october 1994 volume 10 no.3

ILEIA NEWSLETTER

FOR LOW EXTERNAL INPUT AND SUSTAINABLE AGRICULTURE

WASTES WANTED

ILEIA
NEWSLETTER

october 1994
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The ILEIA Newsletter is a publication of the Information Centre for Low-External-Input and Sustainable Agriculture (ILEIA), Kastanjelaan 5, PO Box 64, NL-3830 AB Leusden, Netherlands. Tel. +31-33-943086; Telex 79380 ETC NL; Fax +31-33-940791; e-mail ileia @ antenna.nl *or* ileia-nl @ geo.geomail.org

SUBSCRIPTIONS Individuals and organisations in the Third World and students: US$ 13.75 or DFL 27.50/year. Others: US$ 27.50 or DFL 55/year. Payment by direct bank transfer to RABO Bank Leusden, Account No. 3359.44.825 (or to this account via Postal Account No. 27.81.35), or by cheque (if Eurocheque, in DFL) made payable to ILEIA, mentioning "ILEIA Newsletter". Third World organisations may ask to receive the Newsletter free of charge.

CONTRIBUTIONS Articles, short communications and news items should be written in easy-to-read English. Articles should be less than 1200 words long, and should include at least 2 illustrations. Authors of published articles will be paid DFL 165 per printed page. A guideline for preparing articles can be obtained from ILEIA.

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ILEIA (Information Centre for Low-External-Input and Sustainable Agriculture) was established in 1982 by the ETC Foundation and is funded mainly by the Netherlands Ministry of Development Cooperation. Project funds are assured till early 1999.

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

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

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

ILEIA seeks to reach these objectives by operating a documentation centre; publishing a quarterly newsletter, bibliographies, resource guides etc; holding international workshops; and supporting regional networks in the Third World.

COVER PHOTO: A boy is looking for valuable wastes on Smokey Mountain, Manila, Philippines. Photo: Bart Eijgenhuijsen/Hollandse Hoogte.

WASTES NOT ALWAYS WANTED

While working on this issue of the ILEIA Newsletter, we got alarming news from environmental groups in India: "Dutch and Indian businessmen are making plans to resolve the waste problem of Dutch agriculture by shipping excess manure to India!" On 10 September, Dutch newspapers highlighted protests of angry Indian farmers in New Delhi, saying: "We have enough dung in India. Manure from the Netherlands may bring diseases, parasites, hormones and heavy metals. It will compete, like chemical fertilisers, with local sources of nutrients. Dutch agriculture should solve its own problems." This plan to recycle wastes around the world, just as the ever increasing exports of agricultural products, shows the widening distance between producers and consumers. The growing accumulation of organic wastes in cities is a reflection of the same problem. What are the environmental and social effects of this widening gap? Can the world really afford such a transport economy? In our opinion, products and wastes should be cycled locally as much as possible. In this ILEIA Newsletter we brought together some inspiring examples to optimise the use of locally available organic wastes.

