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LEISA INDIA

Magazine on Low External Input Sustainable Agriculture

Recreating living soil

LEISA INDIA

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

The editors encourage readers to photocopy and circulate magazine articles.

Dear Readers

This issue of LEISA Magazine is focused on three important approaches in agricultural development: Conservation Agriculture (CA), Integrated Soil Fertility Management (ISFM) and System of Rice Intensification (SRI). All three approaches are deeply rooted in 'ecological soil management' and move towards LEISA, agriculture that makes optimal use of the ingenuity of nature. The articles prove that farmers, who work with nature instead of against it, can produce high and sustainable yields. The articles also demonstrate the creative and innovative force of farmer experimentation and participatory development processes. Especially, the development of Conservation Agriculture in Latin America by millions of large and small farmers is a break-through in the development of agroecology / LEISA.

Part of the international issue has been produced in close collaboration with the Conservation Agriculture Working group of FAO. Their support is very much appreciated.

We are extremely grateful to International Development Research Center (IDRC), Canada for supporting the production and distribution of this Indian edition of LEISA magazine.

The Editors

The articles on Conservation Agriculture (p.6-12) discuss the concepts of and experiences with this approach in Latin America and Africa.

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System of Rice Intensification gains momentum

Norman Uphoff and Erick Fernandes

The System of Rice Intensification, developed by small farmers in Madagascar, is spreading fast. The first International Conference on SRI took place in Sanya, China, in April 2002. Based on the experiences from 17 countries presented at this conference, the authors have written a 'state of the art' on SRI for LEISA Magazine. The article shows the impressive potential of this ecological approach, irrespective of the use of hybrid or traditional varieties, and discusses best practices. It also shows the creative power of farmer innovation to adapt promising technologies to local conditions.

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Experiments with spiders, ants and other indigenous practices

K.J.N. Gowtham Shankar

IDEA is working with tribal people in the northern Ghats in India. During documentation of tribal indigenous knowledge they found that social spiders were used to control stem borers in paddy. This practice, which was still known only to a few families, has now been disseminated to many farmers in the region who are now using Bulu also for pest control in other crops. This is just one of the many indigenous pest management practices documented and shared by IDEA. The tribal farmers in the region invite the readers of LEISA Magazine to exchange experiences with them.

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Editorial

Conservation Agriculture spreading fast

Thirty years ago it all started with herbicide-based Zero Tillage (ZT) for grain crops like maize and soybean. Gradually a much broader and ecologically sound approach evolved, which is now being called Conservation Agriculture (CA). CA is based on reduced or no tillage, direct seeding and crop rotation. The soil is covered with a mulch layer of crop residue, green manure or cover crop, and herbicides or mechanical or natural methods for weed control are used when required.

Presently, many crops, e.g. sugarcane, banana, cassava, tobacco, rice, onion, tomato, cabbage and lettuce, can be grown in CA systems in humid, dry and temperate climates. CA is practised widely: from commercial, large-scale, relatively simple mechanised systems using herbicides, pesticides and inorganic fertilisers to semi-subsistence, complex systems with integration of trees and animals replacing slash and burn (p. 10). CA is challenging farmers to produce in a more integrated and ecological way by following Integrated Pest Management (IPM), Integrated Weed Management (IWM), Integrated Soil Fertility Management (ISFM) or Agro-forestry, or even to go organic.

The potential benefits of CA - reduction of soil erosion, more efficient use of inputs, important savings in labour, fossil energy and total costs, and increase in production - are impressive. CA has become one of the fastest spreading approaches in agriculture, not only in the USA and Australia but also in Latin America, where millions of farmers are practising it (p.6). The CA movement in Latin America is an important breakthrough in the acceptance and development of agro-ecology / LEISA. However, in Africa and Asia, despite some initial successes, practitioners are still few and far apart.

Different actors working together

The past decade has witnessed important advances in herbicide technology and in the designing of special equipment for mulching, direct seeding and spraying. Also green manure/ cover crop (gm/cc) technology is developing fast. Larger and smaller farmers in Latin America now have a wide choice of herbicides, equipment and gm/cc species, both leguminous and non-leguminous.

In Latin America, development of CA is strongly site and crop specific and driven by farmers' organisations with participatory support from research and extension. Private enterprise is playing an important role as well, especially in development, production and sale of herbicides, equipment and gm/cc seeds. FAO and many other international development organisations are strongly supporting CA.

Also multinational companies like Monsanto are investing in the introduction of ZT approaches to increase their sales of seeds and agrochemicals. They propagate high-external-input ZT based on direct seeding, monocropping and hardly any mulching of crop residue. They seem to offer an attractive opportunity to farmers but not without hidden risks. NGOs and a small farmers' organisation in the Philippines point at the risk of upland farmers getting too dependent on these companies and their costly and health affecting agrochemicals. It may also mean that farmers lose their own local seeds and end up with the genetically engineered seeds propagated by these multinationals. It is not at all necessary to take these risks when organic- and traditional seed-based alternatives are available at low cost as in the Philippines (Biotechnology and Development Monitor No.46, June 2001, p.13). It is therefore important to establish a clear distinction between low-external-input based Conservation Agriculture and high-external-input based Zero Tillage.

Traditional Conservation Tillage - entry point for CA

The practices applied in CA (zero tillage, mulching, direct seeding, crop rotation) are not new; many traditional systems have similar characteristics. Some examples have been published in LEISA India Vol. 2, No.3. Traditional Conservation Tillage is practised by many small farmers in the humid as well as the dryer parts of Africa, but is now under pressure. *The immediate future challenge is to build productivity enhancing improvements into these systems without destroying their unique advantages* (Kayombo, Elis-Jones and Martin). These traditional practices can be good starting points for the development of small farmer CA systems (p. 10).

In the ILEIA Newsletter's special issue 'LEISA in perspective' Vol. 15, No. 2/3, p. 37-39, Hien reported on an interesting Conservation Tillage/mulch farming case now spreading on the Mossi plateau in Burkina Faso. Here, traditional mulching is used in combination with other traditional water and nutrient management strategies (planting holes, stone and grass contour bunds) and increasingly with composting, tree planting, production of fodder and intensification of animal husbandry. Recent studies (IFAD/GTZ-PATECORE) found that this ecological intensification trajectory is leading to resource conservation, increased yield and income, and improved social conditions in the villages (Haramata No.41, June 2002, p.9-10). Such cases may provide important learning points for development of CA for small farmers in Africa.

Integrated Soil Fertility Management a new chance

Breman (p.15) stresses the importance of increasing soil fertility, as a first among other measures, in combatting poverty in Africa. And, according to him, inorganic fertilisers have a key role to play in this. The International Fertiliser Development Centre (IFDC) has concluded that the conventional way of using inorganic fertilisers is not profitable in most places in Africa. IFDC suggests that Integrated Soil Fertility Management (ISFM), also called Integrated Plant Nutrient Systems (IPNS) or Integrated Nutrient Management (INM)), combining locally available natural nutrient resources and inorganic fertiliser, can change this. ISFM can double fertiliser use efficiency and increase water use efficiency and fodder and cereal production 3-5 times. IFDC-Africa now follows a Farmer Field School approach for participatory development of ISFM in strategic sites where benefits from inorganic fertilisers are highest. This is mainly on compound fields, around cities with markets for cereals, fresh vegetables and fruits and in regions with intensive production of cash crops like cotton or irrigated rice, or where intensification of animal husbandry through intensive fodder production is profitable. ISFM and CA can support each other very well.

However, in large parts of Africa, even as part of an ISFM approach, inorganic fertilisers still may not be profitable. Only more efficient and creative use of the local natural resources and ecological processes can provide improvements in such regions, for which there are still many opportunities. Hien's case from

Burkina Faso mentioned above shows that mulching alone increased sorghum yield by 50-75%. Researchers and small farmers in these regions can work together to improve traditional biological soil management e.g. through enhancing the activities of termites.

Farming System Approach for more holistic development

It is being increasingly realised that integrating various farming systems on a given piece of land will make farming more sustainable, as one system feeds into the other. Based on this principle, Rudraradhya (p. 13) attempts a model farming system on an acre of land. This model illustrates how the food, fodder, fuel and cash needs of a farm family could be met by utilising the land in an optimal way and also integrating various farming systems like livestock, poultry, fisheries etc. with crop production.

Photo : H.M. Premarathna

Soil life in good hands with SRI farmers

Soil micro-organisms increasingly popular in Asia

Also in Nepal, farmers, researchers and development workers are working closely together in a Farmer Field School approach to develop IPNS (p.16). Farmers have identified several possibilities for improving soil management such as improvement of manure quality, increasing fodder availability, legume cropping, agro-forestry, growing high value crops and using inorganic fertilisers. Liquid manure teas are becoming very popular and in some places are replacing urea on the local market. In Indonesia, farmers are discovering that Mother Nature still has many wise lessons for them, among others, the effectiveness of creeping ferns and leguminous weeds to maintain soil fertility. Also here, liquid manures, biological extracts, effective microorganisms and compost starters are becoming popular. These are effective innoculants and boosters of micro-organisms which can considerably increase the efficiency and effect of organic fertilisers (p.18). However, Rahayu and Thijssen (p.20) also warn that these technologies, on the long term, can break down soil organic matter if not enough organic fertiliser is returned to the soil. Compost starters based on micro-organisms (yeast) from the roots of *laos (Languas galanga)* and other plants or from over-ripe fruits have revolutionised compost technology in Indonesia. A next step and challenge for agricultural development in Indonesia could be to develop Conservation Agriculture.

Feeding the soil instead of the crop

The importance of soil micro-organisms (mycorrhiza, bacteria, yeast, fungi, termites, earthworms, etc) and the potential benefits of technologies that make use of these micro-organisms is being better understood. One of the main learning points of CA is that for efficient, productive and sustainable agriculture, farmers should create favourable soil conditions and feed the biological community in the soil instead of only the crop (FAO Soils Bulletin 78). FAO has an interesting web page on how soil micro-organisms can and are being used by farmers (see p.30).

Farmers and researchers should learn to think in terms of 'ecological soil management' instead conventional nutrient management, which has proven to be unsustainable.

Rice farmers eager to reduce inorganic fertilisers

The experiences with the System of Rice Intensification (SRI) (p.22) are confirming this conclusion. Experiments in many countries have proven that rice has the potential to produce more tillers and grains than now observed, and that early transplanting, and optimal growth conditions (spacing, humidity, biologically active and healthy soil, and aerobic soil conditions during the vegetative phase) can fulfil this potential. The Indian farmers experience (p.28) shows that by adopting SRI, the paddy yield doubled while utilising only 50 percent manuring, 35 percent water, 5 percent seed material and 80 percent of human labour as compared to conventional method of cultivation.

Researchers cannot explain how such high yields can be obtained and sustained with modest amounts of (organic) nutrients. Further research on ecological soil management is therefore still needed. Farmers in many countries are actively trying to adapt the basic SRI practices to their conditions and are developing innovations to make application easier and more effective, In some countries, farmers are even experimenting with no tillage-based SRI.

Time for governments to change their policies

The adaptation, innovation and diffusion process of SRI could become very similar to the participatory development process of CA in Brazil. Also in SRI, participatory development of appropriate tools is very important. The active role of farmers in the development of SRI and CA shows their eagerness to return to more natural and less costly ways of farming. Now, organisations like the FAO and World Bank are strongly supporting CA and are confirming the need for ecological soiI management. It may be time for governments to change their policies as well. Countries like Brazil and Costa Rica (CA), but also Indonesia and Sri Lanka (SRI) are already leading the way.

The experiences with CA seem to confirm what the famous Japanese conservation agriculturist / natural farmer Masanobu Fukuoka stated in 1975: *"whether or not farmers spread straw over their fields may well decide the fate* of *the agricultural land"*.

■

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Photo : Sally Bunning

Direct sowing through a cover of crop residues, avoiding ploughing and minimising soil disturbance" soyabean grown under CA in Brazil.

Planting concepts and harvesting good results

José Benites, Sandrine Vaneph and Alexandra Bot

In large parts of Latin America, Asia, Eurasia and Africa soil tillage by plough or hoe is the main cause of land degradation leading to stagnating or even declining production levels and increasing production costs. It causes the soil to become more dense and compacted, the organic matter content to be reduced and water runoff and soil erosion to increase. It also leads to droughts becoming more severe and the soil becoming less fertile and less responsive to fertiliser.

In the early seventies, farmers in Paraná, Southern Brazil, recognised that continuing soil erosion and declining crop yields were forcing them to abandon their land and move into a marginal existence. Their first attempt at changing this trend was to rigorously adopt conventional terracing systems. The mixed and often disappointing results led them to tackle the problem of erosion at its source, considering the direct impact of rainfall on the bare soil. They abandoned the plough, broke their compacted soils, introduced cover crops, stopped the burning of crop residues and developed cutting rollers to turn crop residues and cover crops into mulch. This mulch layer eliminated rainfall impact on the soil, reduced the speed and quantity of runoff and virtually eliminated soil erosion. It also significantly increased soil fertility and yields, and reduced the labour and cost of land preparation (Hercilio de Freitas 2000, see also ILEIA Newsletter Vol.11, No.3, pp.16-17).

This was in the early nineties, at the beginning of the Zero-Tillage (ZT) movement in Latin America. At that time 'conservation'-, 'reduced'-, 'no'- or 'zero'-tillage or 'direct planting' in combination with herbicides was already being practised by commercial farmers, mainly in the USA. But it was only after ZT was combined with cover crops and crop rotation, adapted to tropical conditions, and improved herbicides and special equipment were developed, also for small farmers, that the tremendous benefits of this approach were widely appreciated and it spread faster.

At present, ZT is being practised on about 60 million ha, mostly in Latin and North America. In Latin America, particularly in Brazil, Argentina and Paraguay, some 25 million hectares have been converted to ZT in the past ten years. As the approach has become far more comprehensive than simply ZT, it is now being referred to as Conservation Agriculture (CA) by FAO and other organisations (see also LEISA Magazine Vol.17, No.3, p.22).

In Latin America, farmers, their organisations and networks took the lead in the development of CA. Government support was initially limited as ZT was not an officially recognised technology and researchers, extension agents, trainers and policy makers were reluctant to accept new ideas. Now, all this has changed and CA is developing fast due to effective collaboration between farmers, private enterprise, research and extension. CA has long passed the stage that it was only suitable for grain crops, like maize, beans and soy. Now, crops like sugarcane, cassava, tobacco, onion, tomato, cabbage and lettuce are all successfully grown under CA.

CA also fits into an increasing number of cropping conditions of large and small farmers in the humid and dry tropical, semi-tropical and temperate climate zones in Latin America, Africa, Eurasia and Asia. The FAO is playing an important facilitating role in promoting and further developing CA, among others, by its field projects, by actively supporting regional CA networks and by providing information on CA through its publications and web site. This article provides an overview of principles, practices, potentials, constraints and methodologies. The articles on p. 10 and 11 present two FAO-supported cases of CA in Honduras and El Salvador. The article on p. 13 discusses the perspectives of CA in Africa. Previous issues of LEISA Magazine have presented approaches similar to CA: New Kekulam zero tillage rice farming in Sri Lanka (Vol.13,No.3,pp.20-21); traditional mulch farming in Burkina Faso (Vol.15, No.2&3, p 37), traditional shifting cultivation and analog agroforestry (Vol.16, No.3); the Rice Wheat Consortium approach to CA in India and Pakistan(Vol.16, No.4, pp.8-10). Other cases can be found in (García-Torres, Benites and Martínez-Vilela 2001).

General principles of CA

Three technical principles are crucial in CA:

- ***No mechanical soil disturbance*** *– direct seeding or planting*
- ***Permanent soil cover*** *– particularly with the use of crop residues and cover crops*
- ***Judicious choice of crop rotations*** *– multiple cropping, agroforestry and animal integration*

The permanent soil cover provided by growing crops, crop residues or mulch not only protects the soil from the physical impact of rain and wind, but also stabilises the soil moisture and temperature in the surface layers. This zone thus becomes a favourable habitat for a number of organisms, including plant roots, worms, insects and microorganisms such as fungi and bacteria. This soil life uses the organic matter from the soil cover, recycling it into humus and nutrients, and contributes to the physical stabilisation of the soil structure, allowing air and water infiltration and storage. This process, which can be called "biological tillage", strongly enhances soil and water conservation and soil fertility. Mechanical tillage is avoided in order to maintain soil life and soil structure, and to reduce mineralisation of soil organic matter. A varied crop rotation is important to avoid pest and disease problems, improve soil conditions and make full use of the entire soil profile and the synergetic and complementary interactions between different plant species. Green manure/ cover crop species (leguminous and non-leguminous) that are part of the crop rotation are essential in building up the soil organic matter content. The soil cover also provides new habitats for natural enemies of pest and disease organisms.

Box 1. Key features of CA systems

- No ploughing, disking or seed bed preparation
- Green manure / cover crops are integrated into the cropping system
- Crop, weed and cover crop residues applied as mulch protect the soil permanently
- Direct seeding or planting
- No burning of crop residues or fallow vegetation
- No uncontrolled grazing
- Nutrient cycling through the biomass in and above the soil
- Surface application of lime and fertilisers
- Specialised equipment for seeding and mulch management
- Continuous use of cropland
- Crop rotations and cover crops are used to maximise biological controls

It provides a physical barrier to weeds and releases allelopathic substances that reduce weed germination. Thus a healthy soil which offers optimal physical, chemical and biological conditions for the growth and reproduction of plants is created.

Specific practices

Many traditional shifting cultivation systems follow the above principles of slash and mulch. Uncontrolled burning (slash and burn) and grazing, however, works against these principles. There are no blueprints for the development of new CA systems and the general principles and key features (see box 1) have to be adapted to each specific agro-ecological, socio-economic and cultural context. The success of such a new system depends entirely on the creativity and flexibility of its practitioners in developing management practices suited to their particular situation and needs. Traditional practices and species, which are adapted to the local context, but abandoned due to reasons of low productivity, are often re-introduced with good results. Agrochemicals are not excluded, but low or decreasing quantities are used efficiently. CA often includes Integrated Soil Fertility Management (ISFM), Integrated Pest Management (IPM), Integrated Weed Management (IWM), agroforestry and crop/livestock integration, for which the three principles provide an excellent basis. The integration of trees and livestock into the system is especially important. CA can come close to or be completely organic.

Benefits are many

Permanent vegetative soil cover ***strongly prevents soil erosion*** and reduces the need for other soil and water conservation measures, bunding, terracing, etc. The increased soil organic matter content allows more water and nutrients to be stored in the soil profile, so ***more soil moisture and nutrients are available for plant growth.*** The excess water filtrates to deeper soil layers, ***recharging groundwater supplies*** and reducing floods and sedimentation of waterways downstream. The water conserving effect of the soil cover and the increased organic matter result in an ***economisation of irrigation water,*** as is shown in table 1.

With time, the accumulation of soil organic matter and the increased activity of soil micro-organisms lead to ***higher efficiency of organic and inorganic fertilisers*** and thus allow lower application rates. This saves costs and increases the profitability of in-organic fertilisers, thereby making them affordable to more farmers.

Increased soil moisture and soil fertility favours root penetration and development, which in turn ***boosts biomass production and crop yields.***

CA is a successful strategy for ***ecological intensification, among others of shifting cultivation and slash and burn systems,*** which can evolve into permanent agroforestry systems, while burning is abandoned.

CA allows ***early and timely planting*** due to the absence of tiresome land preparation activities. The effects of the soil cover result in an agricultural system that is ***less vulnerable to drought, heavy rainfalls or other natural disasters.***

Also ***the risk, scale and frequency of weed, pest and disease infestation are reduced considerably.*** Where chemical pesticides or herbicides are applied in CA, the amount needed often decreases with time as farmers gain skills and new ecological balances are established. Compared to conventional tillage, ***the use of chemical pesticides and herbicides is less*** in CA.

The improved workability of the soil and less agronomic activities during the production cycle ***reduce the labour requirement substantially*** (see table 4, p.12). This is especially important for those who rely only on family labour and in areas where labour is becoming a constraint because of deaths and diseases. The reduction in the on-farm labour requirement allows ***farmers to diversify their activities***, including processing of agricultural products, and thus improve their incomes. Besides the reduction in labour, ***the cost for land operations and maintenance of tools and equipment are also reduced.*** Even where mechanical traction is used, CA leads to ***considerable savings in the use of fossil energy***. As CA also strongly contributes to carbon sequestration due to the increase of biomass in and on the soil, it could when applied at large scale, provide ***a major contribution in controlling global warming.***

All this contributes to ***increased and more stable yields and revenues (up to double or even triple)*** which build up during a period of 2-6 years. Diversification of agricultural production also plays a role in ***improving the farmer's livelihood: less risks, increased income, improved diet, etc.***

Table 1. Economy of irrigation water through soil cover (Pereira, 2001).

