability. The barometer has been tested in a number of countries.

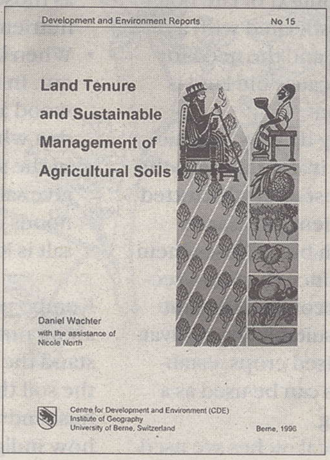
The assumption is that a society is only sustainable when people are considered an integral part of the ecosystem. Therefore, two indices are calculated: ecosystem well-being and human well-being. The intersection of the values gives a reading of the progress being made towards sustainability. In the graphic presentation, the lower score over-rides the higher score on the other scale. Thus, any trade-off between ecosystem well-being and human well-being is avoided. Such trade-offs are only acceptable at a micro level, but are inconsistent with sustainability at macro level. The separate axes allow for a transparency of results. This will facilitate discussion.

Proposed groups of ecosystem indicators have to be defined in terms of land, water, air, biodiversity and resource use. The human dimension is expressed in terms of health and population, wealth and livelihood, knowledge, behaviour and institutions, and equity. The final choice of indicators depends on the local situation and process. There is a hierarchy in the assessment: indicators lead to indicative issues, these to dimension, and finally, to the system. In this process, indicators may have to be weighted according to their relative importance.

The paper is organised as follows: Meaning and goal of a sustainable society; assessment framework; key features of the barometer; main purposes of the barometer (how to use it for choosing indicators, setting the scale, calculating indicator scores and combining indicators) and finally, analysing issues and results.The barometer's purpose and use is first and foremost to stimulate people to pay more attention to the underlying issues. An interesting approach, presented in a clear and concise style. (WB)

Organic recycling in Asia and the Pacific. *FAO Regional Office for Asia and the Pacific (RAP), Maliwan Mansion, Phra Atit Road, Bangkok 10200, Thailand.*
Produced annually, this series lists research results on nutrient recycling and looks at a wide range of aspects: various biofertilizers, composting, use of industrial waste, green manures and mulches, biogas, nightsoil, and integrated farming.

Virtually all the experiments described were carried out on-station. The presentation is concise, but no indexes are provided, apart from the table of contents: a serious omission for this type of *enumerative* publication. To the best of our knowledge, it is available free of charge on demand. (WB)

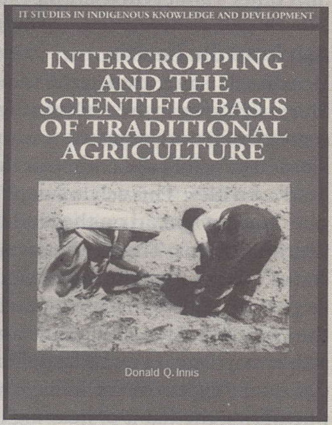


Land tenure and sustainable management of agricultural soils *by D Wachter and N North. 1996. Centre for Development and Environment (CDE), Institute of Geography, University of Berne, Hallerstrasse 12, CH-3012 Berne, Switzerland. 39 p. ISBN 3 906151 08 5. SFR 15.00. (Development and environment reports ; 15).*
A central aspect of sustainable natural resource management is the issue of land tenure and property rights. Such property rights should be legitimatised by traditional rights if they are to be effective and this is also true of indigenous resources, genetic resources, tropical forests, and tribal lands. Wachter and North, however, deal primarily with the issue of land tenure, a subject of much strife in human history. Today, over 18% of all rural households in developing countries are landless, a fact that vividly reflects their vulnerability. Wachter and North argue that insecurity of tenure is a major reason for non-sustainable soil management. Apart from examining the interaction between soil degradation and land ownership, the authors' focus on the causes of and possible remedies for insecurity. The aim of their study is to incorporate tenure issues more systematically into project designs and they discussed the following issues in detail. First, conflicts between indigenous land rights and state legislation; second, tenure insecurity in political conflicts; third, gender aspects in land tenure and finally, lack of access to formal credit.

The third part of the study deals with staggered action and puts forward recommendations for development projects that include an increased focus on land rights in development projects; improving tenure security without redefining land rights through registration and titling to counter informal ownership and as an ultimate measure, the redefinition of land rights by initiating land reform. (WB)

Green manure production systems for Asian ricelands *by JK Ladha, DP Garrity (eds). 1994. International Rice Research Institute (IRRI), Los Baños, Manila, Philippines. 195 p. ISBN 971 22 0060 4. USD 26.00. (Soil and crop management for rice). Toeche-Mittler Distribution, Hindenburgstrasse 33, 64294 Darmstadt, Germany.*
Contains a selection of papers from an international symposium organised by IRRI in 1987, with a follow-up on a smaller scale in 1992, - published in 1994 - where research findings were presented dealing with the substitution of synthetic fertilisers by renewable natural resources, notably green manures. IRRI concludes that, at the time of publication, the practice of green manuring in farmers' fields has not produced the desired results. In their judgement, however, irrigated rice is considered and not upland rice. In irrigated rice IRRI's conclusion may hold true. However, upland rice farming systems were not considered. (WB)

Soil and crop growth variability in the Sahel: highlights of research (1990-95) at ICRISAT Sahelian Centre *by J Brouwer, J Bouma. 1997. 42 p. ISBN 92 9066 365 0. International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru 502 324, Andhra Pradesh, India. (Information Bulletin; 49).*
This report of a five year project on soil and crop growth variability produced by ICRISAT and the Agricultural University of Wageningen highlights the great variability in crop yields in the Sahel and examines the influence of water, plants, animals, farmers, pastoralists and agronomic researchers in maintaining or changing this variability. In just 40 pages, an extremely clear description is given of the various factors involved. The paper has some wonderful photographs. A great publication, written in a very simple language. An important addition to the leterature available to those who are involved with Sahelian agriculture. (WB)