the editors

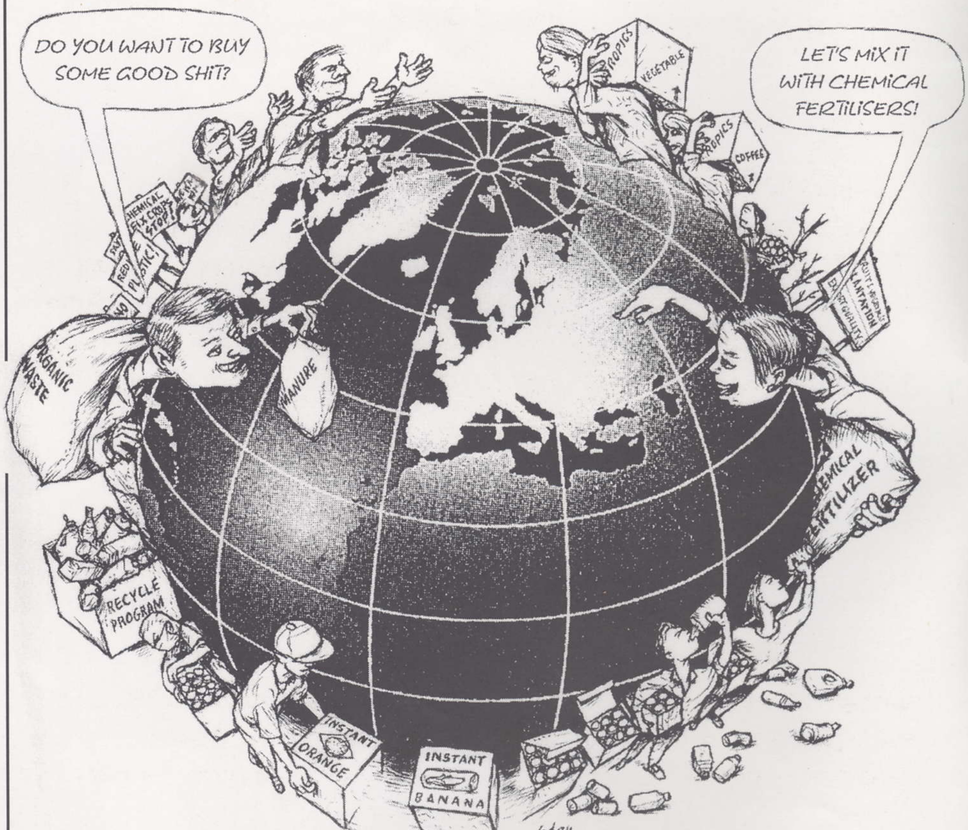

Photo: Bo Ling

Recycling urban night soil

Since ancient times, the nutrient flow to Chinese cities has been brought back to the land. However, when rural life drastically changed after 1979, it was difficult to collect and transport human wastes. Nowadays, farmers rediscover the value of night soil and village level treatment in biodigesters will make safe handling possible.

Modified anaerobic composting

As part of an integrated organic farming system, Mr. K.T. Thomas Kuruvinnakunnel in India developed a modification of common composting methods. He received the Indian "Award for Sustainable Agro-technologies" for this innovation. Some small farmers in the area have started adopting the system. But maybe it is more practical at community level?

Drawing bioresource flows

Biological resources, wastes and by-products are indispensable for the ecological and economic sustainability of the farm. But how to increase relations between farm enterprises? A drawing made by farmers themselves can be of great help.

Photo: Jagdish Nazareth

Photo: Chris Pennarts.

"I was extremely surprised to find out that farmers hijacked the governmental trucks that emptied septic tanks. They paid the drivers around 2000 cedis, directed them to their farms, and let the night soil pour over their fields. For me this meant that the need for nutrients was high because of the aversion people normally have for human waste. In the Tamale region in Ghana, all organic waste products from cotton ginneries, abattoirs and municipalities are being collected and used since the last 1-2 years" (Cinty Visker p 13).

Wastes wanted

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"Modern" farming techniques have brought about considerable change in agriculture. For example, by using chemical fertiliser, it was possible to raise soil fertility and hence productivity, without the hard work of recycling organic waste. This made it possible to increase market production to satisfy the demand of the fast growing urban population and export. Now, enormous amounts of agricultural produce are brought to the cities but only small amounts of urban organic waste are returned. As it is less costly, urban waste is often dumped in landfills and waterways where it contributes to pollution and degradation of river and coastal ecosystems. Deforestation and soil erosion, also a result of degrading traditional agricultural systems, add to this problem. This linear flow of organic matter, nutrients and silt away from the land is only partly compensated by a return flow of chemical fertiliser, mainly NPK. The result is degradation of agricultural land, nutrient mining and nutrient imbalances which are showing in the decline of productivity in many regions of the tropics. If sustainability is the objective, these linear flows of soil fertility have to be turned into circles again. This will not be easy as the causes, like the serious gap in scientific thinking about soil fertility management, the increasing distance between producers and consumers, the lack of funds to cope with the growing waste problem and the inadequacy of the economic system to deal with environmental problems, are inseparately linked with modern economies.