Percentage of soil cover	0	50	75	100
Water requirement (m^3 ha^{-1})	2660	2470	2090	1900
Reduction in water requirement (%)	0	7	21	29
Number of times irrigated during season	14	13	11	10
Number of days in between irrigation	6	6	8	9

Table 2. Increase in yield and farm income
(in monetary units; CA=Conservation Agriculture)

	Conventional Agriculture	CA Year 1	CA Years 2-4	CA Years 4-6	Year 6 and Onwards
Gross output	2000	1800	2200	2300	2400
Total variable costs	1400	1300	1200	1100	1000
Gross Margin	600	500	1000	1200	1400
Total fixed costs	200	200	200	200	200
Net farm income	**400**	**300**	**800**	**1000**	**1200**

(FAO, in print. Conservation Agriculture. What you should know about... economic aspects of Conservation Agriculture. Training module. AGLL. FAO Rome.)

CA provides a truly sustainable production system, not only conserving but also enhancing the natural resource base and ***increasing biodiversity*** without sacrificing yields at high production levels. Therefore CA is a major opportunity that can be exploited for achieving many objectives of the international conventions on combatting desertification, on biodiversity and on climate change.

Constraints and challenges

Conversion from conventional tillage to CA is not simple and poses many constraints that need to be resolved, demanding time, effort and money. It may include costs for purchasing specialised equipment and agrochemicals, possible temporary income decreases until the new dynamics are established, and a learning process by the farmer to acquire higher management skills. For many (small) farmers, a general lack of financial resources and lack of access to equipment, chemical inputs or green manure seeds can be serious limiting factors.

Tenure may also be a constraint in situations where most of the land is collectively managed and where land is accessible to multiple users often having contradictory interests in terms of land use, for example pastoralists and farmers. Farmers who have insecure tenure may be reluctant to adopt CA even though they see the benefits, because improving the soil productivity increases the risk of losing the land to more powerful persons in the society. This is a major problem for landless persons and female heads of households.

Pest, disease, weed or soil fertility problems could occur in the transition stage when the system has not yet stabilised ecologically. This may require the use of chemical pesticides, herbicides or fertilisers for which money could be a constraint. In moist areas for example, a major issue raised by the permanent soil cover could be pest and disease management. The crop cover may harbour small animals such as rats or snakes. In drier areas, the lack of biomass due to water or nutrient shortages and other uses of the biomass (livestock feeding, cooking) is often a major issue. Where population density is low and agriculture is marginal, availability and the cost of equipment and agrochemicals is a constraint. Social and cultural acceptability may also be a problem where CA differs substantially from the indigenous or conventional system.

Before starting with CA, it may be necessary to eliminate some major effects of degradation, such as compacted soil layers, plant nutrient deficiencies or heavy weed infestation. Subsoiling of compacted and degraded soils can, due to higher water infiltration, result in immediate yield increases of up to 30%, but may be too costly for small farmers.

Box 2. "Friends of the Land" clubs in Brazil

In Brazil, the main obstacles for farmers in the adoption of Zero Tillage were the lack of knowledge, information and technical support. These obstacles were overcome through the activities of "Clubes Amigos da Terra" (CATs), non-profit, non-commercial and non-political farmer organisations. The operational basis of the CATs is farmer-to-farmer exchanges of experiences on a monthly basis and organisation of promotional events, such as field days and debates. CATs also organise on-farm research and pilot projects with the support of other organisations. An important factor for success has been the assistance which medium and large farmers, through individual CATs and the Brazilian Federation for Direct Planting, have provided to small farmers wishing to adopt ZT. Private sector support was fundamental to the expansion of ZT as well. In South Brazil, where ZT by small farmers is well developed, there are more than ten manufacturers specialising in ZT machinery for small farmers. Both in South Brazil and Paraguay, ZT systems that eliminate the need for herbicides have been developed, especially for small farmers.

Recently, the Landcare movement in South Africa adopted an approach similar to CAT in Brazil, advocating the establishment of local Landcare Groups which would conduct situation analysis, broaden their strategic understanding with a visioning process of CA, and then undertake participatory land use planning.

Conversion from conventional tillage to CA calls for a drastic change of thinking. CA is based on agro-ecological processes and systems which require farmers to think in terms of ecological concepts such as soil as a living system, plant communities, nutrient flows, pest – predator and animal – crop – soil relations, etc. If farmers are unable to radically change their thinking and vision on farming, they will not succeed in making CA work effectively. This is not only true for farmers but also for technicians, extensionists and scientists.

Farmers who depend on their local resources may have a lot of traditional / indigenous knowledge that fits with CA. Often, extensionists and researchers find it difficult to accept indigenous knowledge and learn from and with farmers. For them, shifting to the concept of CA and a participatory way of working means a tremendous change. The resistance to change of researchers, academics and advisors can be much greater than that of farmers.

Farmer groups crucial for CA

Access to information, cover crop seeds, equipment, training and technical support is a prerequisite for successful conversion to CA. In addition, financial support, especially for small farmers, is often a major requirement to catalyse the conversion process. But, one of the lessons learned from Brazil is that new technologies spread fast only when farmers feel the need to change their practices and when they take the lead in technology adaptation and innovation. Simple extension of the message, even coupled with demonstration, usually will not suffice. Also, successful improvement of land husbandry depends not just on the motivations, skills and knowledge of individual farmers. The formation of farmer groups and associations or, even better, building on existing and active groups for testing and adaptation to local contexts and learning from shared experiences is crucial for CA to take off. In Brazil such groups have become action groups, transmitting the new ideas and technologies from farmer to farmer, stimulating and supporting members to make the change (see Box 2). In addition they have also become important local pressure groups, managing to obtain improvements at institutional and political level.

Strategies for conversion to CA

Specific conversion strategies are needed to make conversion to CA attractive and affordable to farmers. In Latin America, building up soil organic matter content in the soil with intercropped green manure / cover crops (associated with the normal cash or subsistence crops) over a period of one to three years before moving to ZT is the strategy followed by most farmers. In this way the conversion takes place without loss in productivity, while costs (for tillage and equipment) already drop considerably (Rolando Bunch, Fallow Net email discussion on CA).

Farmers may have their own specific reasons for wanting to change their farming practices. These reasons can vary from community to community and from one social group to another within a community. This calls organisations working with farmers to offer specific entry points. Saving labour, increasing yield, reducing costs, drought proofing, improving health or the livelihood system in general can be appropriate entry points to start CA. It must be the farmers themselves who decide on trying

Box 3. Principal mechanisms for mass conversion to CA

- farmer-to-farmer exchange
- extension activities
- commercial and NGO-sponsored events
- small farmer pilot projects
- technical assistance/promotion activities of private sector
- private and co-operative technical assistance
- NGO/government/private-sector publications
- press and television reports
- small financial inducements

out or transferring to CA and which entry point is most important for them. They should also decide on the use of external inputs: choosing between herbicides and mechanical weeding, and using fertilisers and lime to correct initial soil imbalances. Good information on potential benefits, opportunities and constraints is a prerequisite for farmers in making their choice.

Finding the right approach of facilitating a farmer-driven participatory conversion and technology development process while ensuring the communication of a very straight-forward technical message is challenging. It requires the support of convinced and capable extension workers and researchers. Often, low-cost or ecological options can be found for adaptation to the local context and resolving conversion problems, for example weed control with hand tools, cover crops and crop rotations; use of manure and biological nitrogen fixation; home-made "soups" for disease control; compost starters etc. (Barber 1999). Sometimes new innovations are needed.

CA started in many countries as a farmer-driven adaptation of a production system. But researchers and extension workers from both public and private sectors have played an important facilitating role in reaching a critical mass of farmers and generating knowledge and adaptations to the system as a whole or to equipment in particular. In addition the process has drawn sectors together and allowed the development of coherent integrated strategies and approaches (see Box 3) addressing crops, livestock, land and water resources, as well as infrastructure, marketing, education etc.

Involving the private sector

The large-scale shift to CA in Brazil and Argentina was possible among others due to close collaboration between innovative farmers and the private sector to develop and disseminate appropriate equipment. CA is challenging the existing private sector companies and local craftsmen/ artisans to support the transition to CA systems. In particular, the testing, manufacturing and provision through local markets of required tools and implements. The same applies for cover crop seeds and associated herbicides plus spraying equipment, in case chemical weed management is chosen (see Box 4).

Exchange and networking

Access to information is very important in reaching a critical mass of CA practitioners, both within a country and between countries and organisations. Part of the information can be made available in the form of selected case study material describing CA experiences under different conditions. Researchers can gather in-country information on, for instance, validation of different cover crop species and testing and adapting of hand and animal drawn equipment.

The transfer of the concepts, principles and technologies of CA needs network interchange within and between countries, so as to facilitate sharing of known solutions to problems identified during the continual learning process. Such networks can accelerate the advancement of knowledge and techniques being steadily accumulated by both national institutions and community groups in their efforts to reverse land degradation on a global scale. For this purpose several regional networks -RELACO, ACT, SACAN and ECAN- have been founded in Latin America, Africa, South Asia and Central Asia (see Websites p.30) respectively.

Policy support

CA will only spread rapidly and widely when and where government policies, services and infrastructure facilitate the conversion to these systems. Policy support is needed to adjust legislation and to provide an enabling environment to meet the requirements and facilitate the initiatives of local groups and land users. This means an appropriate policy and institutional framework and the provision of incentives (pricing, markets, land reform, security, etc.). Existing incentives and subsidies should not jeopardise the implementation of the system. New incentive measures may be needed to encourage CA uptake, including the identification and multiplication of seeds and supply of equipment through public and private sector involvement. Financial support alone cannot boost a CA programme. It is essential to make the general public, decision and opinion makers aware of the social benefits of the adoption of these practices in order to gain the government's support for natural resource management initiatives of farmers.

Finally, international organisations such as World Bank and FAO, and OECD countries in their own right, should encourage a vigorous international and regional media campaign emphasising the importance and relevance of CA as an entry point to the process of rural poverty alleviation, food security, and environmental protection. Development of CA can only be achieved by integrated action at farm, community, national and international levels.

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Box 4. Development of equipment for CA in small farms

Even in 1990, there were few small farmers working with CA in Brazil. Although the general principles were broadly applicable, the planting technology for manual and animal traction had not been developed. It was pioneer research and small manufacturing firms, which resolved the problems of adapting the planting technology in direct collaboration with farmers. Equipment for direct seeding in mulch (e.g. jab planter or animal driven direct seeders), management of vegetative cover (e.g. knife rollers and slashers), spraying of herbicides (e.g. adapted knapsack sprayer) and mini-tractors were thus developed for small farmers (see illustrations on cover, p.3,13,14). Collective purchase and use of such equipment was stimulated, as CA allows for greater flexibility in the time of sowing.

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The Quesungual system in Honduras

An alternative to slash-and-burn

Luis Alvarez Welches and Ian Cherrett

Slash-and-burn agriculture is an efficient system as long as population pressure is low enough to limit impact on the tropical forest. As the rural population grows the cycle of land clearing becomes shorter, leaving little chance for the vegetation and soil to recover. The lack of fertile land pushes subsistence farmers onto steeper hillsides and into the more humid forests. This leads to accelerated deforestation and environmental degradation and land use becomes increasingly unsustainable.

In Central America, and especially in Honduras, slash-and-burn agriculture has been 'technified'. In an attempt to modernise basic grain production by small farmers, projects and NGOs have promoted credit, fertilisers and other inputs without changing the production system. The result has been even worse for the small farmer and the environment: the rural population has become debt-dependent and the process of deforestation and degradation of land and water resources has accelerated further. This has increased the vulnerability of the countryside to natural phenomena such as hurricane Mitch in 1998 when many died and rural incomes dropped dramatically (see LEISA Magazine Vol.17, No.1, p.18-20).

The Quesungual system

In the department of Lempira, one of the poorest and most isolated regions of Honduras close to the border with El Salvador, small farmers cultivate their land (1-5 ha) on hilly terrain, 200 to 900 meters above sea level. Supported by the Lempira Sur collaborative project initiated by FAO, a massive shift to a new production system has taken place over the past ten years. This system is called "Quesungual", after the village in which it was first developed. It is a Conservation Agriculture system with a tree component which allows small farmers to cultivate their land on steep slopes continuously while regenerating it.

The Quesungual system is an adaptation of an indigenous agroforestry system, which can be found in the dry tropical forest ecosystem (140-800 masl). This system is characterised by three layers of vegetation: mulch, crops, and dispersed shrubs and trees. It usually combines grain crops with naturally regenerated trees and shrubs with high-value/multipurpose timber and fruit trees. A typical plot has numerous pollarded trees and shrubs and about 15-20 large trees: timber and fruit species. The diversity of species in the system is high (see table 3).

Burning has been abandoned, vegetation and plant density are controlled by hand and in addition some farmers use herbicides prior to sowing. Maize is intercropped with sorghum and beans, using zero-tillage, mulching and direct sowing technologies. The natural vegetation is used as a cover crop, in between the grain crops.

In the dry season, the trees and shrubs are pollarded at a height of 1.5-2 m, in order to eliminate the branches and regrowth, and to provide light for the future crop. The pollarded material is used as mulch to cover the soil. The branches and trunks, which can be used as firewood and poles, are removed from the plot. In general, high-value timber trees and fruit trees are not pruned. Farmers achieve an ideal density through the management of the natural regeneration. Before sowing the second crop (often beans) the field is cleared a second time but trees and shrubs are not necessarily pollarded. Mineral fertilisers are expensive and thus used only when maize and sorghum are both grown as first crop. Only once during the cropping season, weeds are cleared either manually or by using a herbicide. The crops are harvested in the traditional way (FAO, 2001).

Impacts on resilience, natural resource base and production

For the farmers it is the moisture retention qualities of the system that makes it so attractive. The agroforestry system retains 15% more water in the soil in the driest month (April) than the slash-and-burn system (8% humidity in a traditional field and 23% in a Quesungual field). This difference is equivalent to 20mm of rainfall, which means that crops can be sustained 20 more days without rainfall. And it is this difference that counts for the success or failure of a crop in a climatic regime with irregular dry spells during the rainy season.

Besides better infiltration of rainwater into the soil profile through the soil cover, the increase in soil moisture can be explained by the increase in organic matter content of the soil. The organic matter content was monitored during four years, in three different places, and increased from 2.4% to 4.5%. At the same time soil erosion has been nearly stopped. The loss of nutrients through erosion has been estimated to be more than 10 times lower in the Quesungual system than in the slash-and-burn. Taking into account only the nutrients, these losses represent US$34/ha under the Quesungual system, instead of US$396/ha, in the slash-and-burn system.

The improved soil conditions make the system more resistant to climatic phenomena. Compared to farmers who remained with the old system of slash-and-burn, the Quesungual farmers didn't experience a total loss in maize production during the dry period of el Niño in 1997. Even in the following year, when hurricane Mitch passed over Central America resulting in excessive rainfall and many farmers losing their crop for a second time, the Quesungual farmers produced more or less the same quantity as the year before.

Table 3: List of tree and shrub species found in Quesungual plots

Timber species		Fruit species	
Common name	**Scientific name**	**Common name**	**Scientific name**
Salmwood	Cordia alliodora	Guava	Psidium guajava
Guacima	Guazuma ulmifolia	Nance	Gyrsonima crassifolia
Honduras Cedar	Cedrela odorata	Plantain	Musa sp.
Guachipilin	Diphisa robinioiles	Cashew	Anacardium oxidentalis
Mahogany	Swietenia sp.	Avocado	Persea americana
Paradise tree	Simaruba glauca	Papaya	Carica papaya
Stinking toe	Cassia grandis	Mandarin	Citrus sp.
Orchid tree	Bauhinea sp.		
Almond	Andira inermis		
Mother of cocoa	Gliricidia sepium		
	Luhea seeamoinii		
Trumpet tree	Cecropia peltata		
	Lonchocarpus oficinalis		

(after Hellin, 1998)

Photo : Alexandra Bot

A farmer in the steep lands of southern Honduras using a planting stick to sow his maize in a mulch layer of fallow vegetation.

Farmers are reporting increases in maize yield of a minimum of 60%. Even more important is that yields remain stable at a higher level for longer periods. The longest period fields have been under continuous maize production is seven years. These fields, with a slope of 35% and poor soil have an average production of 2.9 t/ha. Before, on the same fields, the best yield was 1.6 t/ha while the land had to be left fallow for several years after a two-crop cycle. Besides maize and sorghum the plot is providing the farmer with firewood and poles, which give an extra value to the production. Additionally, from the first year onwards, the farmer can rent his/her terrain for livestock grazing, because of increased stover production on the field. Usually this is done for two months. Efforts are still needed to integrate livestock production better into the system.

Rural development enhanced

The Quesungual system not only meets the household subsistence needs for fruit, timber, firewood and grains, but generates a surplus, which when sold on the market generates cash income. This change is just the beginning of a process of intensifying land use and increasing land and labour returns. Once the farmer feels comfortable with the enhanced food security (maize and beans), (s)he starts to diversify into crops for the local market or home consumption, soya, sugarcane, indigo, pumpkin etc., as well as small animals for the market such as pigs and chickens. Increased grain availability is accompanied by the improvement of the household post-harvest storage system. When basic grain security is assured, families begin to invest time in improving their living conditions and education, and devote time also to community organisation. Women's production cooperatives are now making dairy products. Farmer and trade organisations have also been established. The people themselves are now taking full responsibility for planning improvements in their communities.

Obstacles to adoption

This experience has generated great interest not only in Honduras but also in the region. The south of Lempira is now known as the region where farmers no longer burn - a label they are proud of. Nowadays, the Quesungual system is being adopted elsewhere in the country and is being adapted by farmers according to local conditions. The major obstacle to large-scale change from slash-and-burn to agroforestry is not the small farmer. They are well aware of the problems connected with slash-and-burn agriculture and respond rapidly to sustainable alternatives. It is the extensionists and their professional superiors who clinch to their production-based, single-crop focus and oppose a systems approach. It is their lack of training in demand-driven participatory extension and the still dominant paradigm of rural development projects with their focus on physical, supply-driven indicators. Although much is said about collaboration between local and professional knowledge systems, the practice is still in its infancy.

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Experiences in El Salvador

Conservation Agriculture and rural development

Marcos Vieira and Jan Van Wambeke

Besides knowledge, technologies and supplies, adoption of Conservation Agriculture (CA) needs a favourable (policy) environment, motivation and participation of farmers and their communities. The presence of leaders and/or farmers' organisations is important for knowledge sharing and capacity building. The combination of all these parameters with CA at catchment level results in sustainable rural development based on the integrated management of natural resources.

Productivity and conservation

In Guaymango (El Salvador), about 85% of the land area is used for agriculture, and consists of small hills and slopes between 40 and 90%. Half of the agricultural land is used for pastures, the other half for crop production (mainly maize and sorghum). Monoculture, overgrazing, burning of crop residues and intensive tillage rapidly led to severe land degradation, low yields, poor nutrition and increased poverty in the early 1970s. Following the spread of the Green Revolution in wheat and rice, the thinking on research and extension in El Salvador was conditioned by traditional extension methods, combined with a "package" approach. The package disseminated by the Ministry of Agriculture, primarily during the late 1960s and throughout the 1970s, consisted of the following technology, according to Sain and Barreto (1996):

- use of hybrid maize seed,
- use of nitrogen and phosphate fertilisers,
- increased plant densities, through reduced row distances,
- application of herbicides and insecticides.

During a diagnostic appraisal that was held in the area of Guaymango in 1973, three major problems were identified: high poverty levels, food insecurity and recurrent health problems in the community. Based on this appraisal, it was concluded that low productivity of the agricultural system was one of the main causes of the high poverty levels found in the area (Calderon, 1973). Furthermore, it was concluded that the low quality of the soils caused by serious degradation in the area was the main reason for the low productivity of the agricultural systems. Based on these conclusions, an intensive programme was launched by the Ministry of Agriculture and several private and public institutions to increase maize and sorghum productivity and to improve soil conservation practices. A number of soil conservation measures were added on to the package mentioned above, based on zero tillage and improved crop residue management, and included the following components:

- no burning of crop residues,
- uniform distribution of crop residues over the field,
- use of living and dead barriers, and
- contour sowing.