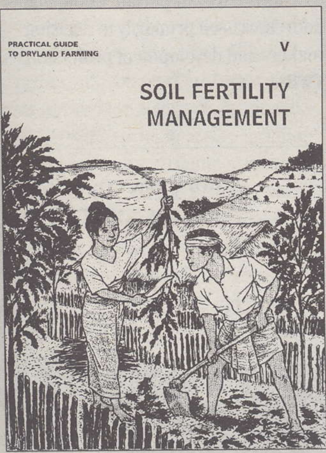
Intercropping and the scientific basis of traditional agriculture *by DQ Innis. 1997. Intermediate Technology Publications, 103-105 Southampton Row, London WC1B 4HH, UK. 179 p. ISBN 1 85339 328 2. (IT Studies in Indigenous Knowledge and Development Series).*
This book documents the agronomic and ecological advantages of intercropping and its economic and financial benefits. It is based on the author's work with small farmers in Jamaica, Nepal and India where farmers managed to maintain and conserve soil fertility and carefully nurture their non-renewable resources. Many factors involved in intercropping are discussed, such as spacing, land equivalent ratio, availability of water, nitrogen and other nutrients, the use of light, growth period, cost of labour, erosion and pests, disease and incidence of weeds. This monograph is scientifically sound and pleasant to read. (IHG)

ODI Rural Development Forestry Network network papers. *Overseas Development Institute (ODI), Regent's College, Regent's Park, Inner Circle, London NW1 4NS, UK.*
Lots of interesting papers are pub-

lished here at the occasion of Mailing 21, Summer 1997, with six titles of direct relevance for the theme of this LEISA Newsletter issue on soil fertility management:

- Forest farmers: a case study of traditional shifting cultivation in Honduras by Paul House.
- Shifting cultivation and deforestation in Indonesia: steps toward overcoming confusion in the debate by William D. Sunderlin.
- Towards a practical classification of slash-and-burn agricultural systems by Sam Fujisaka and German Escobar.
- Two papers on shifting cultivation, livelihoods, land use and property rights in South and South-west Cameroon.
- 'From the field', with information on *kaingin* in the Philippines, farmer-initiated R&E in East Africa, slash-and-burn in Sweden's history, and the conservation of forest genetic resources.

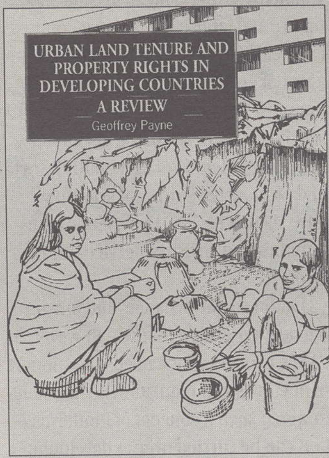
The shifting cultivation theme is also highlighted in the Rural Development Forestry Network Newsletter No. 21, published at the same time as the network papers. (WB)



Soil fertility management. *1996. 32 p. South-east Asia Media Support (SEAMS), Studio Driya Media, Jl. Makmur 16, Bandung 40161, West Java, Indonesia. (Practical Guide to Dryland Farming series; 5). World Neighbors, 4127 NW 122 St., Oklahoma City, OK 73120, USA.*
Presented in the familiar World Neighbors extension style with many drawings and a simple text full of practical information. This small how-to booklet on soil fertility management can be obtained - free of charge, as far as we know - at either of the two addresses given here. The setting is the Nusa Tenggara region in eastern Indonesia - steep hillsides with little topsoil and erratic rainfall offering all the ingredients for heavy erosion. (WB)

Land quality indicators and their use in sustainable agriculture and rural development. 1997. FAO, Land and Water Development Division and Research, Extension and Training Division, Viale delle Terme di Caracalla, Rome 00100, Italy. 212 p. ISBN 92 5 103975 5. (FAO Land and Water bulletin, ISSN 1024 6703 ; 5).
As a response to the major challenges introduced by the Rio Conference (Agenda 21), a global coalition of international agencies has been established to contribute towards the more sustainable management of the worlds land, water and biological resources. The proceedings of this FAO Technical Workshop provide a rich source of documentation on the subject of developing land quality indicators. It is indeed a useful compilation of advice, experience and opinion on why land quality information is important for sustainable development. Though initially intended for professionals and policy makers interested in the field of land resource evaluation, it touches topics of interest to monitoring and evaluation, and more specifically to indicator development for sustainable agriculture. There is a good deal of information on current thinking on developing land quality indicators, their value and implementation. A thought-provoking contribution by S. Garcia on indicator development in the global fisheries sector provides a very good overview of requirements and potential pitfalls. Often the developed indicators are complex, expensive, time-consuming and of no relevance to the primary agricultural producer, i.e. the farmer. Moreover, the capacity to analyse and to interpret recordings swiftly is often over-estimated. For this reason these Proceedings assist both researchers and development workers to reflect upon the use of indicators for sustainable development. (BL)