The tide is turning

However, due to adjustment policies and trade liberalisation, in many countries in the tropics, subsidies on chemical fertiliser are being withdrawn. For "modern" farmers who operate just above the economic bottomline this can mean that chemical fertiliser becomes too expensive and that they have to join the majority of farmers who use nearly only natural fertiliser. Farmers who are still well above the economic bottomline are also getting interested in alternative, cheaper sources of nutrients. This development is strengthened by a growing awareness that organic matter is indispensable to keep the soil productive. This explains the increasing interest in organic "waste" as demonstrated by farmers in Tamale, who even hijacked trucks with nigthsoil and by the researcher of International Fertiliser Development Center, who noticed this incident while surveying the stock of organic "waste" in Ghana. Changing practices and increasing awareness start to turn the tide. Still a lot of work has to be done, like making people understand and accept the need for sustainability. Producers and consumers have to be brought closer together so that circles can be closed again. Integrated farming and landuse systems which make optimal use of these circular resource flows have to be rebuilt.

This issue of the ILEIA Newsletter focuses on recycling of organic waste, at urban as well as farm level. To what extent is organic waste used and brought back to the land? What are major constraints to bend the linear flows of the organic matter and nutrients? What are promising experiences to make recycling of organic waste more efficient and profitable? How can development workers support farmers to analyse the resource flows in their own landuse systems to optimise the productivity and sustainability of these systems?

Quantification needed

The articles by Lardinois and Van de Klundert (p6), by Owusu and Visker (p12) and Bo (p10) give some indication of the large quantities of organic waste and nutrients that are involved. However, they do not give a complete overview of all organic matter and nutrient flows in agricultural production, trade and waste management. Quite a lot of organic matter and nutrients are circulated within the system but also quite a lot are lost in the environment. In the end all external nutrient inputs, like all chemical fertilisers, become wastes or losses that can pollute production systems. But, *to what degree* can recycling of organic wastes still be increased and losses prevented to reduce the use of external inputs and pollution? Locally, quite a lot of organic waste is already being used as feed for animals and fish, as source of energy or for compost making. We also get the impression that in many countries there is still ample scope for reuse. However, complete recycling may not be possible. The efficiency of reusing organic waste at field and farm level is often very low, although losses may be used again somewhere else in the production chain. Better quantitative insight in these flows and losses of organic matter and nutrients is needed.

Limitations

The articles show that there are important limitations to recycling. Labour and transport costs are considerable constraints. These costs make that city compost often has to deal with strong competition from chemical fertiliser, especially when further away from the cities. The study presented by Lardinois and Van de Klundert shows that in Asia city compost is only used within a circle of 25 km around the cities. Also other products of waste conversion, like biogas (Guiking, p14), can lose the economic competition.

Compost making is often not interesting enough to farmers due to its low labour productivity. But by using, for example, micronutrients to boost the value of compost (Nazareth p18) or by using a specific fungus (*Trichoderma harzianum*) to speed up composting, the process draws the attention of farmers again.

Sanitary problems related to handling waste material, pollution of organic waste by chemicals and heavy metals, technical and organisational problems and cultural taboos related to waste handling can be serious constraints too. Lardinois and Van der Klundert even pose that urban waste recycling in low-income countries is in crisis. The technology for large-scale waste processing imported from Europe does not work. Small-scale, labour intensive alternatives are preferred.

Ample scope for innovations

There is clearly ample scope for appropriate innovations to improve urban waste conversion. But also by south-south exchange (Lardinois and Van de Klundert) effective practices may get wider circulation.
Also at farm level there are many opportunities to make better use of organic waste from internal as well as from external sources. In this newsletter some cases are presented. In India, Mr. Nazareth (p18) had very good results with "Micronutrient Fortified Compost". In his region Farm Yard Manure (FYM) is not well cared for due to the low value given to it and widespread micronutrient deficiencies. By composting FYM and adding micronutrients, yields were boosted. Mr. Bhawalkar (p20) is doing research on commercial use of earthworms for processing organic waste and improving soil productivity. He found that vermicastings can replace the use of chemical fertiliser in a profitable way. Similar positive results are experienced by small farmers in Ecuador. Mr. Landin (p9) reports on their experiences with garbage recycling by farming earthworms. Mr. Kuruvinakunnel (p16) developed a new type of biodigester based on a combination of aerobic and anaerobic processes to increase the efficiency of reusing organic waste on his farm.

To improve these techniques, to make them applicable in other situations as well and to analyse their economic and environmental impact, still a lot of research is needed. But are research institutes really interested to get involved in such unconventional techniques? How can the necessary political and cultural reorientation be stimulated?