The promotion of these measures was the starting point of a new phase in land management in the area, based on conservation tillage. Through this programme and later through land reform, farmers improved agricultural production, increased their net income more than 2.5 times and adopted "conservation" practices at the same time. Close collaboration between institutions and organisations participating in this programme was also an important factor, which has contributed to the successful adoption of Conservation Agriculture practices by farmers.

Integration of crop and livestock

The interaction of crop production and livestock within the agricultural production system is vitally important in understanding the adoption of conservation tillage practices by farmers. Livestock in the farming system is probably the most difficult challenge, particularly when there are other uses for crop residues than cattle feed, like mulching and soil improvement.

At the end of every crop cycle, the improved maize-sorghum system in Guaymango produces almost 10 tons of crop residue per hectare. At the end of the dry season, nearly 6-7 tons of crop residue per hectare remains for use as mulch. Compared to similar regions (2.3 tons per hectare) this is a substantially greater quantity and can be explained by three main factors:

- farmers here value the use of crop residue as soil cover more than elsewhere;
- the high economic importance of cattle in the farming system (number of cattle and duration of grazing period);
- the high degree to which a fodder market has been developed (trade of grazing rights).

The experience of Guaymango is one of the few that reports successful integration of the crop and livestock components of the farming system, without creating competition in the allocation of crop residues. The amount of residues produced by the system is enough to serve both the conservation purpose and as fodder for livestock (Choto and Saín, 1993). This is precisely why farmers do not sow hybrid varieties of sorghum in Guaymango, but local varieties that have a high straw/grain ratio (Choto et al., 1995) instead.

Farmers' perceptions

According to local farmers, the adoption of conservation tillage practices and the improved crop production technologies have induced a considerable change in their livelihoods. The most apparent differences are the increased yields - it has doubled and in good years even tripled; and the labour required for sowing has been reduced by 75%, which according to the farmers is because the soil has become softer and easier to work with. When residue burning was used to clear the fields, the soil was very hard and it took almost a day and 10 people to sow a hectare, compared to 5-6 people needed now in half a day.

The mulch effect of crop residues has additional advantages. According to the same farmers, it conserves more soil moisture, which allows them to harvest in dry years. It also prevents seeds from being washed away by rain showers, just after sowing, and facilitates rainwater infiltration. The decomposing mulch layer gives the soil a darker colour, which is usually an indicator of better soil fertility. The presence of more earthworms was mentioned as a positive change because 'their excrements are like fertilisers'. "Tilling the soil at this stage would mean destroying the existing fertility (residues and roots) and soil life", said one of the farmers.

After 25 years of managing crop residues optimally, some farmers are even applying less fertilisers to their maize fields than when burning residues was a common practice.

Table 4. Increase of yield and farm income with CA (in monetary units)

Covered distances (km) by man (m/f) for the cultivation of one hectare of maize, using animal traction under conservation agriculture and conventional tillage (Melo, 2000).

Operation	Conservation Agriculture	Conventional Tillage
Ploughing	–	40
Harrowing	–	15
Furrowing	–	40
Planting	5	15
Fertilisation	10	10
Knife roller	7.5	5
Weeding	–	10
Nitrogen application	10	–
Bending over of the cobs	10	30
Harvest	15	15
Total distance (km)	**57.5**	**145**

Pest and disease incidence has been reduced. One of the insect species, white grub ('gallina ciega') (Phyllophaga sp.), which was formerly reported as a pest in maize, is still present in the fields, but is no longer a problem. Farmers think that the larvae now feed on the roots and residues of the previous crop, instead of attacking the roots of the crops growing in the field. The mulch layer also prevents birds from feeding on recently sown seeds. The birds, which still visit the fields, are now a form of biological pest control, because they feed on caterpillars and larvae found in the crop residues or on the plants.

Full adoption after only ten years

The expectation of increased yields and the increased awareness of the value of appropriate crop residues management as a soil conservation measure are the main reasons given by farmers for not burning crop residues when preparing their fields. Although many farmers were initially sceptical about changing from burning crop residues to more conservation-oriented soil management, full adoption of the technological package was achieved in just 10 years. Both the successful agricultural extension programme and the link between practical recommendations, incentives and restrictions were key elements that induced this change in soil management.

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A model of farming systems approach for sustainable agriculture

M. Rudraradhya

More than 70% of the Indian farming community own less than one hectare of land. They belong to the small and marginal category. These farmers feel that, except going for a single cropping system, there is hardly any possibility of trying new practices or methods for farm improvement. To address the needs of sustainable farming of such small and marginal farmers, a farming model has been developed. This low cost model integrates local farming practices with watershed concepts. This model has been tried out in the Agricultural Research Station of Tarikere in Shimoga district of Karnataka.

The main objective of developing this model is to enable a small farmer to produce his family's requirements of food and fodder on a sustainable basis, supplemented with a regular cash income through one or two farm related enterprises.

Design of the model farm

This model has been developed on a farm size of one acre (100mX40m) keeping in mind the small farmers of watershed area (See Figure 1).

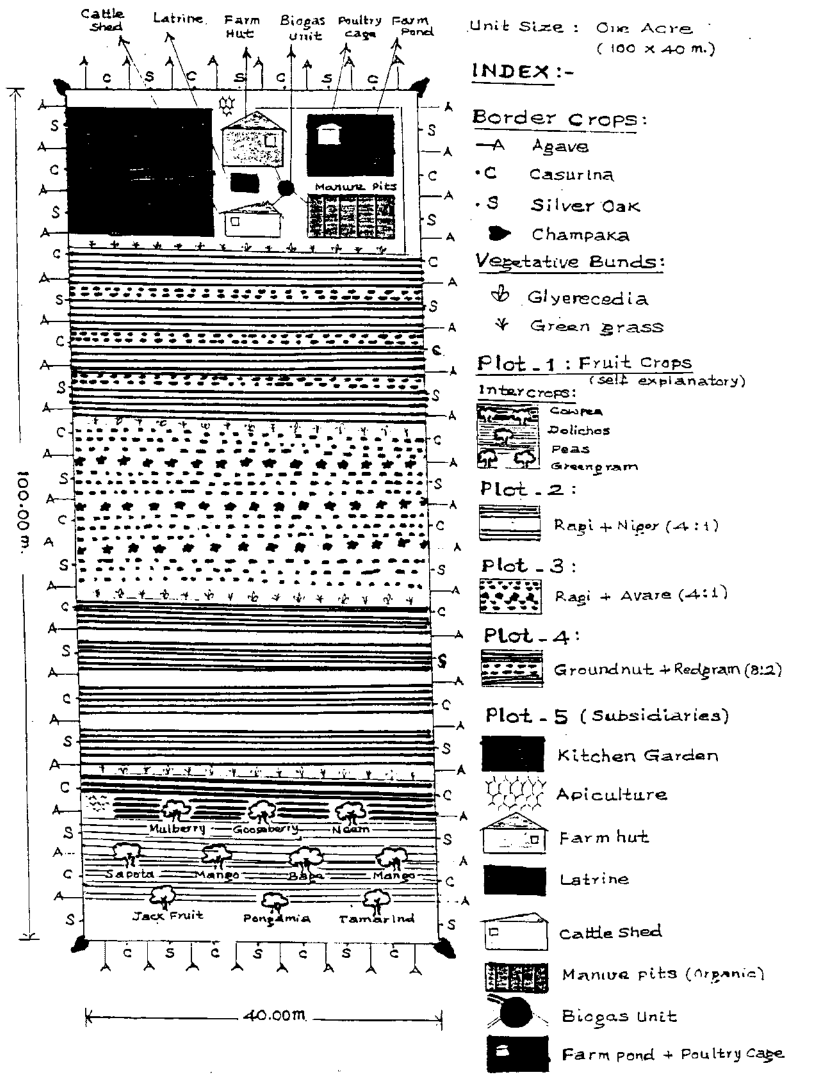

Figure 1. Model farm layout

Design & Layout : Sri. M. Rudraradhya

The model farm area is fenced by trees like casuarina and silver oak. They are planted on the boundaries. Agave is planted in between these trees resulting in live fencing of the farm. Besides Agave, trees like bamboo, pongamia, neem, hibiscus etc., were also planted for fulfilling various farm family needs. The area has been divided into 5 parts or plots. To conserve water, these have been separated by field bunds across the slope. These bunds were planted with glyricedia.

Five plots of equal size were made on the one-acre farm.The *first plot* was planted with fruit trees like mango alternating with sapota, jackfruit, tamarind, pongamia, neem and jamun trees in the ratio of 2:1 in a triangular pattern with 10mX10m dimension. In between these trees, pulse crops like horse gram, dolichos lablab, peas etc. were raised.

Four rows of ragi and one row of sesamum were intercropped in the *second plot.*

In the *third plot,* 4 rows of ragi and 1 row of dolichos lablab were intercropped. In this plot, after ragi's harvest, high yielding local variety of dolichos lablab crop was raised.

8 rows of groundnut and two rows of redgram were intercropped in the *fourth plot.*

In the *fifth plot,* there are five sub components - a small house for the farmer to reside, housing for livestock, one sanitary latrine, a bio-fuel unit, 5 units of organic manure production, one farm pond, a poultry unit and a kitchen garden have been designed.

The *farm house* has been constructed with locally available materials like bamboo. Climbers are raised on the rooftops of farmhouse. Stoves using biofuels has been erected in the kitchen. Sanitary latrine is constructed using brick and cement. In the farm house surroundings, floral plants, one or two coconut trees, medicinal plants etc., are raised. Wherever possible, banana plants are raised.

In the *cattle shed,* space has been provided to house 3-4 cattle and 10-12 sheep. The shed design enables enough ventilation and light. Special racks have been made to store the feed. One light is powered by using biofuel. Climbers are raised on the rooftop of cattle shed.

Five *compost units* (one vermicomposting unit, one phospho compost, one NADEP model, one stone walled compost unit and one compost unit made of glyricidea branches) are set up. A shade is provided over the pits. Vegetable climber crops like gourds are raised over the support.

Farm pond of size 5 sq.m X 8 sq.m with 2 m depth is constructed. About 100 fishes can be raised in this farm pond during June to December. Each fish would weigh around 0.5-0.75 kg. Above this, a poultry unit is set up wherein 20 poultry birds can be raised. For this, *white leg horn* breed is the most suitable one and not the local breed. All around the pond, a fence is erected and vegetable climbers are raised.

Kitchen garden is raised in an area of four guntas. Vegetables like brinjal, bhendi, beans, tomato etc., have been raised. 12 plots are made and 12 different types of green leaf vegetables are grown.

Benefits from this model

This model has had its impact in two ways. Firstly, better conservation and use of on-farm natural resources, like the soil moisture and soil fertility status. Secondly, this model has been able to meet most of the family needs of food, fodder, fuel and cash income to a great extent.

1) Conservation and utilisation of on-farm natural resources

Soil moisture conservation

Bunding done across the slope, both on the boundaries and in between the plots reduced the speed of water flow, thus enabling more moisture to be available to plants. The vegetation on the bunds helped in stabilising the bunds, besides providing fodder and green manure.

The farm pond is situated at the lowest point on the field. The excess water which would have otherwise gone waste, got collected in the pond. The harvested water was used for irrigating vegetable crops.

Soil fertility

During the first year, fertilisers were applied. From second year onwards, there was a gradual shift towards application of organic manure. The crop residues of the five plots and the animal wastes have been the major source for composting manure. The five compost units produced enough compost to meet the requirements of the five plots. Moreover, the vegetation on the bunds provides green manure based on availability. Thus the soil fertility was managed by lower external inputs and more from the on-farm produce itself.

2) Meeting family needs

The model farm was able to meet the following needs of the family, besides generating income.

Food needs

During the previous year, the model plot was able to produce 12 kg horsegram, 69 kg dolichos lablab, 25 kg peas and 10kg green gram from the first plot, 2 bags of ragi and 20 kg of sesamum from second plot, 2 bags of ragi and 30 kg dolichos lablab from third plot and 120 kg groundnut and 123 kg redgram from the fourth. On the whole, the food requirements of cereals, pulses and oilseeds were largely met from these plots.

In addition, 12 different types of green leaf vegetables were grown in the kitchen garden. These provided greens for the family for a period of 8 months and chilly crop provided green chillies for 3 months. The remaining chillies were dried and stored which weighed 6 kgs. Tomato grown based on the availability of water in the farm pond is another source of nutrition for the family. During the first year, vegetables worth Rs.2500 were produced.

Household milk requirements were met by the Murrah buffalo.

Fodder needs

The bunds planted with Glyricedia, served as a regular source of fodder supply. To get a continous supply of fodder plants, the crop was cut from one bund at a time. Thus, by the time the fourth bund is harvested, the first bund is once again ready with vegetation for harvest. By this way, feed for livestock was ensured for 8 months in a year.

Fuel needs

The bio-fuel unit, besides providing fuel for cooking, also provided power for lighting bulbs, one in the cattle shed and one in front of the farmhouse. The light in front of the house helped in identifying the pests as they got attracted to the light and fell in the water tub arranged below. This helped the farmer to take adequate crop protection measures.

The farm house in fact is being known as a “Hi-Tech Hut”. Here, no firewood is burnt for cooking, no soot is generated in the kitchen, no usage of electric power for lighting purposes. Instead, bio-fuels are used. Such a biofuel unit can be set up by majority of the small farmers as government subsidises the cost of installation.

Income generation

Livestock rearing started with one Murrah breed buffalo and 4 sheep. The Murrah breed buffalo produced 8 litres milk per day. After meeting the households’ milk requirements, on an average, the daily income from sale of milk was Rs.40-50. Sheep rearing was started with 4 sheep. The sheep numbers has increased to 10, of which 2 are rams. An additional income of Rs.8000-10000 was generated by selling 4-5 well-grown sheep.

Other farm enterprises

Pisciculture is one activity that has been possible because of the farm pond. Farm pond is constructed in such a way that the excess rain water gets in the pond. When the poultry shed is cleaned the droppings fall into the farm pond. This serves as feed for the fishes. The light near the farm house also attracts the insects. The insects falling into the farm pond offer a wonderful meal to the fishes.

Other benefits

Over a couple of years, besides the above mentioned benefits, the farm family can benefit from production of fruits from horticulture plants, flowers, fuel from trees etc. They can serve nutritional needs and also provide some cash income. Ropes can be made from agave which is a fibre plant, to be used for livestock. These types of enterprises provide labour for the family over the entire year.

Conclusion

The model depicts a fine blend of all the farm enterprises where in each and every component feeds into the other, thus making efficient utilisation of products, bye products and also wastes generated on the farm. This model is thus being recognised as a useful one by small farmers for sustainable living. ■

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Integrated Soil Fertility Management

Opportunities for smallholders in West Africa

Henk Breman

Low soil fertility is the main reason as to why West African farmers deplete their soils. Integrated Soil Fertility Management (ISFM) provides a way to reverse this (LEISA Magazine Vol.16, No.1, pp24-25). ISFM aims at progressive improvement of soil quality and nutrient, water and labour efficiency through the combined use of soil amendments and inorganic fertilisers.

ISFM in practice

Experience shows that ISFM is effective in all climate zones having one or two rainy seasons, from the Sahel to Guinea savannah. In time, ISFM leads to improved agronomic efficiency of inorganic fertiliser, especially of N, but also of P. It usually takes 2 - 4 years or longer before this becomes visible to farmers in the form of increasing crop yields.

A three-fold increase of total millet biomass has been obtained in the Sahel, where five-fold fodder yield increases have been obtained. Similar fodder yield increases have been obtained in the Soudanian savannah. Maize yield increases due to ISFM are reported from the Soudanian, the Guinea and the Coastal savannah. While average farmer production is in the order of 1000 kg/ha, grain yields up to 6000 kg/ha have been registered with ISFM. Other crops that have reacted positively are sorghum and irrigated rice.

A whole series of soil amendments and related production systems in combination with inorganic fertilisers has been tested already. It concerns crop residues, manure, compost and household wastes, legumes and phosphate rock, agroforestry and perennial grass-crop rotations, leading to improved soil organic matter status. Part of the testing and validation is done in cooperation with rural development projects. An example is the use of a leguminous cover crop (Mucuna) in combination with local phosphate rock, to improve fertiliser use on a maize-cassava relay cropping system. An IFAD-funded project for village organisation and agricultural development in Southern Togo enabled IFDC to test and improve this ISFM option in 60 villages during 4 successive years. Such opportunities are exploited to develop and understand numerous options, to write and test technical advisory notes, and to develop a general guide on ISFM.

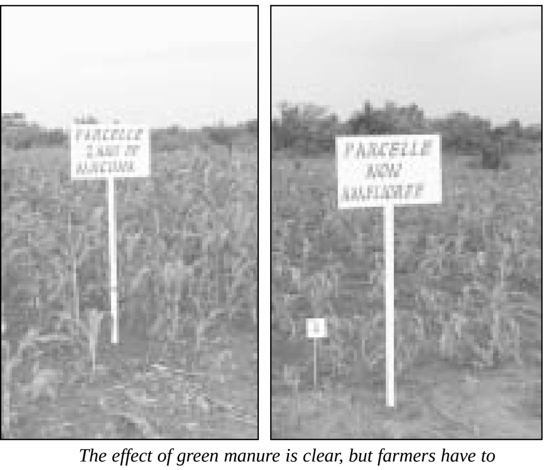

Photo : Henk Breman

The effect of green manure is clear, but farmers have to find a way to fit into their farming system

Strategic site selection

Three zones are distinguished in this context: 1 - zones where the use of inorganic fertilisers is already economically feasible; 2 - zones where the use of inorganic fertilisers can become feasible thanks to ISFM; 3 - zones where due to present fertiliser and crop prices, even ISFM cannot result in favourable cost benefit ratios for the use of inorganic fertiliser. Large parts of Africa comprise of marginal lands falling into zone 3.

For effective introduction of ISFM in zone 2, strategic site selection is a must. IFDC-Africa has developed two types of selection: Type I - for the choice of zones and villages, and Type II - for the choice of fields. Criteria for type I are the availability of inputs, relatively good production conditions, the accessibility of markets, and serious overpopulation with strong overexploitation of natural resources. The last criterion selects farmers with growing difficulties to make a living out of their land. Further resource depletion may be just enough for bare survival, but insufficient for courageous farmers seeking to improve their income and conditions. Such farmers are therefore very motivated to try new ways.

In West Africa, combinations of favourable conditions are found around cities with their market for cereals, fresh vegetables and fruits, in regions with intensive production of cash crops like cotton, and in regions with irrigated rice. Another example is regions with crop-livestock integration where intensification of animal husbandry through intensive fodder production is economically feasible. The Soudanian savannah, in particular, has strong comparative advantages for ISFM based crop-livestock intensification.

The IFDC-Africa approach exploits the opportunities created by favourable conditions within strategic regions, and aims for progressive inclusion of more marginal adjacent zones.

The second type of strategic site selection concerns the choice of fields at village and farm level. Practice shows that increasing cash income is the best stimulus for farmers to turn soil mining into sustainable production. Therefore, fertilisers and other external inputs have to be used on the best soils, not on the poorest or most depleted ones. Compound fields often offer the best chance of making fertilisers profitable. Farmers in Northern Togo succeeded in increasing maize production by almost 1000 kg/ha using 50 kg/ha of urea, while the same dose resulted in an increase of only 370 kg/ha on bush fields.

Participatory and holistic ISFM introduction

IFDC-Africa is introducing ISFM in a participatory and holistic way, working with farmers through NGOs, extension services and national research institutes. The process approach is indispensable: ISFM development can only take place through a careful integration of outside scientific knowledge and indigenous knowledge and experience, in particular where conditions are heterogeneous and the technology options are diverse and flexible. It is only by working together, evaluating progress and failures, and assuring that cooperation adds capacity to farmers and other stakeholders that progress can be made.

Investments are required to increase the capacities of farmers and other stakeholders, and to enable networking. Even for the relatively favourable strategic sites, ISFM can not be introduced without external financial support for credit, training and networking. ■

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A full version of the article is available on www.ileia.nl

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Sustainable Soil Management Programme

Sustaining soil fertility: useful practices and methods in hill agriculture

Photo : SSMP

FFS farmer's group discussing the quality of their soils

Farmers in the hills of Nepal have, over the past centuries, developed complex farming systems based on a close integration of crop, livestock and forestry/grassland management. Manure derived from livestock is the main source of soil fertility management. About 32% of the fodder resources are derived from crop residues while the rest is derived from terrace risers, bunds and forests. Although fodder is in short supply and milk production is thereby reduced, farmers keep livestock partly for the purpose of manure production.