The toposequence concept: methods for linking partners in on-farm research for rural development *by WA Stoop, WJ Brinkman, WJ Veldkamp (eds). 1997. 189 p. Agricultural and Enterprise Development Section, Royal Tropical Institute (KIT), PO Box 95001, 1090 HA Amsterdam, The Netherlands. (Working paper series; 1).*
Like the previous paper, this collection of papers of a KIT workshop in Sikasso, Mali, examines variability in land resources. Presented is the toposequence concept, a tool to identify and analyze variability in land types and land use. Toposequences are defined by the type of parent rock and the types of terrain, in short: the landscape. As it can be made visible easily, it is often used as a communication tool between farmers and researchers. The authors argue that the toposequence concept is best used in conjunction with participatory approaches in on-farm research. A more formal publication on the subject is in preparation, which will help in laying out the material in an orderly way. (WB)

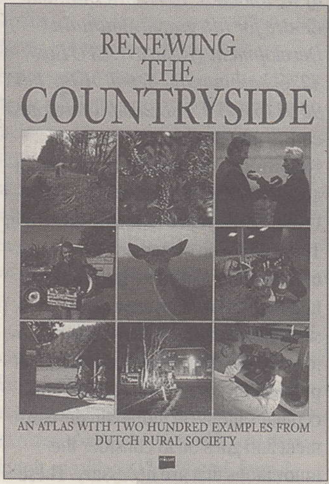


Urban land tenure and property rights in developing countries: a review *by G Payne. 1997. 73 p. ISBN 1 85339 400 9. GBP 12.95 (pbk). Intermediate Technology Publications (ITP), 103-105 Southampton Row, London WC1B 4HH, UK.*
An annotated and very thorough literature review on a very important aspect of urban agriculture. Urban land tenure and property rights is a critical aspect of urban agriculture. Often, there are frictions between different systems, particularly in urban areas where land is scarce and expensive. Access to credit very much depends on the definition of property rights. Changes in ownership may have drastic effects on the price of land and, therefore, the extent to which it can be used by the urban poor. Although this book deals with city areas much of what is presented is also relevant for rural areas. In urban areas the clash between old and new laws are accentuated because old legal constructions have clearly become inadequate. Clarity in the status of tenure is all-important: the challenge for poor city dwellers is how to obtain more security of tenure, in order to be able to investment without stimulating a disproportionate increase in land prices, which would be catastrophic for them. In this publication, the main tenure types are catalogued and explained: customary tenure, private tenure, public ownership, religious concepts, and indigenous as opposed to. imported concepts. The author concludes that careful analysis of existing systems should be carried out before embarking on major reforms. This is all the more important as tenure measures used as a policy tools are often more inflexible that fiscal or monetary policies. Interestingly, full tenure does not appear to be essential to increasing levels of tenure security. In Botswana and Indonesia, the establishment of a statutory system (i.e. by the State) was firmly grounded on traditional principles. The text has many boxes with case descriptions, thus rendering this difficult and specialized subject reasonably accessible. At the end, we find an elaborate, annotated bibliography and a very welcome glossary of terms. There is also a typology of the main categories of land tenure. All in all, a publication produced with great care and thoroughness. (WB)

Pathways towards a sustainable mountain agriculture for the twenty-first century: the Hindu Kush-Himalayan experience *by RE Rhoades. 1997. International Centre for Integrated Mountain Development (ICIMOD), GPO Box 3226, Kathmandu, Nepal. 161 p. ISBN 92 9115 645 0. USD 20.00 (developed countries) ; USD 10.00 (others).*
Following the inclusion of a mountain chapter in the final document of the UNCED conference in Rio de Janeiro in 1992, the issue of sustainable mountain development came more sharply into focus. Based on experiences of a sustainable mountain agriculture project in eight Himalayan countries, this publication reviews the existing conceptualisations on mountain development and goes on to consider the innovations that are necessary. These should be based on sustainability and farmer involvement.
Recommendations include the establishment of a specific mountain science (montology), the introduction of the computerised mapping of mountain agricultural systems, and information on mountain societies. Rhoades seems to address only policy makers, planners and researchers and is his book is not always easy to read. Unfortunately, recommendations are only sought in the fields of knowledge generation and database establishment, and lack practical guidelines for field activities that directly involve farmers. As a result, it is questionable whether farmers' reality, their problems and needs are taken sufficiently into account. (MD)

New in print

For ALL generations: making world agriculture more sustainable *by JP Madden, SG Chaplowe (eds). 1997. World Sustainable Agriculture Association (WSAA), 8554 Melrose Ave., West Hollywood, CA 90069, USA. 642 p. ISBN 0 9655767 0 1. USD 10.00.*
Gradually, concerns about the way environmental damage and industrialised farming threaten the physical and mental health of people as well as their ecosystem, are gaining recognition. The adoption of more sustainable farming methods in response to the shortcomings of conventional agriculture is becoming a viable alternative. This book provides a guide in this direction. It contains chapters on different aspects of sustainable agriculture including community-supported agriculture and the role of NGOs and urban agriculture. The second part contains profiles of organisations working for sustainable agriculture and descriptions of their work to make agriculture more sustainable. The book concludes with an index of sustainable agriculture organisations and is inexpensive given the value of the information it contains. (IHG)



Renewing the countryside: an atlas with two hundred examples from Dutch rural society *by R van Broekhuizen et al. (eds). 1997. 240 p. ISBN 90 5439 0514. NLG 35.00. MISSET Publishers, PO Box 4, 7000 BA Doetinchem, The Netherlands.*
A book on rural development, or in this case rural renewal, in the Netherlands is rather an unusual addition to our columns. The authors consider the transition essential in the light of the stagnating benefits and ever rising production costs facing Dutch farmers. At stake is the viability of the Dutch countryside. Dutch post-industrial society calls for farmers to take on a new role, far beyond their traditional tasks of producing food. The publication takes the form of an atlas and describes 200 examples of renewed agriculture. New products, from regional specialities to exotic plants and animals; new services and the integration of production, processing and marketing are described clearly and succinctly.