Biotechnology

It is not a coincidence that all these cases are based on harnessing microorganisms as these organisms play such an important role in decomposing organic matter. The development of biotechnology for waste conversion and soil fertility management probably has a bright future. Professor Teruo Higa from Japan devoted his scientific career to this subject. By isolating and selecting different microorganisms for their beneficial effects on soils and plants he developed a set of soil inoculants which he calls Effective Microorganisms (EM). EM seems to be very successful in increasing the efficiency of organic as well as chemical fertiliser. A fast growing network of research institutes (Asia-Pacific Natural Agriculture Network, APNAN) in Asia but also in the USA, Europe and elsewhere, is now involved in testing and further development of EM. Mr. Hussain (p15) reports on EM research and development in Pakistan.

Food chains

Decomposing organic waste takes place via different "food chains". Some of the products of these food chains even have a high economic value. For example, by processing organic waste in a biogas digester instead of composting, valuable biogas can be obtained. But organic waste can also be used to feed fish after it has been used to feed cattle, pigs or ducks or to feed earthworms after it has been used to produce mushrooms. Each consumer uses only part of the nutrients available and leaves enough for the next consumer who has different food needs and different possibilities to get what it needs. Fish, cows and mushrooms are all valuable products. Moreover, in all production processes a by-product is high quality organic fertiliser which can be used again to grow crops, e.g. to feed the first consumer again. Which "food chain" is most profitable and fits best in a farm system depends on the economic situation and the availability of labour, capital and skill. In the more complex systems a larger part of the energy and nutrients of the waste is used and losses of energy and nutrients to the environment are relatively low. However, to know exactly which "food chain" is most effective and profitable, the whole circle of production and consumption including human beings as producers and consumers has to be analysed.

Resource flow analysis

On farms, resource flows are often not in balance or optimum use is not made of the available resources, like organic wastes, water, energy, labour and funds. Different options for better use of resources have to compete with each other and existing practices for scarce labour and capital. To analyse how available resources can be used more profitable or in a better balanced way, analytical tools such as bioresource flow diagrams (Lightfoot, Prain and Lopez, p22) and/or computerised analysis of the nutrient balance (Chinnakonda p24) can be helpful where farmers and scientists work together. A limitation of these analytical tools is that they focus on only one resource flow. However, farms are complex systems in which different resource flows interact and are influenced by many different aspects, technical as well as economical, social, cultural and political. It is still not possible to include all the interactive processes and conditions in one computer model. Therefore the experience, reasoning and intuition of farmers never can be missed in such an analysis.

■

Photo: WASTE Consultants

Recovery of organic waste in cities

In many cities in low and middle income countries, municipal refuse collection and disposal services are woefully inadequate and thus, waste accumulates in the streets and at transfer stations. Large scale high-tech recycling projects have failed because installations were too complicated, too expensive to run and not suited for local conditions. Consequently, some facilities have been closed down and many operate well below their planned capacities. Alternative methods are sought to utilise this important resource more effectively.
At the request of the Undugu Society of Kenya (USK), a comprehensive research was carried out (1991-1993) in Africa and Asia to study options for solid waste recycling appropriate for small-scale enterprises. Organic waste was one of the ten materials researched.

Inge Lardinois
and Arnold van de Klundert

Organic waste can be used for compost making, raising animals or fish and as a source of energy (see boxes). All options are very common in low income countries. In Lahore, Pakistan, for example, 40% of urban refuse is collected by farmers and used as animal feed and soil amendment. Direct reuse of organic waste as fuel for home cooking is quite common too. Woody residues such as coconut shells are frequently used when oil based fuels are either too expensive or too difficult to get hold of. To a limited extent, organic waste is also used by small entrepreneurs to make and sell compost. For example, in Bamako, Mali, compost is made at the dump sites by sieving decomposed waste materials. Mainly due to simple and cheap technologies and absence of transportation costs, entrepreneurs earn about three times the minimum wage (see box).

From the viewpoint of environmental management and healthcare, collection and disposal of waste is usually considered to be the responsibility of the government. However, now that municipalities have to admit that capital-intensive options often did not work, the importance of the informal sector is slowly recognised and valued.