Farmers have constantly changed and adapted their farming systems over the past centuries as need and opportunities arose. New crops such as maize and potato entered the hills centuries ago and are now staple food crops contributing to food security. The expansion of fruit crops and vegetables is a more recent phenomenon improving food quality and farm income. At the same time, farmers have maintained traditional practices such as terracing, manure management, legume inter cropping, and mulching where appropriate.

Searching for innovation

The rapid intensification of land use, reduced access to biomass from public land, increasing access to input and output markets, new crops and cropping systems have exposed farmers to new challenges. Therefore, farmer-support organisations need to accelerate farmers' efforts to increase the productivity of the farming system with new practices and knowledge while maintaining its diversity and sustainability.

This article summarises experiences on the promotion of sustainable soil management of more than 50 governmental and non-governmental organisations under the common umbrella of the Sustainable Soil Management Programme (SSMP). More than 14000 households in 10 hill districts participated directly in project activities since 1999 through more than 1500 field trials or demonstrations per year. About 700 farmers participated in a recent evaluation of the programme. The major learning points so far are outlined below.

Technical opportunities for SSM

Various opportunities for improved soil management have been identified and confirmed with farmers over the past 3 years. For instance:

- ***Farm yard manure quality*** can be increased by better decomposition and the N-content can be increased by at least 2 to 3 times from about 0.5% N to 1.5% N through proper management of urine and manure. In particular, urine collection and the proper management of manure are new to most farmers, as many have initiated stall-feeding only over the past 1-2 decades. Previous recommendations for manure (use of starter, turning etc.) were derived from composting and proved to be too labour demanding and missed the importance of urine collection and N-preservation.
- ***Liquid manure*** can be prepared from urine and various plant extracts rich in minerals or secondary plant compounds. These "manure teas" were shown to be effective liquid fertilisers on crops such as vegetables and also for organic pest and disease management. Local marketing systems for such "manure teas" are emerging in some areas. The use of urea fertiliser declined in several areas due to liquid manure use.
- ***Increased fodder availability*** from fodder trees and grasses on private land has improved the fodder supply and quality for livestock. The quantity and quality of manure has increased (remember: about 80% of N in fodder is excreted through urine). Additionally the workload for fodder collection and transport, in particular for women, has been reduced.
- ***Legume cropping*** was not a successful intervention in many areas. However, it did expand considerably if the legume species was selected with farmers and well targetted to local ecological conditions and marketing opportunities. Groundnut has attracted, for example, the attention of farmers as a cash crop with local processing and marketing potential for women. Farmers have adopted Four-Season Bean, a climbing variety of Phaseolus vulgaris, as a vegetable and food crop.
- ***Multistorey Agroforestry*** systems have attracted farmers' attention in the case of inter cropping coffee (a new cash crop for most farmers), ginger, fruit trees, vegetable and fodder trees in the western and central region. Shade trees are essential for sustainable management of coffee plantations in minimising damage by stemborers, drought stress and low winter temperatures.
- ***High value crops with SSM*** such as fresh vegetables in areas with market access or ginger in more remote areas have stimulated farmers to care for their land and soil fertility. The initial doubt was whether short-cycle cash crops would contribute to an overexploitation of the soil and to a decline in soil fertility. However, field studies have confirmed that farmers increase their investment into soil fertility, if the information on the cash crop is delivered together with information on sustainable soil management. Fodder and manure production, for example, increased on these farms.
- ***Fertilisers*** may provide a response of at least 25-30 kg of additional maize yield per 1 kg of nitrogen applied if the fertiliser use is at low-moderate rates, correctly applied and well synchronised with crop demand. Farmers in accessible areas have started to complement manure with an inorganic fertiliser top-dressing. However, farmers' experiences on the correct type, amount, timing and placement of fertilisers in combination with indigenous organic manure management are still limited.

Technical challenges for SSM

Some major challenges remain to be addressed. We herewith invite readers to provide ideas and experiences on how to tackle the following challenges:

- ***Preventing the gradual acidification*** of soils is the most difficult challenge for sustaining soil fertility in the hills. At least one third of the soils have an inherent low soil pH and these soils will acidify further if inorganic fertiliser use expands and organic matter applications are reduced.
- ***Increasing phosphorous availability*** is another major challenge for SSM in the hills. Many soils have considerable P-reserves. A large part of the available P is linked to organic matter dynamics ("organic P") and the management of such P-pools, in particular in acidic soils, needs to be explored. Experiences with mycorrhiza application or P-mobilizing crops may be relevant.
- ***Organic pest and disease management,*** in particular of soil pests and soil-borne diseases, is required to manage soil fertility and soil health in an integrated approach. Experiences on the control of white grubs and red ant, in particular, and organic vegetable management in general are welcome.

Research over the past 5 years has confirmed the need for a combined use of different management practices to maintain or improve soil fertility under an "Integrated Plant Nutrient Management System" (IPNS). A joint effort between staff from the Nepal Agricultural Research Council, the Department of Agriculture, the Ministry of Agriculture and Cooperatives and various NGOs was initiated in 2001 to design and implement Farmer Field Schools on IPNS. Preliminary field trials indicate that the use of external inputs can be reduced to at least one half or can even be eliminated (using urine instead of urea) without yield reduction. More than 20 Farmer Field Schools on IPNS are under implementation in 2002.

Methodological opportunities

The promotion of SSM is not only based on technical interventions but is also a social process. Organisations working with SSMP use various approaches, methods and techniques in the promotion of SSM. Some have gone through a cycle of learning and improvements over the past years. This process continues, while the following conclusions can be drawn:

- ***Indigenous and new knowledge:*** Women and men farmers have confidence in their indigenous knowledge. New knowledge complements indigenous knowledge. Thus, methods of extension that build on discussion and interactive learning among farmers are most appropriate. Commonly known visual tools for soil characterisation (e.g. pH-paper, hydrogen peroxide, litter bags, erosion boxes) proved essential for stimulating discussion. The Farmer Field School approach for IPNS is centred around such a learning process.
- ***Soil fertility and land productivity:*** The farmers' concept of soil fertility is closely linked to land productivity as shown by various surveys. Farmers' interest in SSM-practices is much higher, if these are closely linked with complementary practices for increased soil productivity (e.g. vegetable plus better manure).
- ***Farmer-led experimentation:*** Farmers need to integrate new practices into their highly heterogenous hill farming systems. Methods of farmer-led experimentation were explored in 2000/2001 by some organisations. Simple experiments on inter cropping, crop arrangements, manure or urine use were most common. This proved to be effective in increasing farmers' role and commitment in the overall testing and diffusion process. Experiences were shared with others and over 30 organisations have started supporting farmer-led experimentation in 2002.
- ***SSM implications for women and men:*** Slightly more than 50% of all farmers participating in the field activities were women. However, this quantitative participation did not prove to be sufficient, particularly in more traditional communities. Thus, efforts were initiated to assess with farmers the implications of adopting specific SSM-practices for women and men farmers. This resulted in the identification of specific actions to address qualitative gender equity, which have become part of the strategy in a technically-oriented programme.

Methodological challenges

- ***Participatory planning, monitoring and evaluation (PPME):*** The introduction of new SSM-practices into traditional and complex farming systems is a gradual process of testing, adaptation and learning. Participatory surveys in project areas proved to be of a consultative character and were mostly dominated by staff of organisations. Additionally, surveys were quickly outdated by changes in opportunities and problems perceived by farmers. Thus, a regular process of PPME at the level of the farming community is considered essential to adjust projects to emerging needs and opportunities. SSMP supports this through annual work plans (Activity Proposals) and respective budget allocations to each project. However, the overall process of learning with farmers needs to be further strengthened. An exchange of experiences on PPME and on the integration of constant learning into project cycles would be appreciated.
- ***Farmer-to-farmer diffusion:*** As improvements of local SSM are a result of the integration of new and traditional knowledge and practices, experienced farmers turned out to be the best local promoters for SSM. Additionally, demand-led extension tends to be more effective and efficient than mandated extension. Thus, a new approach of farmer-to-farmer diffusion is under testing since 2001. The most experienced farmers received additional training so as to enable them to offer their services as local resource persons. A total of 400 farmers groups are expected to hire the service of these farmers with limited financial support by the projects. More needs to be learned about modalities to support demand-led farmer-to-farmer diffusion.

Governmental policies

Recent changes in governmental policies have in general been supportive of SSM. The termination of fertiliser subsidies, the recognition of organic amendments as fertilisers and the incorporation of IPNS into the Fertiliser Policy have set a new framework. The recognition and promotion of partnership between public and private organisations in agricultural development under various policy documents has set the stage for new institutional collaboration. Community forestry has strengthened the confidence in local management mechanisms. These changes were essential for creating a supportive environment. They coincided and were partly a response to a growing strength of civil society actors in the country. The gradual implementation and internalisation of such changes, however, does require continuous efforts and sometimes struggle.

■

The paper summarises the work and experiences of many persons and organisations. For further information please contact: STSS, Department of Agriculture, Harihar Bhawan, Lalitpur, Nepal; or PSU, SSMP, GPO Box 688, Kathmandu, Nepal. Email: psussmp@wlink.com.np.

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Microbial tools – a key to sustainable productivity

Dhananjaya P. Singh

One of the dreams of human endeavour is the sustainable increase in the pace of agricultural productivity to fulfill the demands of rapidly growing human population. During the last few decades, use of modern technology resulted in increased agricultural production. However, the need and greed for crop yield has resulted in over-exploitation of the soil ecosystem. The effects are manifested in the form of degraded soils in terms of soil nutrition and organic matter.

In the Indian context, the seriousness of the issue can be understood from the following facts. About one fourth of the nitrogen, more than half of phosphate and total potash are being imported either in the form of raw material or finished product. However, only a considerable portion of these nutrients put into the soil remains available to the plant roots. A major part of it is lost due to the physio-chemical as well as biological activities. Long term experiences have shown that neither the organic manure nor the chemical fertilizers alone can achieve sustained high yields. Integrated use of organic manures, bio-fertilizers and chemical fertilizers, therefore, remain the only promising option in improving crop productivity.

Microbes balance soil ecology

Microbes are an integral part of every soil ecosystem. Various kinds of biological activities are continuously going on in the soil. Metabolic activities of the microbes such as bacteria (Plant Growth Promoting Rhizobacteria – PGPR), fungal organisms (mycorrhiza, cyanobacteria) and soil fauna (nematodes, worms, protozoans etc.) promote soil health and crop productivity.

Almost all the beneficial microbes essentially need carbon source for their survival. This explains as to why the soils poor in the organic matter content are usually poor in microbial activities. In the past, application of huge chemical inputs have made soils poor, or even worse in terms of affecting microbial activities. This led to decrease, or in many areas, extinction of a number of beneficial soil biota such as PGPR, fungi, earthworms, actinomycetes etc. This situation prevails in almost all types of soils across the country. For example, in Chandauli district of Uttar Pradesh state, both qualitative and quantitative change in the rice-wheat cropping system has been observed in the past 10 years. The yield as well as the quality of the harvest declined drastically. Emergence of high alkaline patches in the field and crop failure due to increased fertilizer doses are reported by the farmers. Such a situation is common in many parts of the Eastern U. P.

The Foundation for Agro-Technology Development and Resource Management working in that area helped the farmers in the region to assess their situation and adopt remedial measures. The farmers adopted biofertiliser application in rice ecosystem in a step-wise manner. Soil was first mixed with FYM and Sewage Sludge Waste (SSW) in equal quantities (1: 1 ratio) at the time of field preparation for rice cultivation following flooding. This was followed by the application of mix culture of cyanobacterial strains (originally isolated from the field and then cultured under similar conditions) @ 15 kg per hectare, 10 days prior to transplantation. This resulted in the improvement of both quality and quantity of rice crop and also improved soil conditions for the next wheat crop.

Biological Nitrogen-Fixation (BNF): a nature's gift

Nitrogen is one the most abundant gases found in the atmosphere but unusable by the plants in its gaseous form. Many microbes, however, are capable of converting the gaseous nitrogen to nitrate. The nitrates can be easily utilized by the plants. This process is called 'Biological Nitrogen Fixation'(BNF).

BNF has an assured place in agriculture mainly as a source of nitrogen for legumes and other important crops. On a global scale, BNF provides the largest input of nitrogen to agricultural soils. Inoculation of *Rhizobium* as biofertilizer in the crops such as groundnut, pigeonpea, soybean etc. provided 19-22 kg of nitrogen per hectare which increased production by 17-33%. Similarly, use of non-symbiotic bacteria *Azotobacter* in wheat, sorghum, tomato, cotton, sugarcane and *Azospirillum* in wheat, maize, rice, sorghum crops augmented nitrogen supply to crops to an extent of 20-30 kg per hectare. Thus, resulting in increased crop yield by 10% to 30%.

Blue-green algae (BGA or cyanobacteria) are phototropic organisms that grow wherever water, sunlight and carbon di-oxide are available. The rice ecosystem is an ideal environment for the growth and development of these self-supporting organisms. A large variety of nitrogen-fixing BGA such as *Aiiabaena, Nostoc, Aulosira, Calothrix, Tolyphothrix* etc. colonize the rice field soils. Upon application in the soil, blue-green algal organisms compete well with the native strains, grow profusely near the root zone in soil. Nitrogen fixed by them is released either through exudation or through microbial decomposition after the alga dies. In paddy fields, the death of algal biomass most frequently results in gradual build-up of soil fertility. The residual effects influence the succeeding crops also. Apart from fixing N and adding organic matter to soil, BGA are also known to produce and excrete plant promoting substances like indole acetic acid. Also, continous use of the BGA biofertilizers for 2-3 years adequately builds up the population of these organisms in the soil.

The relative contribution of BGA as a percentage of total nitrogen-fixed in paddy fields varies widely and is estimated to be 15-35 kg nitrogen per hectare in India. In areas where chemical nitrogen is not used for various reasons, algal inoculation enhances a minimum of 4% to a maximum of 32.8% crop yield with an overall average of 16.1%. Even at the levels of chemical N fertilizers being used in different states, the application of BGA biofertilizer resulted in an increased crop yield of 8.85%.

PGPRS: Low-cost input from nature

Besides nitrogen fixers, many bacteria colonize plant roots. Some of them promote plant growth significantly. They help in mobilization of the soil nutrients and production of phytoharmones or growth regulating substances. These phytohormone producing microbes have been classified as PGPR. Of the many such bacteria identified, the role of fluorescent *Pseudomonas and Bacillus* species have attracted much attention. The substances produced by them have natural biocontrol and plant growth promoting capabilities. Increased amount of nutrient uptake by plants inoculated by *Pseudomonas putida* has been attributed to the production of growth regulators by the bacterium at root surface which stimulates root development.

Pseudomonad (group of *Pseudomonas* species) inoculants produce indole acetic acid-like substances (plant harmone) in the rhizosphere of wheat grown in field conditions. Many PGPRS, for example, *Pseudomonas fluorescence, Pseudomonas aerugnosa and Bacillus subtilis* also produce substances such as siderophores and saponins, which are responsible for the removal of heavy metal toxicity. These organisms are also responsible for enhancement of rhizospheric competitive ability by antagonistic effects on other harmful bacteria, control of plant diseases that affect root density, production of chemicals that interfere with the organisms infecting plant roots, enhancing the availability of nutrients that improve the efficacy of plants. PGPRs are therefore being widely evaluated for their role in sustainable resource management as biocontrol agent and biofertilizer.

Integrated nutrient management in fodder-cowpea

Thomas Abraham and R.B.Lal

Soil health care is fundamental to sustainable farming. Biological diversity has the potential for compensating among various components of the farming system. This brings in yield and economic stability. There is a need for buffer, both biological and economic, in the current farming systems. This needs to be in terms of alternatives, depending more on on-farm renewable resources.

Organic farming implies total abandonment of fertilizer and chemicals. This system in its strict sense is difficult to be adopted in the near future, particularly by the small and marginal farmers in India. Hence, an effective blend of traditional practices with the modern science would be the preferred choice. This in popular parlance is expressed as *'ruminate the tradition, assimilate the recent advances and construct the future'*.

The adoption of appropriate crop rotations that include legumes is one of the means to maintain soil fertility and productivity. The poor farmers get higher returns by inclusion of legumes and fodder crops in the cropping system. Besides, soil fertility is maintained and production is sustained.

Fodder crop component, particularly, summer legumes find very insignificant position in most of the cropping systems of the eastern belt of Uttar Pradesh. This accentuates the overall socio-economic standard of the peasants. A study was therefore conducted to find out the influence of integrated nutrient management (INM) on legume fodder (cowpea) based cropping system. Different combinations of chemical fertilisers, organic manure, bio-fertiliser and organic sprays were used to understand the impact.

There was a marked response in dry matter accumulation when only one third amount of recommended dose of fertilizer (6.66, 15.66 and 6.66 kg/ha of N, P & K respectively) was applied. It was however interesting to note that accumulation of dry matter was higher when organic manure was used. Here, farm compost (mainly consisting of crop residues and cattle manure) was combined with poultry litter during the early stages and with vermicompost during later stage. Both these combinations were found to be suitable nutrient carriers for summer growing fodder cowpea.

Use of biofertilizer was found to be a viable alternative as a partial substitute for inorganic fertilizers. Phosphate Solubilizing Bacteria (PSB) was used along with Rhizobium. 33% cow's urine was sprayed twice at 20 and 35 days after sowing. This resulted in higher nodulation as compared to crop fertilised with zero or 1/3rd levels of nitrogen application.

Different combinations of nutrient sources had influence on different aspects of the crop. The crop applied with fertilisers (one-third recommended dose) in combination with farm compost and vermicompost registered significantly higher yield than other combinations. Similarly, the carbohydrate content was higher in crop fertilised with chemical fertilizer (one-third of recommended dose) only. On the other hand, a combination of fertilisers (recommended dose), farm compost and poultry manure as well as the dual culture of PSB with Rhizobium proved to be superior with regard to protein content of the herbage.

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An **indigeneous method** has been developed by the Foundation for the production of biofertilizer rich in bacterial population at the farmers level. The idea is to use beneficial microbial population, already acclimatized with the pH and other physiochemical conditions of local soil. Roots of existing crops, grasses and weeds were cut from the rhizospheric region along with the adhered soil and chopped into fine pieces. The whole material was dipped (suspended) in a bucket of water containing 5% molasses solution overnight. Further, this solution along with the chopped material is transferred to field at the time of transplanting. By this low cost, indigenous process, mixed population of root-rhizospheric bacteria can be increased manifold and maintained by the local farmers as per their requirement. The process reduces synthetic fertilizer inputs. Farmers of Varanasi and Ghazipur region, U.P. (Villages- Bhopapur and Ramna, Hansrajpur and Yusufpur, respectively) are being trained by the workers of the Foundation in such processes.

Mycorrhizal Fungi (VAM)

Mycorrhizae play a dominant role in making unavailable soil nutrients available to plant roots and increasing the potential gain of available resources. These organisms ensure easy availability of organic carbon and complex organic nitrogen and phosphorus sources, increase phosphorus solubilization and availability in clay soils. These fungi work upon large volumes of soil. Their hyphae extend outwardly from the roots ranging from a few centimeters to several meters in the soil. This results in increasing the effective absorbing surface of the host root by as much as 10 times, resulting in enhanced absorption of immobile nutrients such as phosphorus, zinc, copper etc. in the soil by 60 times. Mycorrhizal fungi also transport many other nutrients including calcium, magnesium, sodium, sulphur, iron, chlorine etc., all essential for plant growth and development. It has been observed that plants with mycorhizal association are more tolerant to heavy metal toxicity. These plants survive well in drought and arid conditions as improved water movement is facilitated by mycorrhiza.

Theoretically, the most efficient level of nutrients is the concentration of mineral elements in the plant tissue just above the 'critical level' necessary for optimum growth. Further addition of chemical fertilizers may be taken up by plants, as 'luxury concentration'. This adds very little to plant growth. Now, these microorganisms help in constituting the 'optimum level' of minerals in the plant tissue even at low level of fertiliser inputs. They fix nitrogen, solubilize phosphorus and facilitate uptake of minerals by roots. Thus, these microorganisms in the form of biofertilizers are essential for maintaining good soil fertility, better soil conditions and sustainable agricultural productivity. ■

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Wise lessons from Mother Nature

Ambarwati D. Rahayu and Rik Thijssen

Characteristics and processes of natural ecosystems can be used as the basis for designing sustainable farm systems. This is, however, conditional to proper observation and collection of information for learning about the beneficial features of nature, as well as in understanding the various natural processes. The international development organisation VECO collaborates in Indonesia with more than 40 local NGOs, spread over 7 provinces, on the development of sustainable agricultural systems that can help to alleviate food insecurity.