Dutch rural areas are important for tourism and recreation and farmers are profiling themselves as hosts to a new tourism offering a wide array of recreational services including restaurants, guided tours and festivals. In another sector the farmer emerges as an environmental expert and an architect of nature and landscape, a sharp contrast to an earlier image of the farmer as the agent of environmental destruction. Amongst the many activities described are those that draw on the health-restoring potential of agricultural work and farmers tell stories of how they have set up creches, therapeutic communities and advisory services on their farms.

Finding a new balance, and integrating new agrarian initiatives, however, is a slow process which needs the support of new laws and regulations. The extent to which such a concept of modernisation can be carried over to developing countries remains an open question. (WB)

Sweet potato extension package: facilitators' training manual *by WP Jatulan, ERA Bonilla. 1996. Small Islands Agricultural Support Services Programme (SMISLE); Box 1193 Central PO, Cebu City, The Philippines.*
This training manual has been compiled by SMISLE, a project aimed at improving the living conditions of communities on five small islands in the Philippines in a participatory way. The manual consists of eight modules on sweet potato production and tackling all aspects from site selection to marketing. It provides step by step instructions to extension workers on how to present the various technologies to the farmer using a participative adult education method. The direct aim of the method is to increase the sweet potato yield whilst in the long term the enhanced decision-making ability of farmers should produce a continuing yield improvement and more cost-effective production. Although clear, some initial training in how to use this manual is desirable. (IHG)

Adaptable livelihoods: coping with food insecurity in the Malian Sahel *by S Davies. 1996. Institute of Development Studies (IDS), University of Sussex, Brighton BN1 9RE, UK. 335 p. ISBN 0 333 633386 5. GBP 45.00. Macmillan Education, Houndsmill, Basingstoke, Hampshire RG21 6XS, UK.*
Famines are often considered abnormal, time-bound events. Providing immediate food aid should help those affected through hard times, after which it is business as usual. This book offers a quite different analysis. Famines are seen as part of a downward spiral of impoverishment and increasing vulnerability which ends in destitution. Famines are an expression of a livelihood in decline and can be expected to recur. The effect they have, however, depends on the situation in which people live. The author makes it clear that many African peoples find themselves in transition along a continuum between resilience and vulnerability.

The book provides a detailed analysis of the Suivi Alimentaire Delta Seno (SADS) project in the Malian Sahel and the Inner Niger Delta. The project approach focuses on how people feed themselves and secure their livelihood, rather than concentrating on what they cannot do. The goal is to increase resilience.

Therefore, the main aim of the project is development intervention before emergency relief becomes necessary. The originality of the approach resides in the way Early Warning Systems (EWS) are treated: adaptation strategies are monitored rather than the collapse of food availability. EWS often look at food systems but, in order to achieve effective interventions, it is suggested that it also examines food-insecure groups of people who might otherwise go unnoticed and identify livelihood considerations other than food security.

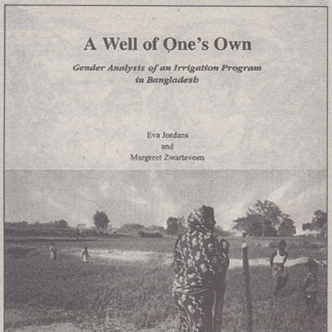
The significant aspect of EWS emphasised by Davies is that information systems should be food security-oriented and not famine-oriented and look at access to food and not to food production. It should be micro-decentralised and not macro-centralised and should have a socioeconomic focus (vulnerable groups) and not a geographical one. Essentially it must be bottom-up and people-centred and not top-down and data-centred and be geared towards generating sustainable improvement in access to food.

At the end of the first phase of SADS, a series of recommendations were made in the interests of improving the food security of particular groups by supporting indigenous responses to food stress and reducing some of the constraints encountered in dealing with their situation. The ultimate aim of the project is an integrated system of monitoring responses and impact assessment. What is needed is a set of indicators that can show how people gain access to food, how they cope and how they adapt.

Four years of project activity have yielded a number of insights into changes in post-drought livelihood systems. Still, some factors central to household food security could not be located over time in a small-scale system: the system did not provide the necessary key indicators. Therefore, a resort had to be made to standard food-aid based responses to food stress. It appears the EWS advocated at the moment is too complicated and is seen as a form of luxury: a trade-off has to be found between what can be realised and what is desirable. As the author puts it: 'decision makers will take decisions irrespective of the quality or quantity of the information available.'

There are a number of factors to consider when dealing with relief aid. First, the present systems do not work well and livelihoods are in jeopardy. Second, even in unaffected areas, vulnerability is increasing indicating a huge future need for prevention. Third, food security should not be isolated from wider livelihood security and poverty issues and finally, decentralisation of planning, vital in this approach, must be embedded in government policies to be effective.