Community involvement

As a city grows, so do the distances between the areas where waste is generated and the dump sites. Transport costs are increasing and land for enlarging dumps is scarce. There is a need for decentralised systems and ways to integrate public and private initiatives. Besides supporting private companies, one alternative could be to set up resource recovery centres that can be operated and managed by community members. Waste disposal cannot be the sole responsibility of municipalities. Those generating waste also have a contribution to make. However, community involvement is not always easy. For example in Calcutta, efforts have been made to separate organic materials from other waste right where it is generated, particularly at municipal markets. Unfortunately, neither households nor markets could be convinced to do this. For the residents of low income areas, waste removal is rarely a priority. Their lives are dictated by an economy of survival. Therefore the approach taken should emphasise the economic benefits. The increasing value of waste materials could provide an incentive for individual families to separate and save or sell certain items from their garbage. Enterprises involved in resource recovery hold the double promise of obtaining economic returns and improving health conditions. Organised on a cooperative basis, such schemes allow the community to retain control over the profits generated. These benefits could be particularly important for women. Because of their responsibilities within the household, they are most likely to participate in community waste recovery activities. (see box).

Costs and benefits

On the cost side of waste recovery there are four main categories: raw material costs, production costs, distribution costs and hidden costs. The benefits include market value of products and by-products, opportunity savings and hidden benefits. Assessment cannot solely be done on a commercial basis, since other hidden positive and negative effects, for example on the environment, also need to be taken into account. There is no agreed methodology for quantifying these effects, so economic comparisons of different recovery systems are difficult.

The costs of composting organic waste are largely determined by the technology chosen. With simple hand tools and locally made equipment the production capacity is limited (2-3 tonnes/day) and investment and processing costs are low. More capital-intensive mechanised options will substantially increase production capacity (10-100 tonnes/day) and need fewer personnel and less space. The initial unit costs of production will be high, but they will gradually decrease as the capacity is more optimally utilised. A comparison of the cost effectiveness of different composting methods in India has shown that unit production costs of manual composting methods vary from one to five US$ per tonne organic material, as compared to about 11 US$ per tonne for mechanical treatment. Therefore, small-scale manual composting methods can be cost effective, whereas mechanised methods cannot.

Resource recovery in low-income countries provides many jobs. Although income is usually minimal, some traders and reprocessors have managed to set up a viable business, making reasonable profits. But, in terms of finances, not all organic waste recovery activities are cost effective. One of the bottlenecks in organic waste processing is the marketing of end products, especially compost. High transportation costs limit the use of compost to the areas surrounding the city. In examples from Asia, the market radius of compost is limited to about 25 km from the plant. In Egypt, compost is being transported over 140 km as it gets a relatively good price in land reclamation. A sound marketing system is a prerequisite for any recovery activity.

Health and environment

Although recovery of organic waste has many benefits, including ecological ones, reprocessing methods are not always environmentally sound and may pose health hazards to workers and inhabitants, since small-scale, informal activities are often carried out within crowded residential areas. In urban areas, rearing livestock on organic waste presents a number of health risks, not only because human diseases can be spread through the waste, but also because of the unsanitary conditions created within residential areas. For these reasons, and because of the foul odours that are often generated, the practice of animal raising is sometimes forbidden in cities.

Another example of a possible negative side-effect constitutes the quality of the compost. In 1991, a chemical analysis of compost produced at a compost plant in

Community-based waste recovery in Mexico

In 1978 the Alternative Technology Group (GTA) in Mexico set up the integrated system for waste recycling (SIRDO). Each house is connected to a community waste disposal system by two pipes that separate the "grey water", containing detergents from bathroom, kitchen and laundry and the "black water" from the toilet. After filtering, 80% of the grey water can be reused to irrigate vegetable and flower gardens. The black water is channelled into accelerated sedimentation tanks where the sludge is filtered out. The sludge goes to an aerobic decomposition chamber and is mixed with household garbage (co-composting). In the chamber solar dryers evaporate the water and within a year the sludge is transformed into a nutrient-rich dry powder fertiliser which is free from pathogens. Initially, SIRDO encountered several problems. Users complained about flies, unpleasant odours and leakages. Women had to change their domestic cleaning routines and some chemical cleaning products could no longer be used. The system also requires the separation of organic garbage and non-organic materials such as plastic, glass and metals. Attitudes to the system improved when the first harvest yielded a tonne of fertiliser which could be sold to middle-class residents in the neighbourhood. A cooperative of 18 members, 14 of them women, was set up to run the system and sell the products. The men carry out the heavier, periodic cleaning jobs. Simple day-to-day operations that are not too time consuming are done by women who do not have a job outside their home. The system is maintained by members on a voluntary, rotating basis. Most of the earnings from selling fertiliser are reinvested in production enterprises, although small amounts have been distributed among members based on the amount of labour they contribute.