LEISA developments

In mountainous Indonesia, soil and water conservation is an obvious precondition for sustainable agriculture. Frequent losses by erosion not only oppose basic ecological principles of LEISA ("optimising nutrient availability and cycling") but also harm soil life and, therefore, affect the soil negatively, both quantitatively and qualitatively. When VECO partner organisations start a new agricultural programme with rural communities, soil and water conservation is, generally, a good starting point. After making an inventory of the local conditions during a PRA exercise, programme staff and farmers are 'fresh' and eager to get going, while the principles of building erosion structures are quite straightforward and, by now, understood by many. In this way some quick first results can be achieved which have an enormous impact on further LEISA developments.

Using the principles of agroforestry, shrubs and trees can be added to protect and stabilise man-made erosion control structures. However, in cases where soils are not deep and slopes rather steep, experiences from natural forests show that tall-growing trees can be a hazard, and are frequently the cause of landslides during the rainy season. Local farmers in the district of Mamasa, on Sulawesi, recognise this danger and, therefore, plant only shrubs on such slopes and frequently prune and lop the woody species, which tend to grow tall.

Production of different crops using Urea (250 kg/ha) or compost (10 ton/ha)

Crop	Yield with Urea (kg/ha)	Yield with compost (kg/ha)
Rice	1,200	2,680
Maize	800	1,460
Groundnuts	975	1,125

Cover crops are in most agricultural development programmes another means of curbing erosion. The soil-creepers, mostly leguminous plants, can also serve as soil fertility improvers. But what could be done in situations where soils are rather acidic and common cover crops do not grow well? Or in cases where cattle roam freely around and could destroy the cover crop by trampling or browsing?

Learning from local insights

Ethnobotanical surveys often provide important information and local insights with which such issues could be tackled. During an ethnobotanical study in the area of Balla Satanatean village in Mamasa District, an answer was discovered for the first question. Soils here are acid and farmers use lime to increase pH on their fields. The common, natural soil cover here is a creeping fern, *paken (Gleichenia linearis)*, and large areas on slopes have been colonised by this "wire fern". Local adat (customary law) demands great respect for the functions of this plant and people will think twice before they do anything that might damage the protective 'blanket' formed by this fern. The soil-holding capacities of paken are so well understood that most farmers plant this species on dikes around their sawah (irrigated rice fields).

Farmers in Ngada District on Flores appreciate, already for a long time, the natural presence of the "weed" putri malu (Mimosa diplotricha or giant sensitive plant). This fast-growing species can provide a quick cover on fields between cropping periods or during a fallow. Covered with many small thorns, it is not a crop that invites animals, and people alike, to walk through. According to farmers it is not easy to clear putri malu afterwards, but they take that for granted since it is an excellent soil improver, cover crop and soil binder against erosion.

Another problem that many farmers on Flores face is very hard soils. Low in organic matter after continuous use, soil compaction makes it impossible to plough such soils. Women lament that they cannot grow vegetables or fruit trees near the homes because the soil has become as hard as a rock. Perhaps even worse, because in rocky places there are still some plants and trees that grow.

This last observation has been a challenge to the community. If plants can grow in the wild in places where there are only rocks, then why can plants not grow in their hard soil?

Pits of 30x30x30 cm have now been chiselled out and filled up with soil from other places mixed with organic material. Vegetables and fruit trees have been planted in this olah lubang (pit planting) system. The first results are promising and the hope is that by bringing back some life to this hard soil, the soil will eventually become healthy.

Maintaining soil fertility

To keep the soil in place is one thing. To keep soil fertility in pace with day-to-day agricultural requirements is another. Farmers in Indonesia are searching for alternatives to the chemical fertilisers they have been using since the Green Revolution started. Convinced that inorganic fertilisers have destroyed many of the qualities of their soil, and stressed because of the high prices of the chemicals since subsidies were abolished, farmers in the VECO programmes are, for instance, experimenting with liquid manure. This manure is made by fermenting large amounts of leaves of certain shrubs and trees in containers with water. After a few weeks, the concentrated liquid is diluted with water and used as a fertiliser on small rice fields, vegetable plots or young fruit trees. Reactions from farmers are all very positive. They observe good growth and more healthy plants. There is less damage by pests and products such as onions can be stored for a much longer period compared to produce from fields treated with chemical fertilisers.

Farmer innovation in compost-starters

During a study visit in 1998, to an extension institute in Bogor, the use of a commercial compost-starter EM4 ("effective microbes") was demonstrated to farmers from Bandungrejo village in Malang District, East Java. This technology, developed by a Japanese biotechnology professor, was, of course, tried by the farmers once they got home. The conclusion of the group was that the process of composting mixtures of rice straw and other organic waste was indeed accelerated by using EM4. Where it would take normally months for rice straw to degrade, the new technology took only few weeks!

However, the expenses of buying the litre bottles of EM4 were relatively high (about 25,000 Rupiah or US$ 2.80). One of the group members, Mr. Kusno, therefore decided to try to develop his own compost-starter. From their visit to Bogor, it had become clear what natural processes and components were important for a more rapid composting process. Mr. Kusno, who had ample experience with the fermentation of cassava roots to the local food product tape, reasoned that if the ragi ("yeast") used was able to make the hard cassava root soft, than maybe it would even be able to break down the fibres of the rice straw.

Using the ragi for making tape from cassava roots, they found it is possible to produce mature compost in only a matter of weeks. The compost was analysed by the Soil Laboratories of the Agricultural Department of Brawijaya University in Malang. A cost-benefit study was done and also proved very favourable - using compost could save almost 50% of expenses on chemical fertilisers. While it could even be lucrative to produce compost for selling, since production costs for 200 kg of compost was about 10,000 Rupiah, while compost was sold for 200 Rupiah per kg.

The results of the experimentation by Mr. Kusno and his farmer group has triggered off a complete new thinking about composting. After extension officers had shown them how to make the ragi themselves, farmers have also started experimenting with alternative ingredients to make effective compost-starters. While the ragi for cassava tape is based on micro-organisms from the roots of laos (Languas galanga), starters have now been developed using roots of other plants as well as over-ripe fruits.

Mr. Kusno died in 2000 at the age of 58 years. His work will always be remembered by the many farmers in Indonesia who implement 'his' technology under the name pupuk ragi Kusno (fertiliser from Kusno's ragi).

During technical monitoring and evaluation meetings, the important soil processes concerning mineralisation and nutrient availability are explained and discussed. The accelerating effect that N and P fertilisers have on the decomposition of soil organic matter is always a hot item of discussion. Initially, a bonus effect is created by increasing the availability of macro and micro-nutrients to plant roots. On the longer term, this priming effect causes a larger fraction of the soil organic matter to be broken down annually. Arguably, this is the most important factor why the Green Revolution scored its early successes but finally caused serious problems for main soil qualities.

When confronted with this information, it is not so difficult for farmers to draw a parallel between the use of chemical fertilisers and the use of their liquid manure. Since the liquid fertiliser contains only water, nutrients and microbes, they can only agree that chances are high that similar priming effects could cause new problems, especially because of decreasing the content of soil organic matter.

Therefore, it becomes imperative that organic material of a certain quality is regularly added to the soil. The usual green manures are not applicable since research in alley cropping has shown that the easily decomposable leafy material from leguminous species contributes to a priming effect and does not add significantly to soil organic matter. Animal manure would be fine, but not all farmers keep animals while quantities of animal manure are often not sufficient. This leaves compost as the better option. Especially compost made out of fibrous material such as rice straw and alang-alang grass (Imperata cylindrica) could provide the necessary, long-lasting organic supplement for soils. Crop yields are significantly higher with the application of compost in comparison to inorganic fertilisers as seen in the table. Compost starters are popular amongst farmers and have become cheap and accessible due to farmer innovation (see box).

Conclusion

In order to imitate natural ecosystems in our pursuit of developing sustainable agricultural systems, we – development agents and the farming communities - should be prepared to observe well the many different components, and ingenious arrangements between components, that make up such a natural ecosystem.

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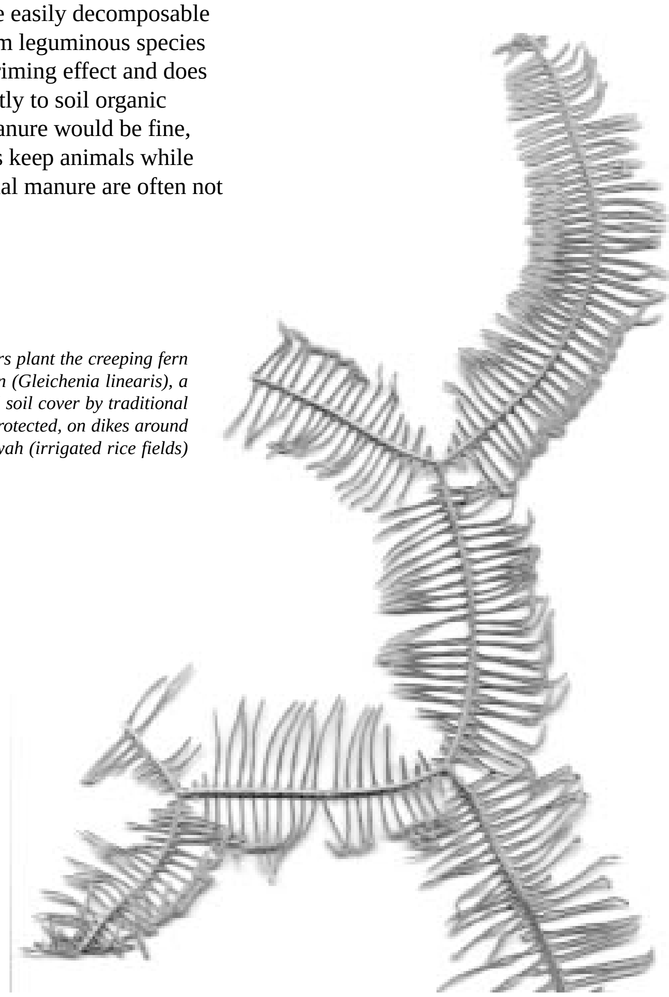

Farmers plant the creeping fern paken (Gleichenia linearis), a natural soil cover by traditional law protected, on dikes around their sawah (irrigated rice fields)

Photo : the authors

Photo : Norman Uphoff

Farmers develop new hand weeders in Sri Lanka to make SRI less labour intensive.

System of Rice Intensification gains momentum

Norman Uphoff and Erick Fernandes

Since 1999, the System of Rice Intensification (SRI), developed in Madagascar by Fr. Henri de Laulanié in association with the NGO Association Tefy Saina (ATS) and many small farmers in the 1980s, is spreading to many countries. Various articles and presentations on SRI at national and international fora, especially those by Dr. Norman Uphoff, Director of the Cornell International Institute for Food, Agriculture and Development (CIIFAD) at Cornell University in USA, have motivated many people to experiment with the approach and evaluate it for themselves.

SRI is a 'system' rather than a 'technology'. It is based on the insights that rice has the potential to produce more tillers and grains than now observed, and that early transplanting and optimal growth conditions (spacing, humidity, biologically active and healthy soil, and aerobic soil conditions during the vegetative phase) can fulfil this potential. These principles are translated into a set of 'baseline' practices: transplanting of young seedlings, carefully one per hill, with wide spacing; no standing water during the vegetative growth phase; application of compost; and early and frequent weeding (see e.g. LEISA Magazine Vol.15, No.3/4, pp.48-49; Vol.16, No.4, p.12; Vol.17, No.4, pp.14-16). Practitioners of SRI are encouraged to vary and improve these practices, to see which can best give effect to the SRI principles in their specific situation.

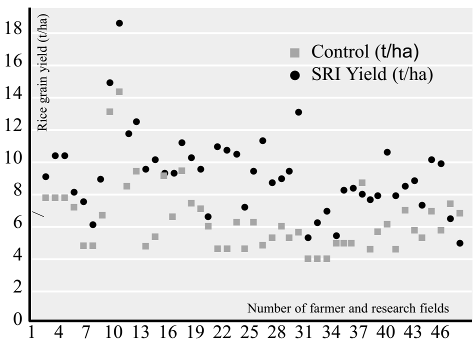

Figure 1 Comparative rice yields reported from cases where data were available on both actual SRI yield and comparison/control yield

The SRI approach has been tried in at least 17 countries under a range of climatic and other conditions. Farmers have worked with many different varieties (traditional, high yielding and hybrids) and soil fertility practices (organic, chemical, and a combination of both) and have developed several variants and improvements of the 'baseline' practices.

First International Conference

As scientific validations of farmer and researcher experimentation have become available, it was timely to hold an international conference on the System of Rice Intensification. This was organised by CIIFAD and the China National Hybrid Rice Research and Development Centre, with co-sponsorship by ATS and the China National Rice Research Institute. It took place in Sanya, China, April 1-4, 2002. The objective was to better understand the variations in practices and the results that have emerged, and to establish means for communication that would facilitate evaluation of innovations from various sources and share them widely, so that farmers in many countries would have a longer "menu" of SRI practices to choose from.

Reports from China, Indonesia, Philippines, Cambodia, Laos, Thailand, Myanmar, Bangladesh, Sri Lanka, India, Nepal, The Gambia, Madagascar, Sierra Leone, Cuba, Peru, and the U.S.A. were presented at the conference. This article is a compilation of the main findings and comments.

Advantages

Numerous benefits associated with SRI practices were reported in the conference papers, the most important being an increase in **total factor productivity.** Specific advantages included:

- **Higher yields:** increases of 50-200 %, with yields of 4-8 tons/ha common, but also yields above 10 tons/ha frequently reported (see Figure 1).

- **Increased returns to labour** with more production per day invested.
- **Water saving:** up to 50%, with higher productivity per unit of water applied.
- **Improvement of soil quality and increased efficiency of fertilisers,** both organic and chemical.
- **Reduced requirement of seed:** 5-10 kg/ha of seed is used, 5-10 times less than the quantity with the regular practice; this makes the use of improved and hybrid seeds much cheaper for farmers.
- **Less requirement of purchased inputs - water, fertiliser, seed and pesticides,** and lower costs of production contribute to higher income for farmers.
- **Higher seed quality:** SRI methods make it possible to increase considerably the yields for traditional rice varieties grown organically for which higher prices can be obtained; also, multiplication of 'breeder seed' can be faster as many more grains can be produced from a single seed.
- **Diversification of production:** less land is needed to produce the same amount of rice, freeing up land for producing green manure or crops with higher value.
- **Environmental benefits,** resulting from reduced demands for water and less or no use of agrochemicals.

The disadvantages reported included:

- **Requirement of good water control,** to be able to apply small amounts of water as and when needed to maintain soil moisture without saturation, rather than flooding fields continuously. Farmers who do not have such control or reliable access to water will get less or little benefit from SRI practices.
- **Requirement of more labour**, at least in the first year or two, as skills are learned for using the SRI practices quickly and confidently (see Box 1). This can be a barrier to adoption, even for poor households which are relatively more endowed with labour, if they need immediate returns from their labour to meet subsistence needs. At the present stage of development, SRI is mainly of interest to small farmers who have sufficient household labour. The challenge is to develop practices that make SRI suitable for situations where labour is more expensive and for larger-scale mechanised farming.
- **Drastic change of farmer practices** which is often not accepted by farmers, their communities, researchers and/or governments.
- **Requirement of greater skill** on the part of farmers, expecting them to adapt SRI practices to their own conditions based on their own trials and evaluations. This can, of course, contribute to human resource development, which is a benefit and not just a cost.

Field experiences and observations

Using young seedlings. This is probably the single most important practice in SRI according to the factorial trial results in Madagascar, adding about 2.5 t/ha in this situation, other conditions being equal (Table 1). Some farmers have tried seedlings as young as 5 days; others have preferred older seedlings (3-4 weeks), e.g., because of slower growth in colder climate. Two evaluations in Madagascar have shown definite benefits from using younger seedlings. The advice to start by using 8 to 12 day-old seedlings remains sound, but decisions about seedling age need to match varietal and climatic differences.

Box 1. Gender division of labour in SRI

We do not know how much SRI affects the gender division of labour within households, so this should be evaluated as a matter of some priority. Since SRI requires more labour per ha., at least initially, there is concern that this could increase the labour burden on women, who usually do the transplanting operation. Labour savings in terms of time spent on nursery construction and management with SRI would accrue usually to men.

However, conversations with women doing SRI transplanting in Sri Lanka indicated that they found SRI methods easier and quicker after the first year, once they became comfortable with handling tiny seedlings. Because lighter and fewer seedlings are transplanted, they reported that SRI transplanting had become quicker for them, and they found the technique more comfortable ("less backache").

In Madagascar, there are still complaints about the method taking extra time and effort, but the spacing for transplanting is still marked with ropes stretched across fields, rather than with a simple wooden rake that scores the surface of the fields with lines. With increased yield, women's burden at harvest time is probably increased, though a larger harvest helps maintain household food security, which is a major responsibility and burden for women.

Effective tillering. There is wide variation in tillering and the effectiveness of tillers. Sometimes there are up to 50% **unproductive tillers,** which cannot be explained very well. More often effective tillering is in the range of 60-80%, with some plots attaining 80-90%. How to optimise effective tillering is an important research question.

Quick and careful transplanting. Farmers have not found it difficult to transplant seedlings within 30 minutes,

Table 1. Factorial trial results, comparing yield responses on clay and loamy soils, Anjomakely, Madagascar, 2001

	CONTINUOUS FLOODING				SRI WATER MANAGEMENT			
	20-day plants		8-day plants		20-day plants		8-day plants	
	3 per hill	1 per hill	3 per hill	1 per hill	3 per hill	1 per hill	3 per hill	1 per hill
CLAY SOIL								
No Fertilizer	2.26	2.78	3.09	3.75	4.82	5.42	5.65	6.25
NPK	3.00	5.04	5.08	6.07	7.16	8.13	8.15	8.77
Compost	3.71	4.50	6.72	7.45	6.86	7.70	9.32	10.35
LOAM SOIL								
NPK	2.04	2.78	2.60	3.15	3.89	4.36	4.44	5.00
Compost	2.03	2.44	3.41	4.10	3.61	4.07	5.17	6.39

The yield figures reported (tons/ha) are each averages from 6 replicated trial plots. The average yield with conventional practices is underlined; that with all-SRI practices is **bold faced.** A traditional variety (riz rouge) was used for all trials, with soil type as one of the variables evaluated. These trials (N=240) were conducted in a village 18 km south of Antananarivo on the high plateau. More complete data from factorial trials conducted by Rajaonarison in 2000 and Andriankaja in 2001 are reported in the conference proceedings.

or preferably 15 minutes or less, if they establish their nursery near the field. Farmers have found that using a trowel or other implement helps minimise trauma to the tender seedlings when they are uprooted from the nursery. Seedlings are sometimes planted in wooden or bamboo frames that can be kept in or near the house for protection and then carried to the field, so that seedlings are uprooted only at the time of transplanting.

Trauma during transplanting can be reduced by paying attention to the soil mixes used in the nursery and by appropriate water management practices. In Sri Lanka, for example, a nursery mixture of one-third soil, one-third sand, and one-third (chicken) manure has given very good results.

Traditional, improved or hybrid varieties. All varieties used so far have given higher yields with SRI practices, though not surprisingly, some varieties respond better than others, e.g., producing more tillers or giving better grain filling. It was observed that 120-140 day varieties responded most productively, but more evaluation is needed on this. The best SRI yields (up to 16 tons/hectare and higher) have been obtained with high-yielding or hybrid varieties, although traditional varieties, considered low-yielding, have also shown great yield increases. Since the latter are commonly preferred for taste and other qualities, and command a higher market price, they may regain popularity with SRI methods that increase yields up to 6-10 t/ha.

Seedlings per hill. 1 or 2 seedlings per hill can give good results depending on local conditions. Where soils are poor it may be better to use 2 seedlings per hill until soil quality is improved. There is enough evidence that 3 or more seedlings per hill retards growth due to plant competition below and above ground, and therefore does not need further experimentation. On good soil, single seedlings have been giving the best results.