This is a very important book, that addresses itself primarily to decision makers and development professionals. (WB)



A well of one's own: gender analysis of an irrigation programme in Bangladesh *by EH Jordans, MZ Zwarteveen. 1997. International Irrigation Management Institute (IIMI), PO Box 2075, Colombo, Sri Lanka. 100 p. ISBN 92 9090 342 2. (IIMI Country paper ; Bangladesh no. 1).*
This study describes the attempts of the Grameen Krishi Foundation (GKF), established by the Grameen Bank, to involve women more directly in its irrigation programme in North-West

Bangladesh. GKF, which supports agricultural development in general through irrigation, credit and services, initiated this process in 1992, recognising that women were heavily involved in farming and were able to generate much more income when given adequate support in farming. Gradually GKF's strategy proved successful and female involvement in irrigation has increased dramatically. As a result, woman's' contribution to household income has increased and their self-confidence has been strengthened. Constraints exist, however, primarily their limited control over the income they generate and their lack of access to land. (IHG)

The greening of Africa: breaking through in the battle for land and food *by P Harrison. 1996. Academy Science Publishers, PO Box 14798, Nairobi, Kenya. 380 p. ISBN 9966 831 34 7. USD 10.00.*

This book was first published in 1987. In the preface to the African edition, the author admits that the assumptions and expectations he had in 1987 need to be reviewed with care. The book advocates a positive approach to environmental improvement in Africa and suggests that the problem should be viewed from different angles. Investments in sustainable agriculture should go together with the need for better access to credit and the acknowledgement of the position of women in the agricultural process. Concepts familiar to newsletter readers, such as farmers' participation and use of locally available resources, receive much attention. Whilst the author pleads for a green revolution for Africa it should be different to the one that took place in Asia where the results have been problematic. In the African context, a green revolution must promote low-cost, cheap technologies that combine high payoffs with the least risks. Technologies proposed are well-documented: soil and water conservation, land reclamation, regeneration of natural forest, and agroforestry. In such a setting, the fuelwood crisis needs to be seriously addressed as well, and development programmes should give more attention to the improvement of pastoralism. Unlike many books devoted to Africa, this one ends on a note of hope and depicts three different scenarios for the future. The author suggests that only a swift rupture with past trends and a shift towards a new set of relations between people and a fragile environment can form a stable basis for progress. A useful overview of Africa's situation, written in easy, clear language. Unfortunately, the presented graphs all end in the mid-eighties and have not been updated. (WB)

Missing a moving target? Colonist technology development on the Amazon frontier *by M Richards. 1997. Overseas Development Institute (ODI), Portland House, Stag Place, London SW1E 5DP, UK. 94 p. ISBN 0 85003 301 2. GBP 10.95. (ODI Research study).*

Colonisation of the Amazon region - interestingly mostly by those who already live in the Amazon region - is characterised by a high rate of turnover of land holdings: colonists soon move on when productivity starts to decline. The constant search for new frontiers is detrimental, not only because it results in more forests being cleared, but also because each move implies the opening up of new infrastructure. This in turn attracts cattle ranchers and land speculators who have an even more destructive impact on the environment. Richards reviews the history of this 'conquest' of Amazonia, as it might have been called had it occurred 100 years ago, highlighting the socioeconomic context of technology development by colonists.

The degree of sustainability of the colonist slash and burn systems is examined. This is dependent on the length of fallow and, hence the availability of land becomes a critical factor in the latter stages of the settlement. A number of alternative technologies and land use options to the slash and burn system are presented. Various relatively successful project activities in humid Latin America are described. Use of green manures or cover crops, in combination with minimum tillage, as in Central America, seems to be a promising way of increasing biomass production and would make it possible to reduce fallow periods whilst simultaneously increasing returns to land and labour.

Interestingly, agroforestry, often regarded as a panacea, has not been extensively adopted. Apparently, smallholders regard it as having limited potential returns and involves high risk. Natural forest management by colonists has potential in the early stages of colonisation and has been adopted by some. The author concludes that technology development should take into account microeconomic realities and is secondary to getting farm-level incentives right. (WB)

Fruitiers sauvages d'Afrique (Espèces du Cameroun) *by J Vivien, JJ Faure. 1996. Ministère de la Coopération, 20 rue Monsieur, 75700 Paris, France. 416 p. ISBN 2 9509970 0 7. Editions Nguila-Kerou, "Le Kérou", 29360 Clohars Carnoet, France.*

This book inventorises the wild fruit tree species of the Cameroon. The authors discovered 300 edible fruit species, in the woods as well as in the dry zones. They provide do not provide basic food but do add variety to village diets by providing vegetables, spices, the basis for drinks as well as nuts and stimulants. Most of these products are consumed by those who collect them, relatively little is traded. However, there may be species with a larger market potential. This book describes the ecological, biological and biochemical properties of these species in detail and contains clear colour pictures and drawings. With indices of scientific and indigenous names. (IHG)

1998 issues of the ILEIA Newsletter

The first issue of 1998 will focus on 'water management' in rainfed as well as in irrigated agriculture. In rainfed agriculture, farmers have developed ingenious ways of coping with droughts as well as floods. Climate changes and droughts caused by human activity often force farmers to adapt their farming practices to a better conservation and use of scarce water resources. As the availability of irrigation water is often limited or may even decrease because of over-pumping, farmers are looking for ways to use the available water in a more efficient way. Articles dealing with indigenous knowledge of water management, farmer innovations or new research findings to make water use more efficient are invited. Information on particularly useful or new publications is also welcome. Contributions should be sent to ILEIA before 16 January 1998.

Photo: Gerrit Marsman

Organic products increasingly enter the world market under the fair trade label. This organic farm shop in the Netherlands sells organic coffee from Mexico, fair trade tea from India and fair trade cocoa from Ghana. The Marsman family have their own organic mixed farm and market products direct to the consumer.

The second issue of the newsletter will focus on marketing. There are very few agricultural communities that are not integrated into the local and international market. As farmers struggle to meet their cash requirements in often marginal and resource poor conditions, they may find themselves forced to mine their soil, make assaults on bio-diversity, resort to agrochemicals or underpay their labourers. There is a growing awareness, however, that fair trade and the creation of market demand and market channels for local, LEISA and organically cultivated products can be of considerable significance in securing viable and sustainable agriculture. We welcome your contributions and articles on this subject. Please send them to Wim Hiemstra at ILEIA before the end of February 1998.