Source: Monasterio and Sminck 1986.

Photo: WASTE Consultants

Manila: raising pigs

One of the simplest ways to recover the value of organic waste material, is to feed it to animals. In the outskirts of Manila, the Philippines, pig raising is a popular backyard activity. Commercial animal feed is replaced by organic waste, which costs 50% less. Pig raisers collect organic waste every day from restaurants in the city centre. Feeding pigs on organic waste reduces production costs considerably: it doubles the net profit per production cycle of 3.5 months. Given the fact that pig raising is a part-time activity, earnings per day are reasonable when compared to minimum wages.

Source: CAPS.

Cairo, Egypt, showed it to be well below European safety standards. It contained high levels of zinc and lead, and even dangerous levels of cadmium. It was assumed that this organic waste was contaminated by mixing it with non-organic, sometimes hazardous waste (such as household batteries) during storage and collection. Efforts are now made to avoid contamination. In an experimental project, 600 households are separating their organic and non-organic refuse before it is collected by the Zabbaleen people. The resulting health and efficiency effects on the participating Zabbaleen community (the men who collect the waste and the women who sort it in their backyards) as well as the quality of the compost are monitored. Separating the refuse into dry (non-organic) and wet (organic) fractions could make the Zabbaleens' job easier and less dirty, while they may fetch higher prices for cleaner "raw materials". Improvements, such as separation at the source but also precautionary measures for workers, like protective clothing and face masks, should be taken into consideration as much as possible.

South-south exchange

The type and composition of waste, the lack of capital and specific technical know-how, the need for employment generation, the existence of a large informal waste collection sector and cultural attitudes are just a few aspects that should be considered when developing a waste recovery system. Rather than copying waste management systems that work in Europe and North America, countries in Africa and Asia could also look for successful approaches in their own countries. The exchange of ideas, adapted technologies and approaches between, for example, Asian and African countries, will probably offer viable opportunities. This has not yet received the attention it deserves.

Future prospects

The earth's resources are finite. Resource recovery and utilisation are essential elements in any effort to achieve a sustainable level of waste management. Stimulating the recovery of organic waste can restore various natural cycles, thus preventing the loss of raw materials, energy and nutrients. However, to develop the full potential of organic waste recycling many issues still have to be looked at. For example, both systems could be improved in terms of profitability, product quality and safety. The precise dangers for people dealing with waste, especially for those who do the dirtiest part of the work, often women and children, are not known yet. Separation at the source might be a way of improving compost quality and working conditions of waste sorters, but it may also deprive people from their work.

Recovery techniques could be improved. Briquetting and biogas production from solid organic waste are relatively new technologies and need to be further developed. But also well-known technologies like composting can be improved in terms of shortening the process or improving compost quality.

Attention should also be paid to economic issues, how to increase the profitability of organic waste reuse. An important question to address is the optimum scale of recycling activities. Large-scale composting activities, also in industrialised countries, have shown that from a macro-economic point of view, environmental benefits are more realistic targets than economic feasibility. Compost production and organic waste recovery in general should be seen as a contribution to social and ecological improvements. Organic waste recovery reduces the overall volume of solid waste to be disposed of in sanitary landfills, thus reducing transportation and disposal costs.

Urban agriculture could be an option for the application of large amounts of organic waste. Links could be sought with many urban women who grow and market vegetables. Urban "greening", creating green areas (e.g. parks) to improve the urban environment, also offers possibilities for the application of compost.