Wide spacing. Some of the highest yields observed with SRI have come with very wide spacing, 50 x 50 cm, when soil quality is excellent. But spacing between plants is something to be optimised, not maximised, since one wants the largest number of grain-bearing tillers per sq. metre. This number is influenced by various factors (soil quality, variety) as well as by SRI practices, of which spacing is one. Most farmers are advised to start with 25 x 25 cm. Often 35 x 35 cm spacing has given the best results but on very poor soils
20 x 20 cm may be better.

Techniques of spacing. Instead of using strings to achieve desired and exact spacing, some farmers in Madagascar and Sri Lanka are now using wooden rakes with teeth (pegs) spaced at 25 cm, or wider, intervals to mark square grid lines on the muddy surface of their paddies. Farmers find that this speeds up the transplanting considerably (see Box 2).

Water management. There is plenty of evidence that in many conditions keeping the soil moist but unsaturated during the vegetative growth period is best. The SRI recommendation has been to add small amounts of water to the field daily, preferably in the late afternoon or evening (unless there has been rain during the day), and draining any excess (standing) water in the morning. This opens the soil to aeration and warming during the day. However, a large number of farmers, seeking to reduce their labour requirements, follow an irrigation schedule of alternate flooding and drying of their field instead of careful watering but not flooding during the vegetative growth period. It is not clear if this gives a higher yield but it does economise on labour. Certainly different practices are needed for clay vs. other kinds of soil. Further research is also needed to understand the implications of such changes at large-scale for water distribution and the environment.

Weeding. When fields are not kept continuously flooded to combat weeds, farmers have to use other practices. With SRI, early and frequent weeding is also

Box 2. Adaptation and innovation of SRI practices in Sri Lanka

One of the reasons for fast dissemination of SRI in Sri Lanka is the enthusiasm and creativity of farmers to adapt and innovate SRI practices to resolve their field problems. The following are highlights:

- Various soil-enrichment practices have become part of the system including green manure (e.g. sunhemp), rice straw, chicken dung, and mixtures of certain green leaf extracts with cow dung. In this way farmers are improving soils degraded by conventional rice production practices without needing to transport huge quantities of compost to their paddy fields.
- Practical problems encountered in using the rotary weeder have resulted in alternative weeder designs to suit the specific conditions of different fields. Weeders are manufactured and sold by several farmer companies and private sector entrepreneurs. A motorised weeder is at the design stage in three locations and will be tested soon.
- To make transplanting easier, a rake was produced to draw lines in a square grid pattern on the ground. Seedlings are planted at the intersections of lines.
- A transplanter that can do careful planting of one seedling per hill in 6 rows at a time with required spacing has been developed.
- A seeder, which can drop one or two germinated seeds at the desired spacing has also been developed and is now in use.
- A foot-pedal water pump with sprinklers is being experimented with to ensure required moisture during the growth period and after panicle initiation. This is especially useful in drought periods when surface water is scarce, and also to ensure production of high-value organic rice for the export market.
- Many farmers are using different combinations of plant extracts, with or without 'effective micro-organisms' (EM), to avoid the use of chemical pesticides. They experiment with different plants available in highlands around the paddy fields. Some plant extracts are used not only as insect repellents but also as a source of nutrients.
- Farmers have stopped plastering their bunds and leave the grass cover on the bunds to protect the habitat of rice-pest predators. In this way they support biological pest control and microbial activity in the soil to improve soil health and biodiversity in the paddy fields. This saves money for plastering and pesticides and thus reduces production costs.
- SRI farmers experiment with different spacing and direct seeding. They also do careful time planning to prevent flowering during the full moon phase. They find that this reduces damage by insect pests.

The benefits achieved by farmers from SRI and other improved practices are attractive. Farmers have been able to at least double the yield they got from conventional practices while also reducing their production costs, often by half. They have become producers of quality rice earning a slightly higher income from sale as seed paddy. Biocide-free SRI rice fetches a higher price in the market, and the demand is increasing. Production of organic and traditional rice for export is increasing with one farmers' group already obtaining certification for production of organic rice. In this way SRI is becoming a viable alternative for farmers cultivating small plots obtaining average yields of 8.5 tons/ha, achieving higher returns from reduced inputs, while increasing the productivity of land, water, labour and capital. Besides, SRI farmers produce clean and healthy rice through eco-friendly practices.

More information on the experiences in Sri Lanka can be found in Box 4 and in the Proceedings of the International Conference on SRI

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Training material used in Madagascar showing the steps involved in planting SRI rice.

important to aerate the surface of the soil. SRI farmers could use hoes or weed by hand, but 'rotary hoes' or 'cono-weeders' are recommended. Access to mechanical hoes can be a bottleneck. Labour required for hand weeding can be as much as 20 – 25 days for one ha in Madagascar. Recently, SRI practitioners in Sri Lanka have developed a new design for a push weeder (see Box 2 and photo on p.24) which makes it possible to weed 1 ha in 3 to 5 days.

Soil and nutrient management. With SRI, the highest yields have been obtained with organic soil amendments, particularly compost. Research in Madagascar has shown that compost gives a considerable increase in yield compared to NPK fertiliser, especially for traditional varieties (Table 1). But it was also reported that most farmers are using neither compost nor NPK on their crop, and still getting yields with SRI methods that are twice as high as with standard methods. Participants wondered how this is possible, and for how long farmers can continue with such nutrient-depleting practices. At some point there may be soil nutrient constraints, e.g., P, that have to be alleviated by adding sufficient soil amendments. Often there are not enough organic nutrients available and chemical fertilisers are too inefficient to be profitable.

Better understanding of soil life and biological soil processes are needed to develop effective, efficient and sustainable soil fertility management strategies for SRI. There seems to be much scope for Integrated Soil Fertility Management (ISFM) practices. Green manure, composted rice straw, micro-nutrients and sprays of soil micro-organisms and

Box 3. SRI adaptation and diversification in Cambodia

After farmers gain confidence in SRI, they become interested in refining the ways of increasing rice production and diversifying rice-based farming systems. The following trends have been observed:

- Farmers modify the way that they transplant depending on their specific conditions, especially the age of seedlings and spacing. They are keen to assess appropriate practices in plant management for themselves through experimentation.
- It is much easier to talk to SRI farmers about integrating green manure after and before the rice crop, and they are more ready to invest in growing green manure.
- Some farmers are developing simple tools for weeding, like small hoes and harrows. The concept of soil aeration through weeding, which contributes to improved root growth, is now well understood by SRI farmers.
- This year, two farmers started with zero-tillage, and there are more farmers becoming interested in the practice. Zero-tillage is possible since SRI makes the cultivation of traditional rice varieties that produce a lot of biomass for mulching attractive again. So far, we observe that rice growing under zero-tillage is doing well, even better than the normal practices.
- When farmers see that their rice yield is increasing, they are willing to use part of their rice fields for growing other crops and for raising fish. We call this a multi-purpose rice field, or the System of Intensification and Diversification (SID) of rice production. Earlier, they would not consider diversification, as growing less of the staple food, rice, was unaffordable.
- Some SRI farmers return to practices of mutual help in transplanting, because those they would normally hire do not have the skills to transplant as required by SRI. By pooling their labour they find they can get good and quick results.

Based on our experiences, the SRI approach contributes significantly to increasing farmers' innovative capacity, community learning and cooperation. Now, we see that ecological intensification of rice production through the small farmer group approach is a very good entry point to sustainable agriculture and rural development in Cambodia.

More information on the experiences in Cambodia can be found in the conference proceedings.

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plant extracts seem to be organic practices with good potential. Incorporation of a green manure crop either before rice (e.g., *Sesbania rostrata, mung bean or bush bean)* or after rice (e.g., jackbean) could work well with SRI. Researchers at the Tamil Nadu Agriculture University in India have good experience with sowing of green manure (S. rostrata) within rows of rice plants and incorporating it into the soil with a cono-weeder, 30 days later. They have developed a special drum-seeder for this purpose.

With wide spacing of plants in SRI, broadcasting of fertiliser is less efficient. Application of chemical fertiliser granules (as successfully used in Bangladesh) or compost near the plants can be more efficient. Flooding and adding chemicals can have a strong negative impact on soil life and may affect crop production, but a lot remains to be understood. More ecological learning is needed to find the best soil management practices. Research presented to the conference from Madagascar indica-ted that crop responses to compost are non-linear, i.e., there may not be greater benefits from applying 4 or 6 t/ha compared to 1 or 2 t/ha, as the smaller amounts appear sufficient to "incite" the biological life of the soil and give good crop results.

Land preparation. Good land levelling is important for getting best results from applying small amounts of water. At the same time, a proper drainage system for the field should be established so that alternate wetting and drying of the soil can be done effectively. With SRI, land preparation (puddling) does not differ from standard practices. There could be considerable saving of labour and energy by combining zero-tillage with SRI practice (both follow similar agroecological principles), but experimentation and evaluation on this remains to be done.

Raised beds, zero-tillage and direct seeding. One of the most promising adaptations of SRI appears to be the use of raised beds as being experimented with under the Rice-Wheat Cropping Systems Consortium in India and Pakistan (see LEISA Magazine Vol.16, No.4, pp.8-10). These beds are elevated 10-15 cm above the bottom of furrows in which irrigation water is intermittently issued. This can give water savings of 25-30%, with positive effects on yield due to soil aeration.

Some SRI farmers who have compared direct seeding with early transplanting found no difference in yield, but some saving of labour. Zero-tillage with mulching and direct seeding is practised with very positive results by farmers in, for example, Japan (Fukuoka), Sri Lanka (Nava Kekulama, LEISA Magazine Vol.13, No.3, pp.20-21), Nepal (LEISA Magazine Vol.16, No.4, pp.11), and Cambodia (Box 2). SRI was developed for irrigated lowland production, but some of its principles and practices could be extrapolated to rainfed areas. Some experiments in Madagascar, of direct seeding instead of transplanting, and using leguminous shrub cuttings as a mulch instead of mechanised hand weeding, have given good results (4 t/ha) in upland rainfed cultivation. This is a new direction for SRI research.

Ratooning. Some farmers in Madagascar let their SRI rice re-grow after harvest for a second crop. The yields are not as high as the first crop, 60-70%, but this is profitable since it saves labour otherwise required for land preparation, sowing and transplanting. In Thailand, some farmers do a second ratooning.

Pest management. With SRI, rice plants are well developed and healthy due to organic soil management, high soil quality and deep rooting, which makes them more resistant to pest and disease attack and drought. Other traditional, organic or Integrated Pest Management (IPM) practices could help to make SRI rice production even more pest and disease resistant.

Diversification, from monocropping to integrated rice-based farming. Some SRI farmers who have discovered that they can produce the same amount of rice on less land have started to diversify their rice farming systems by growing green manure or higher-value crops and trees on the land no longer needed for rice production. This provides a higher income and has some advantages for pest and weed control and for soil fertility management. Integration of fodder crops and improvement of animal production can be a next step. In fact, SRI can be an important entry point for developing integrated rice-based farming systems that combine high production and profitability with high resilience and ecological sustainability.

Adaptation and diffusion

SRI is a complex system, which implies many drastic changes of current farmer practices. To train farmers in SRI is not so difficult, but there could be various difficulties in practising it. It is not just a matter of diffusing a few standard practices but rather of spreading a more holistic understanding of how rice plants can be grown more effectively. As adaptation to local conditions is needed, **farmer experimentation** is an essential part of any strategy for the dissemination of SRI.

From a scientific perspective, precise and well-documented comparisons are needed, both to convince scientists and to gain a better understanding of the potentials and limitations of SRI. Standard systems of evaluation and statistical analyses are necessary for scientific credibility. As this does not always combine well with a process of group-based farmer experimentation, effective **methodologies for participatory technology development and assessment** can be very helpful (see for example LEISA Magazine Vol.15, No.1/2).

Adaptation and diffusion of SRI is a very strategic process. It is important to convince **top-level government people** of the efficacy of these new methods and where possible to get policy-level promotion. **Political backing** for SRI will probably be gained most quickly and strongly where there are enthusiastic farmers who support the methods based on their personal experience and who are able and willing to lobby on its behalf. Successful SRI farmers will certainly be more effective in talking to politicians than researchers.

There should be special strategies to convince **professionals** in agriculture, who often find it hard to accept this new methodology. The mention of super-yields attained with SRI (e.g., 21 tons/ha in Madagascar) is seldom believed by researchers even when yield component information is provided, so it may be best to *stress average yields*, not those that can be attained with best SRI practices.

As long as governments do not accept SRI, there is a need for **alternative strategies** of dissemination. Even where there is government acceptance, multiple avenues for evaluation and dissemination can be complementary. So far, **NGOs** have been most active in taking advantage of SRI potentials, particularly attracted to SRI for its pro-poor, environmentally-friendly features. **Farmer groups** often are very interested in experimenting with SRI and in providing farmer-to farmer training to their colleagues.

SRI could be combined well with **Community IPM** and **Farmer Field School** (FFS) programmes on rice as the philosophy of experimentation and human resource development is common. **Credit facilities** may be needed for purchasing tools, in particular weeders. These can be very cheap, but for poor farmers even small expenditures like this may be a barrier. This, in fact, is the only area in which SRI requires credit.

Conclusions still provisional, further information on internet

As most of the knowledge about SRI is quite recent, conclusions about it must remain provisional for now, pending more years of experience and wider utilisation of SRI in a greater variety of circumstances. Much research is still needed to understand the ecological processes involved and to develop a variety of best practices. More insight is also needed in the applicability and limitations of the approach and the possible risks involved. The initial results are, however, mostly very positive and give reason to suggest that more countries and more farmers should have an opportunity to evaluate SRI for themselves.

The proceedings of the First International Conference on SRI, including all papers, contact addresses, training materials and illustrations are accessible on an SRI internet homepage: **http://ciifad.cornell.edu/sri/** Printed and CD-ROM copies are also available on request. The internet will also be used for follow-up information and discussions. Please send experiences, both good and bad, and comments too!! SRI networks have been established already in Bangladesh, Indonesia and Philippines and are being set up in China, Sri Lanka and elsewhere.

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Photo : Coen Reijntjes

Prof. L.P. Yuan of the Chinese National Hybrid Rice Research and Development Centre explaining his experiments on SRI using super hybrid rice varieties and inorganic fertilisers. Yield of 12 to 16 tonnes are expected

Box 4. Experiences with diffusion of SRI

Several participants reported on how the process of diffusion has proceeded so far in their countries. These experiences differed considerably from one country to the next:

- In **Madagascar,** SRI was introduced first by an NGO, Association Tefy Saina, through training and farmer-to-farmer extension, supplemented by booklets and radio. Subsequently there was also some involvement from the university and government. But most farmers have still been hesitant to try these radically new production methods, and the spread has been slow. No exact statistics are available on the number of farmers using SRI methods. This is at least 20,000, but the Ministry of Agriculture has estimated the number could be as high as 100,000 (10% of rice cultivators). Use is accelerating now that a larger and better-equipped NGO, Catholic Relief Services, is involved in SRI dissemination, with donor support.
- In **Indonesia,** dissemination is just starting after three years of evaluation by government researchers. SRI methods have been incorporated into a new official strategy for raising rice production (Integrated Crop Management) that is being supported on a national basis, expecting to make appropriate local adaptations. This country's IPM programme is also starting to work with SRI as this is very consistent with the agroecological approach and dissemination strategy used in its Farmer Field Schools.
- In **Sri Lanka,** SRI is reported to be spreading fast. Dissemination started with an article on SRI experiences in Madagascar printed in the Ministry of Agriculture's extension magazine in 2000 (30,000 copies were distributed). A researcher from Madagascar, Joeli Barison, had visited Sri Lanka to share his knowledge on SRI in January the same year. Agricultural officers and extension workers who tried SRI on their own accord got good results. TV and radio became interested, creating a process of dissemination that could not be stopped any more. Rotary weeders, since long forgotten, have been reintroduced, with fabrication instructions spread among local blacksmiths. One ecological rice farmer, Mr. H.M. Premaratna, became the leading SRI farmer, trainer and promoter, transforming his farm into a training ground (Nature Farming Centre) where more than 4,000 farmers have been trained. Unfortunately, some researchers in Sri Lanka have remained opposed to SRI, and official endorsement for dissemination has not been obtained yet from the Ministry of Agriculture. The previous Deputy Minister has been very supportive and has used SRI very successfully on his own farm (up to 17 t/ha yield). The present Minister has declared SRI to be an important cultivation practice especially suited for small farmers. A green light from the government is expected once there is more research results to confirm existing findings. Opportunities to export organically-grown rice that uses SRI methods have also helped to raise interest in SRI among farmers.
- In **Cambodia,** the NGO CEDAC has been working with farmers to disseminate and innovate the SRI approach since 1999. CEDAC helps farmers to understand the principles of SRI and to analyse the practices that keep rice from achieving its full potential. Now there are at least 2,000 farmers actively experimenting with SRI.
- In **Laos,** some small-scale NGO experimentation and evaluation with farmers has begun. The International Rice Research Institute (IRRI) programme in Laos has now taken the initiative to launch a national evaluation starting in June 2002. It expects to do three seasons of testing before making recommendations, but some farmers are likely to start using it more quickly if the initial results are good.
- In **Cuba,** some top-level officials became convinced about SRI at an early stage as it meets the country's needs to raise rice production without reliance on petrochemical inputs. Dissemination can go very fast here because of farmers' literacy and their need to find ways of raising rice production without expensive inputs. The first sugar cooperative to try SRI methods on one ha of land got a yield of 9.5 t/ha as opposed to the usual of 6.6 t. The next season, it got 11.2 t/ha from its SRI field, and is fully persuaded of SRI's merits, even though it was not yet using young seedlings or doing any weeding to aerate the soil. Just changing the regime of water management and using wider spacing with single seedlings made a big difference. In the current season, when 12-day-old seedlings were tried on a small plot, their superior growth after 40 days has persuaded farmers to start utilising the full system next season.
- In **China,** SRI evaluations have been done at various rice research stations. Chinese rice scientists are very interested in SRI methods as they can increase the already very high yields of super hybrid rice varieties. They have concluded that SRI is a good way to improve rice production in China, especially given the need to reduce water demands. But certain adaptations will be needed to suit Chinese conditions, where labour costs are high and organic fertiliser material is in short supply. A next step will be to encourage farmers to try SRI methods for themselves. In Sichuan province, researchers have taken SRI already to six different locations (agroecological zones). Many innovations being made in rice production, e.g. triangular planting system, seed inoculation, paper frames for transplanting, intercropping with glutinous varieties for pest control, could be useful outside China as well.

SRI method of paddy cultivation

During 1980 – 1985 there was an acute scarcity for water in Madagascar (West Africa). Dr. Henri-de-Laulani, a Ph.D. in Agricultural Sciences, who was working as a Baptist Bishop, was in search of an alternative for growing paddy with less water. By utilizing only 35% of water, 50% of manuring and 5% of seed material, he was able to double the yield of paddy on his farm within 5 years by refining the practices. The neighbouring farmers were even able to increase the yield four times. In some cases the yield level increased from 20 – 30 quintals per hectare to 150 to 200 quintals per hectare (even with very poor quality of soils with 3.8 to 4.2 PH). This system has become very popular in many paddy-growing countries especially in Cambodia and Sri Lanka. However, this system if popularised in India, can provide the much needed relief to the state governments and the farmers, who are fighting for non existing river waters.

This system of rice cultivation, popularly known as System of Rice Intensification (SRI) or Madagascar method of paddy cultivation was tried out on half an acre of land. This method involves managing plant, water and soil in a cordial relationship rather than as a mere technology. Probably the existing technology of paddy cultivation seems to ignore the capacity and the characters of the paddy plant. A Japanese Agriculture Scientist Katayama had proved by his research earlier to Second World War that most of the seeds belonging to *gramineae* family (paddy is among them) could produce more than 100 tillers from one grain if they are provided with a conducive situation. Paddy has the capacity of doubling its tillers 13 times (*Phyllochrons*) during its vegetative growth.

Unfortunately, improper cultivation practices are being followed. For instance, raising paddy transplants in a thickly sown nursery between 4 to 8 weeks, transplanting densely in the main field in clumps (5 to 10 transplants in one clump) instead of single transplant at a spacing of 25 X 25 or 30 X 30 cms are being followed. Further, transplanting is done like "J" making the roots point upwards. This causes trauma as the roots need 12 to 14 days from transplanting to get the roots established to start growing. In such situations, 8 to 10 stages (*Phyllochrons*) of tillering is lost. Another practice is, submerging paddy field with 4 to 6 cms of water continuously from the date of planting till harvest. In fact, paddy is not an aquatic plant. It can survive and grow during stress compared to other crops belonging to *gramineae* family.