NETWORKING

Food security and harmony with nature

The Third IFOAM -ASIA scientific conference and assembly will take place in Bangalore, India from 1 to 4 December 1997. This conference seeks to increase understanding on the issue of achieving food security through organic agriculture. IFOAM-ASIA feels that it is urgent to bring about an effective dialogue between the practitioners of organic agriculture and policy makers in order to ensure clear perceptions and policies for a sustainable future. The University of Agricultural Sciences in Bangalore is collaborating with IFOAM-ASIA in organising the conference. Papers are invited on healthy soils, biodiversity, environmental quality, education for sustainable lifestyles, indigenous knowledge, consumer awareness, policy initiatives for GO-NGO collaboration, world trade and conducive legislations.

Registration and further information: IFOAM-ASIA, IIRD, Post Box 562, Kanchan Nagar, Nakshatrawadi, Aurangabad, Maharashtra, 431002, India, Fax: +91 240 331036.

New Forests Project: World Seed Programme

The New Forests Project provides packets of tree seeds, technical information and training materials free of charge to groups all over the world who are interested in starting reforestation projects with fast-growing, nitrogen-fixing trees. Available for immediate distribution are high quality seeds of *Learaena leucocephala, Prosopis juliflora, Gliricidia sepium, Cajanus cajan, Acacia nilotica, Cassia siamea, Acacia auriculiformis, Acacia mearnsii, Acacia tortilis, Albizzia lebbeck, Dalbergia sissoo, Robinia pseudoacacia* and *Gleditsia triacanthos*. For more information or if you wish to receive a reforestation package, write to: Felicia Ruiz, World Seed Programme, The New Forests Project, 731 Eight Street, SE Washington, DC 20003, USA, Fax: +1 202 546 4784. If you are ordering a reforestation package please provide an environmental description of your area, including elevation, average annual rainfall, length of rainy and dry seasons, high and low temperatures, soil characteristics and how you intend to use the trees.

Equipment for development initiatives

The TTMI (Traditional Techniques for Microclimate Improvement) - Research and Research Training Project is being carried out at four African universities. The TTMI project, initiated in 1995, has highlighted the importance of on-farm and on-station quantification of the African agricultural environment to both protect and improve crop yield and soils in Low-External-Input Sustainable Agriculture. During our collaboration with African universities it has become clear that these institutes face serious limitations in quantitative field research because of the virtual absence of trained and suitably equipped technicians to support the research. This problem is particularly obvious in the domains of equipment maintenance, trouble shooting and repair, and the operation of basic workshop equipment.

In order not to duplicate efforts while solving these problems in different developing countries, we are currently establishing a project called 'Equipment for Development Initiatives' (EDI). Our initial aim is to develop more or less standard packages of equipment that can be used for maintenance, trouble shooting and the repair of scientific and auxiliary office equipment such as computers. We also propose that the EDI project act as a 'centre' that will co-ordinate the sourcing, ordering, delivery, export paperwork and transport of equipment.

Institutions interested in this initiative should contact Dr. Chris Coulson, c/o School of Engineering and Information Technology, University of Lincolnshire and Humberside, Cottingham Road, Hull, HU6 7RT, UK, Fax: + 44 1482 463783.

Beekeeping in rural development

Cardiff University of Wales is organising a course on 'Beekeeping in rural development' from 16 November to 13 December 1997. There will be two weeks of lectures in the UK and two weeks of practical work in Tanzania. Candidates should have an understanding of the principles of beekeeping. Course fee £4000. There is no funding available.

Further information and registration: Professional Development Centre, Cardiff University of Wales, 51 Park Place, Cardiff CF1 3AT, UK. Fax: +44 1222 874560, e-mail: HudsonGD@Cardiff.AC.UK

International course on rural extension (ICRE)

Rural extension is quickly moving away from transfer of technology approaches. Participation, poverty alleviation, gender issues and sustainable low-external-input technologies are increasingly important issues on the extension agenda. Extension is now being used more as an educational instrument to strengthen clients' capacities to adapt to changes in their social, technical and ecological environments. Against this background the International Agricultural Centre (IAC) has developed a four-week ICRE course on 'New perspectives in rural extension: challenges and prospects'. The course has been designed for managers of governmental, non-governmental and commercial rural development organisations who have at least three years of experience in a leading position. The course will take place in Wageningen, The Netherlands from 24 August to 18 September 1998. Course fee about USD 3250.-

Further information and registration: IAC, ICRE - New perspectives in rural extension, PO Box 88, 6700 AB Wageningen, The Netherlands. Fax: +31 317 418552, e-mail: iac@iac.agro.nl

CONTRIBUTIONS

The following articles have been received by ILEIA but we are unable to publish them. If you are interested in these subjects, please ask Lila Felipie at ILEIA for a photocopy.

Singh, J and Rai, SN. **Vermitech approach for waste management**. Discusses the practice of vermicomposting (compost-making involving earthworms) in a general way. The nutrient status of the vermicompost prepared by *Eisenia foetida* and *Eudrilus eugeniae* are compared in a laboratory setting.

Nicolas JS. **Rice wastes recycling: case studies in Northern Luzon, Philippines**. Documents the traditional use of rice straw as mulch in garlic production, as fertiliser in rice production, as bedding in mushroom production, and in pottery production and fuel. Opportunity costs are calculated and the sustainability of these practices are discussed.

Singh RN. **Composting of cattle dung by an Indian desert farmer: a case study**. In Rajasthan only 34 % of the farmers use cattle manure. The value of the manure can be increased by composting. The use of compost strongly contributes to controlling of termites and weeds and preventing soil crusting. In comparison to chemical fertilisers soil fertility was improved with less labour and cost. When used as a compliment to chemical fertiliser there was a considerable increase in yield. Pit composting contributed to improving hygienic of the environment. The author strongly recommends that the government adopts a composting policy.