Small-scale recovery of organic waste has not yet received the attention it deserves, also because of the negative image of urban waste. Waste is seen as dirty, people avoid contact with it. But if our objective is to create sustainable urban and rural livelihoods, handling organic waste cannot be ignored anymore. ■

A complete overview of the results of this study, which was carried out by EQI and AUC in Cairo; AB&P in Accra; GERAD in Bamako; CAPS in Manila; Ptr Services in Calcutta and USK in Nairobi, and coordinated by WASTE Consultants can be found in Lardinois I. and van de Klundert A. 1993. **Organic Waste: Options for small-scale resource recovery.** Urban solid waste series 1. Technology Transfer for Development / WASTE Consultants. 132 pp. The book can be ordered from TOOL, Sarphatistraat 650, 1018 AV Amsterdam, The Netherlands. Fax: +31 20 6277489.

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Comparing composting enterprises

In Bamako, Mali many farmers and traders exploit the free source of raw compost on the municipal dump for their own benefit. Let's compare the cost-benefit analyses of two small-scale enterprises. One consists of a farmer and his son working for themselves on a part-time basis. On average, they work 8 days a month to produce 20 m^3 compost per month using simple hand tools worth US$ 145. The son only receives pocket money, US$ 17 per month. The market price of compost is US$ 4.75 per m^3 which means that the farmer realises a net profit of US$ 3.20 per m^3, or US$ 64 per month, or US$ 8 per working day, which is more than three times the minimum wage. The initial investment in equipment was recovered from profits within three months. The second unit consists of three labourers employed by a trader at a minimum wage of US$ 2.50 per day. They produce 3.5 m^3 compost per day and work an average 20 days per month, a monthly production of 70 m^3. If all compost is sold, the trader realises a net profit of US$ 168.50 per month. The profit per working day is US$ 8.40, about the same level as the first unit, although the higher labour costs mean that the profit of US$ 2.40 per m^3 of compost is lower than in the first production unit.

Source: GERARD.

Multiple uses of organic waste in Calcutta

Most of the waste collected by the municipal waste services in Calcutta, India, is taken to a landfill next to a large fishery located in the Eastern Wetlands of the city. Numerous scavengers search through the material for paper, plastic, rubber, fuel, rags, etc. A large number of pigs and cows are raised on the landfill's organic waste and fish farmers use the city's sewage in their ponds. As they are filled, the older sections of the landfill are flattened and excess waste is removed and used as fertiliser. About 800 hectares of flattened, mature dump land are leased by the municipal corporation for use as vegetable plots. The city's refuse is a productive substrate: in addition to vegetable residues and coal ash, it contains animal dung, sewage sludge, bones and other organic materials. An estimated 20,000 people find a job in the intensive farming system, growing 25 varieties of vegetables throughout the year, with an average yield of 150 - 300 tonnes per day, without the needing additional chemical fertiliser.

Sources: PTR Services; Furedy 1989.

Earthworms earn their credit

"In the past we suffered because there were no trucks that came to collect our garbage. Now we don't need them, because the limited amount of garbage produced is used to prepare food for the earthworms." This was said by Don Felix, when we visited him to check how things were going two months after our waste management pilot project using earthworms had started. Then, for a moment forgetting his usual shyness, he started asking us all about the recommended procedures for harvesting the compost, its subsequent drying, sifting and prices and contacts for its sale.

Carlos Landín

That day, we started to dream how we could get sufficient funding to let all those modest people receive their "meter of earthworms" (about four thousand), which cost about 12 dollar at Mr. Cangás's.

The third group of seven families participating in the project was ready to receive their credit in earthworms, with the promise to pay back the same amount of worms in four months and more in eight months, so that the project could continue to expand to new families. There was none of the nervousness we had seen in earlier groups. It was clear for them that when the substance was pressed and no water came out, it should be watered and if water came out, it shouldn't. You only had to feed them, the rest was the responsibility of the worms, who surely would cooperate with them, just as they had done before with the people from García Moreno and Los Andes.