The practice of submerging the paddy field came to existence to check weed growth. Let us first understand the disadvantages caused by submerging.

1. The microbial population will be affected due to absence of oxygen essential for their survival in the soil during submergence. This in turn affects the conversion of soil organic matter into humus, the ultimate source of plant nutrition.

2. The nutrients, whether from organic or chemical source, percolate into the soil, much beyond the root zone (or *rhizosphere)* of paddy plant. Besides leading to wastage of plant nutrition, it pollutes ground water source too.

3. Since seedlings are densely planted in submerged conditions (55 to 60 clumps in a square meter), roots do not grow deeper and wider. Thus, cannot absorb nutrients from deeper zones.

4. As roots do not get sufficient oxygen, about 78 % of the roots get degenerated by the time of panicle initiation. Some of the existing roots even form *aerenchyama* (or air pockets). Pores in

Narayana Reddy on his SRI paddy farm

Photo : S Jayaraj

the leaves (blades) and stem have to absorb and supply oxygen to the roots.

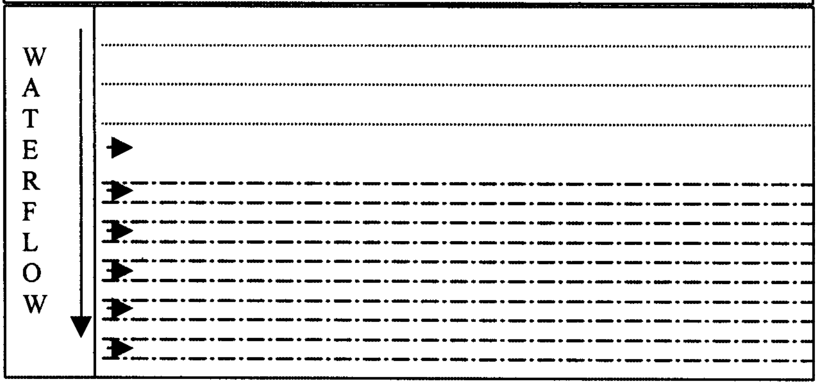
Dense planting does not provide enough light and air for the growing plants. They are increasingly susceptible to pests and diseases. Owing to prevalent practices, paddy plants do not grow healthily. They give very few tillers. The percentage of effective panicle eruption and grain filling in the conventional system is very little compared with paddy cultivated with wet and dry system of irrigation.

My method of SRI cultivation of paddy

Looking at the advantages of SRI, a new way of transplanting was tried out. 10-12 days old seedlings were transplanted to avoid trauma and also save labour. These were planted at a distance of 30 X 30 cms to provide additional opportunities for tillering. Rat damage is also less, if planted at such a spacing.

Half-acre paddy field was ploughed twice. 5 tonnes of good compost manure was incorporated with the third ploughing. The mud clumps were broken and land was prepared to form fine tilth providing 1 % slope for effective irrigation. Narrow strips of about 2.6 meters wide with bunds of 10 X 8 cms height were made on each plot of paddy field to speed up the flooding (as shown in the figure1). The field was marked to dibble paddy at 30 X 30 cms spacing. Paddy soaked for 36 hours (24 hours in water and 12 hours in gunny bag without water) was dibbled. However, paddy need not be soaked if one is not sure of irrigating paddy field within 10 hours of dibbling. In such cases, paddy can be dibbled without soaking and irrigating even after 2 to 3 days.

Figure 1. Method of irrigation



The paddy field was irrigated every 5 days for 25 days without taking up any other work on that land. On 28th day from sowing, weeding was carried out. At this stage, the whole field may look almost vacant because of very few seedlings compared to the regular dense planting. But every week, the number gets doubled. The 6th irrigation was provided on 30th day from sowing. There after, every 3rd day of each irrigation, a rotary weeder was used to avoid cracking of the soil, which would create problem in future irrigation and also cuts off the roots with wide cracking. This operation also helps in checking weed growth and most importantly churns the land to form fine tilth and provides plenty of air for the roots. This activity was carried out 7 times. By 80th day of sowing, on an average, 94 tillers were formed and by 90 days, 65% of panicles had emerged. After 80 days from sowing irrigation was provided every 2 days instead of 5 days as plants need more water during grain filling stage. Now you can stop using rotary weeder as the cracks do not develop because of excessive moisture. In most of the panicles there were 250 to 260 grains.

The only problem faced with this system of cultivation is root grub menace, cutting away many clumps of paddy. Because of very conducive situation of wet and dry condition in the soil, about 840 white grubs were dug out, by which time they had spoiled at least 15 clumps each. However, these root grubs can be controlled by the following ways:

1. Plant 10 or 12 neem branches (2 metres high and 1 metre wide) drenched with high dosage of pesticides for 4 days, soon after the first monsoon rain, so that most of the adult beetles can be killed before laying eggs in the soil.

2. Submerge paddy field for 2 days with 5 cms of water either before sowing or within 25 days after sowing so that root grubs are killed or eliminated from the paddy field.

3. Apply *Bivaneria brangniyarti,* a virus at the rate of 4 kilograms per acre during cooler period of the day. This virus is available with most of the sugar factories and is used to control root grubs in cane cultivation.

By conventional method, on an average, 9 to 10 quintals of paddy was produced from half acre land during the monsoon season. But, by SRI, the production was 18.5 quintals from the same area, utilizing only 50% manuring, 35% water and 5% seed material as compared to the conventional system of cultivation. Labour was saved to the extent of 20%.

If this system of cultivation could be adopted by farmers wherever possible, we could save water, protect soil productivity, save environment by checking methane gas from water submerged paddy cultivation practices, bring down the input cost besides increasing the paddy production providing food for the growing population. Hence the Agriculture Universities, Governments, NGOs and Farmers in particular should give more importance in popularising this useful system as much as possible.

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Tillers per plant in conventional method and in SRI

Photo : S Jayaraj

Information on soil micro-organisms

FAO Soil Biodiversity Portal

http://www.fao.org/ag/agl/agll/soilbiod/default.htm

This web page provides general conceptions on the meaning and significance of soil biodiversity, stressing the need for **integrated biological soil management**. It also provides a framework, under which soil biodiversity can be assessed, managed and conserved, showing examples of successful and unsuccessful practices that have been used in various regions of the world in managing soil biodiversity. Finally, an assessment of needs for further work, research, capacity building and policy and programme development is presented.

Worldwide portal to information on Soil Health

http://mulch.mannlib.cornell.edu/TSHomepage.html

The Gateway to Tropical Soil Health Information currently offers an extensive database of annotated resources on the World Wide Web, an on-line resource reference service, and classified resource listings for products, services, organisations, databases, literature and electronic discussion groups that have direct or indirect links to tropical soil health issues.

Information on Conservation Agriculture

FAO Conservation Agriculture Portal

http://www.fao.org/ag/agl/agll/prtcons.stm

This web portal provides an entry to the main information page on CA: "Intensifying crop production with Conservation Agriculture". Besides the introduction, it contains extensive information on the concepts and principles, on experiences from Latin America, Africa and Central Asia and on the environmental and economic impacts of CA. There are also web linkages to the main networks (e.g. on ACT. and RELACO see below), databases (e.g. CATechnology database see below) and organisations on CA as well as a report on the First World Congress on CA held in Madrid, October 2001. The information is available in English and Spanish.

Conservation Agriculture Technology database

http://www.fao.org/ag/catd/index.jsp

The CAT database lists commercially available equipment, which is specifically designed or is essential for the successful introduction of Conservation Agriculture. Special importance is given to small-scale equipment. The database addresses the needs of farmers, extension staff, technicians and others involved in Conservation Agriculture projects and anybody else interested in equipment for Conservation Agriculture, and where to obtain it.

ACT - African Conservation Tillage Network

http://www.fao.org/act-network/contact.htm

ACT Secretariat, c/o IES University of Zimbabwe, PO Box MP 167, Harare, Zimbabwe. Phone: +263-4-334395, Fax: +263-4-332853, Email: actsecre@africaonline.co.zw

The purpose of the network is to enhance the dissemination of conservation tillage in smallholder agriculture. Its main activities are: support to national networks; maintenence of an informative website and the ACT literature database; publication of an electronic newsletter "Act now" and a very good information series; organisation of topical working groups e.g. on green manure /cover crops, impact on soil quality, implements, dissemination approaches, curricula and training materials for farmers; workshops and pilot activities.

RELACO – Latin American Conservation Agriculture Network

http://www.relaco.cjb.net

Secretariat, c/o EPAGRI, Santa Catarina, Brasil. Email: relaco@epagri.rct-sc.br

The network links up persons interested in CA. It stimulates research and studies on CA and diffuses results. It organises seminars and training courses, stimulates activities of national networks and has published a wide range of documents and manuals on CA in Latin America. Its web site contains information (in Portuguese and Spanish) on important CA events and publications, and also its electronic circular. Information on RELACO in English can be found on the FAO Conservation Agriculture Portal (see above).

CD-ROM# 18 - Conservation Agriculture

This CD-ROM contains detailed information and literature on Conservation Agriculture that can help improve the knowledge base of those interested in this concept of sustainable agriculture. The CD-ROM provides technical staff as well as policy- and decision -makers with information and arguments for supporting, promoting and introducing Conservation Agriculture. For more information please contact: FAO, Land and Water (AGLL): jose.benites@fao.org or click http://www.fao.org/landandwater/lwdms.stm#cd18

Information on cover crops

TropSCORE The consortium for tropical soil cover and organic resources exchange

http://ppathw3.cals.cornell.edu/mba_project/moist/TropSCORE.html

The current members of TropSCORE are:

CIDICCO The International Cover Crops Clearinghouse, an NGO located in Tegucigalpa, Honduras. Operates in Spanish and English. **http://rds.org.hn/miembros/cidicco**

CIEPCA The Cover Crops Information and Seed Exchange Centre for Africa, a group hosted by IITA in Cotonou, Benin. Operates in French and English. **http://ppathw3.cals.cornell.edu.mba_project/CIEPCA/home.html**

CIIFAD / MOIST The Cornell International Institute for Food, Agriculture and Development's working group on Management of Organic Inputs in Soils of the Tropics. **http://ppathw3.cals.cornell.edu.mba_project/MOIST/home.html**

ECHO, a non-profit interdenominational Christian organisation that provides international agricultural development resources including publications and free seed of underexploited food, agroforestry, and soil-improving crop varieties. **http://www.echonet.org**

IDRC website on cover crops

http://www.idrc.ca/cover_crops/

IFDC-Africa has developed a decision support system for the use of legumes in West Africa: **Legumes, when and where an option?** Copies (in English and French) can be requested from the Programme for Integrated Intensification, IFDC-Africa, BP 4483, Fax: (228)2217817; Email: **ifdcafrique@ifdc.org**

Nitrogen fixation in tropical cropping systems by KE Giller, 2nd edition, 2001. CABI Publishing, Wallingford Oxon OX10 8DE, UK, Email: cabi@cabi.org ; 425 pp. ISBN 0 85199 417 2
GBP 60, Euro 97.10

A fully updated and up-to-date standard work on nitrogen fixation by leguminous plants.

LEXSYS Cover Crop Database on herbaceous legumes
http://www.iita.org/research/lexsys.htm

Information Support Project for Soil Fertility and Improved Fallow Management

Institute of Biological Sciences, UP Los Baños, 4031 College, Laguna, Philippines.

ISP aims at providing an avenue for exchange of information on soil fertility, fallow management and shifting cultivation in the upland areas of Southeast Asia and the tropics.

Major activities include:

- publication of **Soil Fertility Matters,** a newsletters on soil fertility and fallow management
- development of databases, e.g. on contacts, fallow species, related references
- establishment and moderation of an electronic discussion list forum **(Fallow Net)**
- networking

The newsletter is available in printed and electronic forms. A free printed copy can be requested from macandog@pacific.net.ph .The on-line version and the other information can be found on **www.icraf.cgiar.org/sea/ifm**

Information on Integrated Soil Fertility Management

International Fertiliser Development Center
http://www.ifdc.org

IFDC's goal is to increase agricultural productivity in a sustainable manner through the development and transfer of effective, environmentally-sound plant nutrient technology and agricultural marketing expertise. Its web site provides information regarding IFDC's programmes and projects, services available, publications, events, news releases, newsletters, training courses, events etc. For information on ISFM you have to go the section on IFDC-Africa

FADINAP

the United Nations Fertiliser Advisory, Development and Information Network for Asia and the Pacific. **http://www.fadinap.org** FADINAP provides assistance to developing countries in their efforts to increase food production by supporting the development of an efficient and effectively functioning fertiliser sector in Asia and the Pacific region. Its web site provides information on a wide range of fertiliser-related subjects: services, electronic newsletter, country gateways, market information and publications, among others on Integrated Plant Nutrient Systems.

Guidelines and reference material on Integrated Soil and Nutrient Management and Conservation for Farmer Field Schools

by Nabhan H, Bot A. and Roy RN. Publication Series: AGL/Misc/27/2000. Downloadable from **http://www.fao.org/landandwater/agll/oldocsp.jsp**

These guidelines provide a basic conceptual framework and supporting reference material for assisting in the development and implementation of effective FFS focused on Integrated Soil and Nutrient Management and Conservation. They are intended for use by FFS facilitators with a background in agricultural extension, agronomy, soil science, plant nutrition, soil conservation or land husbandry and for the production of country or local specific manuals and curricula. These should be adapted to the agro-ecological environment, the cropping/farming systems, and the socio-economic conditions and educational level of the farmers in the areas where the FFS are to be implemented.

On-farm composting methods

by Misra RV and Roy RN, 2002, 26 pp. Can be downloaded from **http://www.fao.org/landandwater/ agll/compost/default.stm**

This paper gives an overview of main composting methods used as a starter for the electronic conference on Organic Recycling conducted from May - August 2002.

DEVECOL a web-based information system for sustainable development

Development Ecology Information Service, 619 Upland Place,

Alexandria VA 2301, USA / hansfree@comcast.net
http://www.devecol.org

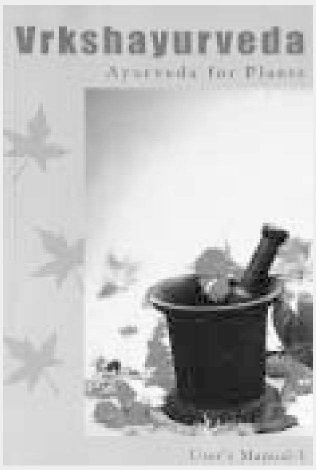
Devecol is an information system and resource designed for field workers in sustainable development who want to take advantage of relevant experiences in comparable environments elsewhere in the world. The information resources consist of geo-referenced documents, base maps and thematic maps. The documents are site specific case studies, evaluations, surveys and research reports, which are full text available as pdf files. The maps show the climatic zones and soil conditions of the area where the studies are located.

At the moment a useful information tool for sub-Saharan Africa is under preparation. This will have with information on projects and case studies, which can be accessed from their map locations. FAO maps of soil associations and climate can be displayed under these locations.

SOURCES

Waste composting for urban and peri-urban agriculture : closing the rural-urban nutrient cycle in Sub Saharan Africa by Drechsel P, Kunze D. 2001. 229 p. ISBN 0 85199 548 9 GBP 45.- IWMI, FAO. CABI Publishing, Wallingford, Oxon OX10 8DE, UK / cabi-nao@cabi.org ; www.cabi.org.

Urbanisation has created a major challenge with regard to waste management and environmental protection. However, the problem can be ameliorated by turning organic waste into compost for use as an agricultural fertiliser in urban and peri-urban areas. This is especially significant in developing countries, where food security is also a key issue. This book addresses these subjects and is mainly based on papers presented at a workshop held in Ghana by the International Board for Soil Research and Management (part of IWMI) and FAO. Special reference is given to sub-Saharan Africa, with acknowledgement to experiences from other parts of the world. Contributing authors are from several European and African countries. This book provides a number of case studies, technical information and an analysis of constraints for the use and production of composted waste.(WR)



Vrkshayurveda : ayurveda for plants by Sridhar S, [et al]. 2001. 47 p. Centre for Indian Knowledge Systems (CIKS), No 30, Gandhi Mandapam Road, Kotturpuram, Chennai 600 085, India / ciks@vsnl.com ; www.ciks.org. (User's Manual-1).

This user manual on Vrkshayurveda is focused on certain aspects of plant nutrition and pest and disease management. Vrkshayurveda is an ancient Indian science dealing with all aspects of plant life. This booklet begins with an introduction to the subject. It lists certain important farmers' practices and provides a rationale for these practices based on the theory of vrkshayurveda. One section is devoted to specific recipes for disease treatment, for increasing general resistance to diseases and pests and seed treatments for increasing crop growth and yield. Use of specific growth regulators based on vrkshayurveda is also recommended. The recipes that have been recommended are based on field trials carried out by the Centre for Indian Knowledge Systems.(WR)

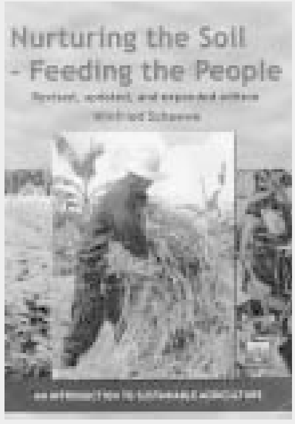
Participatory diagnosis of soil nutrient depletion in semi-arid areas of Kenya

by Gachimbi LN, Jager A de, [et al]. 2002. 15 p. NUTNET programme International Institute for Environment and Development (IIED), Drylands Programme. (IIED Managing Africa's Soils, ISSN 1560 3520 ; 26). Drylands Programme, IIED, 3 Endsleigh street, London WC1H ODD, UK / drylands@iied.org / www.iied.org/drylands.

This paper describes the participatory diagnostic process undertaken as part of a 5-year research programme aimed at developing improved land and water management techniques in semi-arid areas of Kenya. The study indicates that farmers in the drylands of Machakos are well aware of the precarious condition of their soil resources. Soil sampling and nutrient monitoring activities jointly conducted by farmers, extension agents and researchers have increased their understanding of the causes of soil nutrient depletion, and farmers now recognise that soil quality is gradually declining because current farming systems do not use enough inputs to replenish nutrient stores in their soils. The results of the described diagnostic phase have been incorporated into a second programme in which the same group of participants test and evaluate new techniques. We look forward to the results of that project. (WR)

Nurturing the soil - feeding the people: an introduction to sustainable organic agriculture: revised, updated, and expanded edition by Scheewe W. 2000. 277 p. ISBN 971 23 2895 3. Rex Book Store, 856 Nicanor Reyes, Sr.St., Manilla, Philipines.

This is an expanded edition of the book "Nurturing the soil", which we reviewed in 1993 in the ILEIA Newsletter. It is nice that there is a renewed version of this book for all who are interested in an overview of concepts and ideas on



sustainable agriculture. The book is written for extension workers and provides background information on soil management. The book helps to understand the important biological processes required in managing the soil sustainably. The author supposes that principles observed in nature can instruct farmers in the quest to improve farming practices. The book also provides basic information on agricultural practices that can improve the land, like mulching, composting, cover cropping, integrated pest management etc. The appendices contain important addresses and references for more detailed information. (WR)

An evaluation of strategies to use indigenous and imported sources of phosphorus to improve soil fertility and land productivity in Mali by Henao J, Baanante CA. 1999. 75 p.ISBN 0 88090 120 9. International Fertilizer Development Center (IFDC), PO Box 2040, Muscle Shoals, Alabama 35662, USA / general@IFDC.org ; www.ifdc.org.

This report is the result of a fertilizer research project conducted over several years in Mali as a collaboration between the government of Mali, through the Institute D'Economie Rurale, and the IFCD. Findings indicate that phosphate fertilisers are indeed needed for the production of food and cash crops and that Tilemsi phosphate rock is a suitable indigenous source of phosphorus for the sustainable production of important cropping systems in Mali.The report provides clear figures and a lot of data concerning soil fertility throughout the country, including economic evaluations. (WR)

Soil conservation in organic farming : handbook 1 : green manure, green leaf manure, biofertilisers by Jayashankar M, [et al]. 2002. 30 p. Centre for Indian

Knowledge Systems (CIKS), No 30, Gandhi Mandapam Road, Kotturpuram, Chennai 600 085, India / ciks@vsnl.com ; www.ciks.org.