Hunter D. **Paradise postponed**. Describes indigenous soil fertility recycling practices in taro cultivation on the atolls of the Maldives. Farmers use a variety of methods such as pit planting, raised beds and pond fields. Planting material the residue of clearances, is burned in small quantities periodically and used for the cultivation of water melons. In the beginning the ash added to planting holes. However, periodic burning ash continues and ash is still being added to vines when they are two meters tall.

Moorthy EK, Moorthy AK. and Rao KB. **VRF method of composting - a new composting technology**. Recently the Varanashi Research Foundation (VRF) developed a new way of producing compost. Plastic sheets are used to prevent the loss of moisture and nutrients. This article describes the different steps involved and the advantages of the system.

ILEIA News

New staff

There are many new faces in ILEIA: Marilyn Minderhoud-Jones is our new lead editor and she joined us in September. She replaces Carine Alders who brought considerable enthusiasm and competence to this job for many years. Bert Lof joined us in June as our new research coordinator ensuring internal cohesion between our various research endeavours. Una Patton has taken over responsibility for dealing with the subscriptions to the LEISA Newsletter. Our readers can submit matters relating to subscriptions directly to her.

Process documentation

With its activities in the field of information exchange and research, ILEIA wants to position itself in three debates: the Post-Rio debate on sustainability; the debate on the role of agricultural research at (inter)national and NGO level and the debate on approaches to (agricultural) development

In order to do this, we need to describe not only the end-results of our research, but also the **approach** that has led to these results. This description will involve documentation of research progress and process (including PTD and Stakeholder Concerted Action) and of the development process we have started with our partners in Peru, Ghana and the Phillippines.

This process documentation will serve specifically to:

- preserve information;
- describe the methodology used and lessons learned in order to be able to replicate the process;
- assess the validity and impact of the approach (the usefulness or changes needed in the methodology used in order to assess LEISA);
- include the vision and expectations of all stakeholders in the ILEIA programme

Presently, ILEIA and its partners are working on a framework for process documentation that will include information on the objectives of process documentation, the proposed methodology and the media to be used. We will keep you informed on this matter. We are, however, very interested in your experiences with process documentation. Please share any information you may have!

Reference:
Documenting, evaluating and learning from our development projects: a participatory systematisation workbook. 1997. Daniel Selener et al. International Institute for Rural Reconstruction (IIRR), Casilla 17-08-8494, Quito, Ecuador (also available in Spanish).

ILEIA Mandate analysis

After 13 years it is time to take stock of ILEIA as it is today. ILEIA has grown from a small information exchange project established in 1984 into the research and information programme it is today. Its main objective has been to contribute to the development of Low-External-Input and Sustainable Agriculture (LEISA) as an alternative to degrading Low-External-Input Agriculture (LEIA) and modern agriculture (HEIA, Green Revolution).

The present phase of the ILEIA project comes to an end in December 1998 and therefore it is important to assess which ILEIA activities should be continued. To what extent did ILEIA succeed in spreading the 'message' of LEISA? What are the demands that have not yet been met. What must be stressed in the coming five or ten years? What new challenges need to be confronted and what approaches will best achieve more sustainable agriculture and livelihood systems? What are the challenges ahead and how can ILEIA contribute to meeting these challenges? What degree of decentralisation and which institutional forms would be most appropriate for ILEIA and enable it to make the most effective contribution? Such an analysis needs to take into account the presence and capacities of existing institutions and networks and the potential for strategic alliances and other forms of collaboration. In short what should be the new mandate for an institution like ILEIA?

To get an impression of the needs and visions of our readers, ILEIA is organising a mandate analysis. This will be carried out during November and December 1997. Some 60 - 80 key persons will be interviewed by four consultants from Asia, Africa, Latin America and Europe. The results of this mandate analysis will be used as an input for a stakeholder meeting in February 1998. Institutions with a direct interest in the formulation of a follow-up programme will be invited to attend this meeting.

Our readers are also invited to contribute to this mandate analysis by putting their opinions about ILEIA on paper. We value your contributions very much.

Spanish version of the ILEIA Newsletter

In 1996, ILEIA took the initiative to produce a Spanish version of the Newsletter, *Boletin de ILEIA*. So far, four issues have been published. The *Boletin* has been received with great interest by organisations in Latin America, and the number of subscribers has increased with each new issue. We feel that, in future, the issues should not only consist articles translated from the English newsletter, but also contain an increasing number of contributions from Latin America itself. To continue and increase the distribution of *Boletin*, ILEIA asked the Dutch Government for support.

Last July, the Dutch Government (DGIS) approved funding for translating the Newsletter into Spanish for the years 1997 and 1998. Furthermore, they assured funding for the translation of three *ILEIA readers on sustainability* into Spanish and for the implementation of a Latin American market survey. This survey will serve to investigate and define the potential market for *Boletin* , to perfect the production and distribution system, and to investigate potential links between the ILEIA Newsletter (and ILEIA research) and other interesting and relevant projects being carried out in Latin America.

We would like to compliment our Peruvian editorial team for the good work they are doing and will keep you informed on progress and the results of this survey.

PTD Circular

Issue No. 7 of the PTD Circular, ETC's six-monthly update on Participatory Technology Development is out. It is a mixture of book reviews and announcements. Those interested in a copy can write to Ellen Radstake at ETC (same address as ILEIA) for a free subscription or you can send an e-mail to **office@etcnl.nl**.

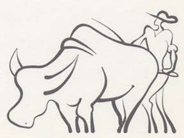
Farmers' research in practice: lessons from the field

Our new long-awaited reader in the series **ILEIA readings in sustainable agriculture** is now available. You can order your copy from IT Publications, 103-105 Southampton Row, London WC1B 4HH, UK. Tel.: +44 171 436 9761; Fax: +44 171 436 2013. You can also order per e-mail at **orders@itpubs.org.uk**. Price, including postage, is USD 22.50 or GBP 11.45.

Future issues

Once again we would like to remind our readers that the first issue of the Newsletter next year will be on water management in rainfed as well as irrigated agriculture. Contributions by 16 January 1998 please.

The second issue of the Newsletter will deal with marketing and the deadline for articles, letters, and announcements is 27 February 1998. Further details can be found on page 33.



In the summer of 1995, ILEIA began collaborating on a research programme to assess the viability of LEISA technology systems in three agro-ecological zones. The regions selected were of contrasting agricultural and socioeconomic potential: the high mountain valleys of Cajamarca and Huancayo in Peru; the dryland savannahs of Northern Ghana and the humid lowlands of Luzon in the Philippines. Later, the Agriculture Men and Ecology (AME) programme introduced a fourth region - the semi-arid Deccan plateau in India. Information on the strategy adopted by the ILEIA research programme can be found in ILEIA Newsletter 13/2 pp. 34-35. Brief insights into the research process in these four regions will be given on the back cover of this and subsequent editions of the ILEIA Newsletter.

Photo: Nueva Ecija

ILEIA research

Highlight on the Philippines

In the Philippines, research is taking place in Nueva Ecija, Central Luzon. Two Working Groups have been established in which KADAMA and KALIKASAN, both farmer organisations collaborate with researchers from the Muñoz-based Central Luzon State University (CLSU) and staff from PRRM-Nueva Ecija Branch, an NGO with a direct working relationship with KALIKASAN.

The main cropping system is irrigated rice during both the dry and rainy season. Farmers who do not have access to irrigation, have a system of rainfed rice followed by a dry season of fallow, beans and, increasingly, vegetables irrigated from shallow wells. Most farmers have some animals such as buffalo, goats, chicken and ducks.

In the seventies Nueva Ecija was the cradle of the 'Green Revolution'. Initially farmers were content with the new technology and both yields and income increased. However, after using high yielding varieties and agro-chemicals for a while farmers began to notice the disadvantages of the 'Green Revolution'. Crabs, frogs and fish gradually disappeared from the fields and later yields and income started to decline. Farmers started to borrow and debts accumulated. Health hazards were increasingly felt because of pesticide use.

Since the mid-1980-s farmers have been looking for alternatives to the technological package offered by the 'Green Revolution' since the mid-1980s. From 1986 to 1994 KADAMA farmers collaborated with scientists from the University of the Philippines in Los Banjos (UPLB) and the ACES Foundation, an NGO involved in the MASIPAG programme. The intention was to develop a technology package which would encompass improved traditional rice varieties, the application of chicken manure, rice-straw incorporation and an adapted planting configuration. In 1986 some 120 farmers started experimenting with the MASIPAG package, today only 20 KADAMA farmers still use these techniques. KALIKASAN was founded with the aim of developing sustainable organic agriculture. Amongst other things, PRRM supports KALIKASAN in buying chicken manure and marketing organic rice.

At the start of the research process, farmers indicated that their main problems were soil fertility management, the lack of irrigation water and pest management. After further analysis it became clear that the problem of soil fertility management has several dimensions.

- What farmers call the 'acidification' of the soil, a degradation probably caused by the continuous and unbalanced application of chemical fertilisers (mainly nitrogen, some potassium and phosphorous) and pesticides. Little use was made of organic fertilisers. Returns on chemical fertiliser application and yields were in decline.
- Increasing cost of chemical fertilisers whilst the price of rice continued to lag behind.
- Dependence on usurers for input loans.

Research by PhilRice and IRRI

At present researchers of the Philippine Rice Research Institute (PhilRice), based in Muñoz, are also experimenting with chicken manure and the incorporation of rice straw. First findings indicate that urea (U) and chicken manure (CM) in combinations of 25U/75CM, 50U/50CM and 75U/25CM are as effective as urea alone. For application of urea and rice straw compost (RSC), combinations with 25 to 50 % RSC seem optimal. PhilRice is collaborating in the International Rice Research Institute (IRRI) co-ordinated programme on 'Reversing trends of declining productivity in intensive irrigated rice systems'. This programme is meant to increase understanding of the present decline in yield being experienced by farmers and in the long-year PhilRice on-station experiments. It also aims at developing strategies for more accurate and rational nutrient management (Philippine Rice R&D Highlights 1996).

Farmers decided to start experiments in order to compare the application of chicken manure (ca. 1500 kg/ha) with chemical fertiliser (350 kg/ha) and a mixture of these two on a 50/50 basis. They also started to compare improved traditional varieties (Ag 8 and Ag 5, developed in the MASIPAG programme) with a local, frequently used high-yielding variety (TC 28). Farmers anticipated that costs per hectare would decrease by about 3000 Pesos (US$ 100) when chicken manure was used and that yields would stay more or less the same. About 120 farmers were involved in these early experiments which were intended to build up trust in organic agriculture and increase the farmers' skill in carrying out experiments. Follow-up experiments are needed to adjust technologies and resolve specific problems. These experiments are managed and monitored by the farmers and will be evaluated by both farmers and researchers using the criteria and indicators identified for sustainable agriculture. The FARMS software package (see page 9) is being used for data handling and for analysing the results of experiments and the farm-household systems of a selected group of farmers. ■

Photo: Farmer Magelito Diamat and a Kadama trial