During all stages, from seeds to harvest, agricultural crops take up a number of nutrients from the soil. The nutrients taken up by the plants during one season of cultivation should be replenished before the next sowing season. Only then can the nutrient level of the soil be maintained without depletion. Several practices are being followed to replenish these lost nutrients. This small manual gives an account of green manure, green leaf manure and the ways in which they could be used for increasing soil fertility. It also describes the different types of biofertilisers and their uses. The book ends with a list of Indian organisations supplying biofertilizers.(WR)

Dynamics and diversity : soil fertility and farming livelihoods in Africa : case studies from Ethiopia, Mali and Zimbabwe by Scoones I, (ed.). 2001. 256 p. ISBN 1 85383 820 9 GBP 16.95. Earthscan Publications Ltd, 120 Pentonville Road, London NI 9JN / earthinfo@earthscan.co.uk / www.earthscan.co.uk.

Ian Scoones is a well known expert in the field of soil fertility and small scale farming in Africa. With this new book on the subject he adds another important work to his list of publications. This book is based on research carried out by teams of researchers from Africa and Europe over three years in a range of contrasting locations. The research results add up to a new approach for looking at soil management issues in Africa, with significant implications for development policy and practice. They suggest a more positive view of the prospects for sustainable agriculture in small-scale farming systems in Africa than the overridingly negative views of crisis and collapse which have dominated the policy debate. The research also points to the need for developing new technologies and management practices which are suited to the diversity of farmer needs and settings, when addressing the challenges of natural resource management. (WR)

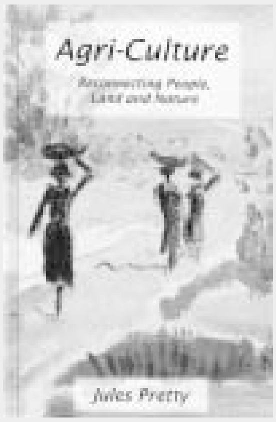
Resource conserving technologies : transforming the rice-wheat systems of the indo-Gangetic plains : rice - wheat consortium, a success story by Gupta RK, et al. (eds). 2002. 42 p. Asia-Pacific Association of Agricultural Research Institutions (APAARI), FAO Office in India, 55 Max Mueller Marg, New Delhi 110 003 India, Rice-Wheat Consortium for the Indo-Gangetic Plains, (RWC) Campus, Pusa, New Delhi 110 012, India : rwc@cgiar.org, www.rwc.cgiar.org. (APAARI Publications 2002/1).

Rice and wheat are two major crops in the Indo-Gangetic plains of South Asia comprising of Bangladesh, India, Nepal and Pakistan. Following an eco-regional approach, the Rice-Wheat Consortium (RWC), convened by CIMMYT, has been operating farmer participatory research programmes from a perspective of system's ecology. These research and development efforts with a focus on resource conserving technologies are being practiced by a larger number of farmers, and a tillage revolution is emerging in South Asia. This booklet provides an account of useful and successful research and extension initiatives. Farmers are practicing zero- and reduced tillage in more than 250 thousand hectares at the moment. The ILEIA Newsletter 16.4 carries an article on the Rice Wheat Consortium. (WR)

Manual on integrated soil management and conservation practices

2000. 220 p. ISBN 92 5 104417 1 downloadable. FAO, Land and Water Development Division and Research, Extension and Training Division, Viale delle Terme di Caracalla, Rome 00100, Italy / www.fao.org. (FAO Land and Water bulletin, ISSN 1024 6703 ; 8).

This manual serves as a guide for technicians and farmers to jointly discover ways to solve the problems and the limitations posed by land degradation in Latin America and Africa. It has been put together with the aim of assisting diverse groups of people who are intervening in the conservation of the natural resources, particularly soil and water resources and in the context of each continent, country or zone. The publication brings together a collection of concepts, experiences and practical suggestions that can be of use for identifying problems and for formulating, executing and evaluating actions so as to benefit and to improve the productivity and conservation of soil and water resources. The manual is based on the training course for soil management and conservation, focused on efficient tillage methods for soil conservation, held in Nigeria in 1997.



Available in English and in Spanish. (WR)

Agri-culture: reconnecting people, land and nature by Jules Pretty, 2002. Earthscan, London, earthinfo@earthscan.co.uk ; www.earthscan.co.uk .

'Agri-Culture' envisages the expansion of a new form of food production and consumption founded on more ecological principles and in harmony with the cultures, knowledge and collective capacities of the producers themselves. It draws on many stories of successful agricultural transformation in developing and industrialised countries, but with a warning that true prosperity will depend on the radical reform of the institutions and policies that control global food futures, and fundamental changes in the way we think. The time has come for the next agricultural revolution (author).

Agroforestry species and technologies : a compilation of the highlights and factsheets published by NFTA and FACT Net 1985-1999

by Roshetko JM (ed.). 2001. 231 p. ISBN 1 57360 032 6. Winrock International, 38 Winrock Drive, Morrilton, AR 72110-9370, USA / forestry@winrock.org

Taiwan Forestry Research Institute. (TFRI Extension Series no.138).

This booklet assembles under one cover 97 factsheets and highlights published by the Forest, Farm, and Community Tree network (FACT Net) and its predecessor NFTA. These bulletins are concise summaries of important information on tree species and agroforestry technologies suitable for many environmental and socioeconomic conditions. A large number of nitrogen fixing trees and actinorhizal trees is discussed in alphabetical order. The publication provides a species index but this is disappointingly incomplete. Still the booklet is a practical reference tool for everyone involved in agroforestry.(WR)

Bridging human and ecological landscapes : participatory research and sustainable development in an Andean frontier by Rhoades RE (ed.). 2001. 368 p. ISBN 0 7872 8473 4 USD 40.97. Sustainable Agriculture and Natural Resource Management (SANREM) / www.sanrem.uga.edu ; anthro@arches.uga.edu. Kendall/Hunt Publishing Company, 4050 Westmark Drive, Dubuque, Iowa 52002, USA.

This book is a synthesis of the rich results of an interdisciplinary research programme on sustainable agriculture and natural resource management conducted in the mountainous landscape of Nanegal Parish, Ecuador. The major themes of the book, and its individual chapters, aim to show how people and the environment have engaged each other over time to create the human and natural landscape of Nanegal. The authors demonstrate that the landscapes are as much a medium of ideas and imagination of the people who live there as they are physical realities. The landscape pervades almost every aspect of daily life, and its pervasive quality derives not only from the natural lay of the land, but from the multiple ways farmers have encountered, constructed and represented it over time. By integrating these visions of the landscape, distinct but complementary, this volume provides a guide map to a sustainable future for people living in the mountains and hillsides of the world. Also available in Spanish, editorial@abyayala.org.

Reorientation of extension : a case study of participatory action research with a Non-Government Organisation in Northern Nigeria by Ehret W. 1997. 275 p. ISBN 3 8236 1279 4. (Kommunikation und Beratung, Sozialwissenschaftliche Schriften zur Landnutzung und ländlichen Entwicklung 17). Margraf Verlag, Postfach 1205, 97985 Weikersheim, Germany / margraf@compuserve.com.

In this book, the author documents a reorientation process of five years which he accompanied as a participative action researcher in a NGO in Nigeria. First the methodology of extension was changed, followed by a reorientation of the entire organization. The introduction of increased participation effects all three levels of extension services, the community, extension workers and organisation. In the communities the number of self-help activities, initiated and accompanied by the extensionists, increased significantly during the research period. For the extension workers it was diffecult to apply participative methods successfully in the beginning. It took at least three years of intensive coaching to get them used to these methods and to get them feel at ease applying these methods. However, at organisational level it was observed that the transformation towards participative concepts was difficult and that participative measures could only be introduced to a certain limit. The reorientation process revealed that achieving participation at the extension/ client interface is easier than establishing participative management within an organisation. Also the specific situation of NGOs has been analyzed with the conclusion that NGOs lose their comparative advantages as they become bigger and, thus, more government-like.(WR)

The living plateau : changing lives of herders in Qinghai : concluding seminar of the Qinghai livestock development project

by Wageningen N van, Wenjun S (eds). 2001. 96 p. ISBN 92 9115 376 1. International Centre for Integrated Mountain Development (ICIMOD), G.P.O. 3226, Kathmandu, Nepal / icimod@icimod.org.np / www.icimod.org.

The living plateau is about interventions by a development project for the improvement of the livelihood of sheep and yak herders on the Quinghai-Tibetan Plateau, China. The document takes stock of rangeland and livestock resources and describes the socioeconomic situation of herders. It summarises the outcome of field trials and technical interventions in the area of rangeland rehabilitation, the control of rodents, rangeland revegetation, seeded perennial forage and cereal fodders, the control of parasites in yak and sheep, and the control of young stock diseases. It further addresses the experiences of disseminating findings through extension services, and it reviews extension, including experiences with participatory rural appraisals. This small but concentrated document is a valuable information source because it contains the critically reviewed findings and lessons learnt from a large development project. (WR)

The real green revolution : organic and agroecological farming in the south by Parrott N, Marsden T. 2002. 147 p. ISBN 1 903907 02 0 EURO 12.- or downloadable. Greenpeace Environmental Trust, Canonbury Villas, London N1 2PN, UK / www.greenpeace.org.uk/ realgreenrev.htm.

Greenpeace has launched an advocacy report for agroecological farming techniques, meant to contribute in the debate on the future of agriculture. The agricultural approach described emphasises the importance of using locally available resources and building agro-biodiversity to create productive and resilient agricultural systems. The report provides evidence from around the globe of the successes of the agro-ecological method: increased yields, enhanced food security and inproved incomes. Recommended for policy makers and organisations involved in advocacy of sustainable agricultural development. This report is downloadable as html file from our website.(WR)

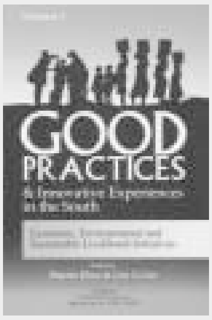
Ethnoagricultural development ; building on the strengths of indigenous beliefs and practices by Cooten DE van. 2001. 191 p. ISBN 1 876862 60 2 AUD 35.00. Kingdom Kookas Publishing, P.O.Box 133, Sanderson 0813, Northern Territory, Australia / winkent@optusnet.com.au.

Donald van Cooten has investigated the indigenous shifting, slash and burn agricultural systems in South Eastern Indonesia from a development point of view. In his book he concludes that ethnoagricultural development is the process of facilitating sustainable, agricultural development in the context of indigenous beliefs and practices. Agricultural development needs to proceed through the traditional religious leaders and bring about an indigenous enrichment movement. He sees the role of outside organisations in supporting and strengthening indigenous leaders and their communities.

This book provides necessary information on the indigenous people of the region and their sustainable, low external input agricultural systems. Agricultural development efforts should be aimed at ensuring sustainable production within the present systems. To make this possible studies like this one are needed, but a more participatory approach is also needed.(WR)

Securing tomorrow's food : promoting the sustainable use of farm animal genetic resources : information for action by Geerlings E, Mathias E, Köhler Rollefson I. 2002. 89 p. League for Pastoral Peoples, Pragelatostrasse 20, 64372 Ober-Ramstadt, Germany / www.pastoralpeoples.org ; gorikr@t-online.de.

Farm animal diversity is vanishing at an alarming rate. As industrial livestock production expands, it is relying on fewer and fewer breeds. We are coming to depend on a livestock population with a dangerously narrow genetic base. Locally adapted animal breeds carry genetic material of immense value. These breeds must be conserved. The only realistic way to do so is by maintaining the production systems they are part of, by supporting the small farmers and pastoralists who manage these animals. The goal of this dossier is to stimulate policy makers, project staff and members of grassroots organisations to support, in their policies and actions, the sustainable use and community-based management of farm animal breeds. Important information, free available.(WR)



Good practices and innovative experiences in the south : vol 1 economic, environmental and sustainable livelihood initiatives by Khor M, Li Lin L (eds). 2001. 260 p. ISBN 1 84277 129 9 GBP 15.95.

Good practices and innovative experiences in the south : vol 2 Social policies, indigenous knowledge and appropriate technology by Khor M, Li Lin L (eds). 2001. 215 p. ISBN 1 84277 131 0 GBP 15.95.

Good practices and innovative experiences in the south : vol 3 Citizen initiatives in social services, popular education and human rights by Khor M, Li Lin L (eds). 2001. 260 p. ISBN 1 84277 133 7 GBP 15.95.

Third World Network, UNDP. Zed Books, 7 Cynthia Street, London N1 9JF UK / hosie@zedbooks.demon.co.uk.

United Nations Development Programme has collected a valuable number of case studies from developing countries all over the world. These case studies are gathered in three volumes of "Best Practices" for sustainable rural development. The aim of these books is to contribute to the exchange of these appropriate experiences between the different countries.

The described practices and experiences have been successful in solving environment, social and development problems. They cover the governmental sector as well as private and social institutions, NGO's and local communities.

Each case study is extensively described, with detailed information on contact persons and background, mentioning the results and problems faced, and possibilities for upscaling.

The topics cover a variety of issues in policy, agriculture, economic, livelihood and gender. These books are recommended for everyone who is involved in sustainable development.(WR)

Ber (Ziziphus mauretania) by Pareek OP. 2001. 291 p. ISBN 854327525 GBP 15.- free of charge for developing countries. International Centre for Underutilized Crops, University of Southampton, Southampton SO17 1BJ, UK / A.Hughes@soton.ac.uk.

This monograph on the tropical fruit trees Ber and Chinese jujube, both Ziziphus species, provides thorough information on production, processing, marketing and utilisation of these species. Tropical fruit trees are important crops which can supplement and improve the quality of diets. Ber is a multiple purpose tree that produces non-food products like fuel, timber and leaf fodder together with a valuable fruit crop. Ber is cultivated all over the drier parts of the Indian subcontinent for its fresh fruits, which are rich in vitamins and minerals. It can be successfully cultivated even in the most marginal ecosystems of the subtropics and tropics. The tree propagates freely and greatly resists recurrent drought. It is thus an important tree suitable for integration into agroforestry systems of warm desert ecoregions. The tree can help in economic sustenance and insure against ecological degradation. Chinese jujube is cultivated in the drier parts of China; it can tolerate very low temperatures and is thus suitable for growing in colder regions.

This book is intended for researchers, students and NGO's. It is written in a rather scientific manner and completed with a list of "ber" experts and a seed suppliers directory. An extension manual for dissemination to farmers, field workers and policy makers is in preparation.(WR)

Participatory communication and adult learning for rural development by Coldevin G. 2001. 36 p. Food and Agriculture Organization (FAO), Sustainable Development Department, Extension, Education and Communication Service, Viale delle Terme di Caracalla, 00100 Rome, Italy / loyvan.crowder@fao.org.

Gary Coldvin has written this review paper on participatory communication and adult learning for rural development. The purpose of the publication is to provide an overview of the FAO Communication for Development Group's work as practitioner of applied communication for agricultural development over the past thirty years. During this period the role of communication has shifted from a one-way, top-down transfer of messages to a social process with a two-way sharing of information among communication equals, participatory communication. By seeking the views of the rural people themselves and involving them from the start of a project, participatory communication has become an important tool for successful implementing development initiatives. This paper provides a number of examples and cases drawn from FAO's field programmes and a lessons learned section.(WR)

Farmers and plant breeders in partnership by Hanacziwskyj P (ed.). 2001. 28 p. Department for International Development (DFID), Plant Sciences Research Programme, University of Wales, Thoday Building, Bangor, Gwynedd LL57 2UW, UK / dfid.psp@bangor.ac.uk ; www.dfid-psp.org.

Participation allows plant breeders and farmers

to learn from each other. In this paper of the Plant Sciences Research programme of DFID, advantages of the participatory approach are illustrated by examples of successful projects on participatory varietal selection and participatory plant breeding in Ghana, India and Nepal. In this research programme, farmers in developing countries are involved in the breeding, selecting and testing of new plant varieties. Such participatory crop improvement identifies or creates varieties to suit local needs, as well to marginal as to high-potential production systems.(WR)

Experiments with spiders, ants and other indigenous practices

K.J.N. Gowtham Shankar

Photo : K.J.N. Gowtham Shankar

Some tribal communities are using social spiders (Stegodyphus sarisinorium) to control stem borers in paddy fields.

IDEA is a NGO working with tribal people in the northern Ghats in India. IDEA is a partner organisation in the COMPAS Programme for Endogenous Development (see LEISA Magazine Vol. 17, No2, p15).

During documentation of tribal indigenous knowledge in 1992, we found that some tribal people use spiders to control stem borers in paddy fields. This was interesting but needed further analysis. We identified the spider as Stegodyphus sarisinorium - a social spider. The spider is called differently in the local languages - Patmakidi in Oriya, Salepurugu in Telugu, and we call it Bulu. We also found that using spiders for pest control is an age-old practice of a specific tribal community - Nooka Dora - of Andhra Pradesh and Orissa, border villages in the north eastern Ghats, India. However, the knowledge was almost dying out as only 5-6 families were practising it in a remote village and that too only in paddy fields. We stimulated some young tribal farmers and senior farmers to conduct several small and simple experiments in the research centre of IDEA, which proved to be very effective. Based on the results, we did further experiments together with farmers in different villages for validation by the community. These were also successful. Then, we designed a systematic process for participatory action research and started studying various aspects of this spider - its habitat, feeding habits, breeding biology etc.

Simultaneously, we experimented with Bulu on horticulture crops (guava and pomegranate), vegetable crops (brinjal, ladies finger, cabbage, cauliflower and chilli) and floriculture crops (roses). We found out that this spider can successfully control fruit borers and mites in these crops.

This study helped us to disseminate the knowledge gained among more tribal communities and farmers. We developed training material on the experimentation and propagation techniques of Bulu and provided training to more than 500 farmers for conducting further on-farm experiments on different crops in their villages together with other farmer families.

The knowledge vested with just 5-6 families of a single community has now spread to more than 2000 farmers of 6-7 communities. It is spreading further to other areas due to regular farmer network interactions and farmer-to-farmer knowledge exchange, which we are facilitating through ongoing projects.

Control of black ants with domestic red ants

We also found that some of the Konda dora tribal farmers control black ants with tiny domestic red ants in their Jawor fields. Mountain farmers face a severe threat from black ants, which eat away the tender Jawor grains and damage the crop. Some of the senior farmers collect these domestic red ants from their houses and drop them in the fields affected by black ants. These red ants eat the eggs of black ants laid around the Jawor plant roots and attack the black ants. The black ants leave the fields within hours. We found this particularly simple technique of using red ants to control black ants very effective.

IDEA's research staff further tested this with other farmers for validation in different villages. The results were successful. We have systematically documented this knowledge and trained farmers in promoting it widely in other areas. Now, many farmers in the mountain villages are using this technique to control black ants in their Jawor and maize fields.

Experiments with botanical pesticides

We also did several experiments with indigenous knowledge of tribals on botanical pesticides. Thus, we have revived the use of many of these botanical pesticides. ■

Our tribal farmers' networks would like to interact with farmers of other countries for mutual exchange of information on indigenous knowledge and endogenous development approaches. We will be happy if you send your comments and suggestions to the following address

K.J.N. Gowtham Shankar, IDEA,
Flat No.6A, Maharaja Towers,
R.K. Mission Road, Visakhapatnam 530 003
Andra Pradesh, India.
Email: gowtham_shankar@hotmail.com

Themes for the LEISA-India

Vol. 6,2, June 2004

The next generation farmers?

Today rural communities are increasingly affected by external influence and rapid change. These processess affect the economic situation, change traditional cultures and particularly influence the younger generation. Are the communities still able to transmit the knowledge and values needed to build a livelihood in agriculture? Or is agriculture and rural life under such pressure that the older generation, perhaps even unconsciously, encourages their children to look outside farming for a future - even though this will deprive the community of one of its most valuable resources, its young people.

This issue of the LEISA Magazine will look at the situation and expriences of children and young people growing up in small-scale farming communities in the South. What livelihood opportunities are available to the younger generation? To what extent does society at large, or formal institutions help young people to develop the skills they need to tackle the problems of living? Do farmer training schemes and other development projects address the needs of the younger generation? What role do they play within their communities and what effect do their initiatives have on the natural resources, productivity and sustainability of the agricultural communities to which they belong?

We are interested in receiving contributions that describe initiatives and interventions that encourage and support rural youth who wish to stay in the rural areas and build their future in these surroundings.

Deadline for contributions is 30th April 2004

You are invited to contribute to these issues with articles (about 800, 1600 or 2400 words + 2-3 illustrations or photographs), suggest possible authors and send us information about interesting publications, training courses, meeting and websites..