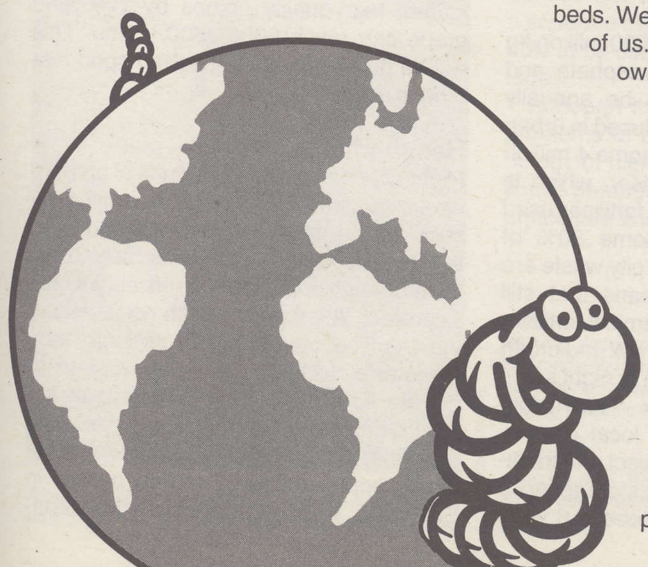
Getting started

Everything had started a few months ago, when Fabián Ramírez, Alcalde of Bolívar, in the northern highlands of Ecuador, asked for help to resolve the garbage problem in the parishes. It was found impossible to manage the wastes in an acceptable manner, given the lack of means and the considerable distance to the district capital. At that time, we were working in a research project on solid waste management, which the Fundación Natura was carrying out with support from IDRC from Canada.

We decided to organise a workshop. Given the predominance of the rural population in the district and in the workshop and given the seriousness of the problem of soil erosion in the area, the proposal of producing compost on the basis of household and agricultural wastes came up easily. The option of earthworms was chosen because there were already two worm nurseries in the region, the owners of which expressed great willingness to collaborate with this initiative. Now the number of families participating officially in the programme has reached 100. In many cases families handed over small quantities of worms to their friends and neighbours, apart from their obligations to the programme.

A family job

People say they have experienced a change in attitude, because previously they burnt the stalks and leaves of their bean, wheat or barley harvest. "In the past we turned around, lighted a match and ready we were. Now we have come to realise that those materials are also useful." Some farmers say that the whole family takes part in this activity and that it has served to bring them closer together. Housewives gathers the garbage and the kids, who were previously loafing about, now have something to keep them busy. "They take charge of preparing the food and moisten the earthworm beds. We divide the tasks between all of us. Now they even want their own bed."



Spectacular results

Results are beginning to show. People found out that it helps to put agricultural wastes in corrals or stables, to speed up maturing. They also mix it with animal manure before putting it in the earthworm beds, which should not be placed below eucalyptus trees. Solutions are sought to protect them from hungry chickens. People start to discover that the alfalfa to which the compost has been applied looks more vigorous.

Judging from Mr. Romel Pavón's experience, one of the experienced worm growers in the region, crop results are very good. In experimental plots of 100 m^2, sown with potato, he has obtained yields of 270 kg using chemical fertiliser (18-46-0, in quantities recommended after soil analysis) and 590 kg using compost. As a rule, the amount of compost he uses is three times the amount of chemical fertiliser recommended for a certain product. Under these conditions, compost (4.5 US$ per 45 kg) ends up being a little cheaper than chemical fertiliser (15 US$ per 45 kg). Mr. Pavón might not be completely objective, since he succeeded in selling his complete compost harvest (67,500 kg), mostly to Colombian buyers. With this compost it is possible to reduce the number of sprayings for pest control from six to one, or at two the most.

When looking at the amount of beans harvested, the results are less spectacular. Planted in comparable plots, beans treated with chemical fertiliser yielded 12 kg while those treated with compost yielded 16 kg. An experiment with peas showed similar results. The case of the avocado trees is also worth mentioning. The residue resulting from sifting the compost before it was packed for sale was applied around the trees. Harvest increased from 100 to 1000 fruits per tree.

To be continued

In October 1993 the Fundacíon Natura Solid Waste Management project ended. Although our team has spread out over different organisations, we keep in touch with the people and it is satisfying to see the earthworm programme is still going strong. The municipality continues to support it through an extensionist. Expectations for its expansion have even improved: we know World Vision is initiating a similar project in the area and we are sure that ways will be found to work together.

As the population concentrates in the cities it seems quite natural that products are extracted from the land, while wastes are deposited elsewhere. But for how long can we continue to do that? Perhaps the time has come to accept that this concentration of products, required for the well-being of the cities, requires a planned deconcentration of waste, so that it is returned to nature without offending it.

Either we do it, or nature does it herself, but the bill will have to be paid by someone, probably our children. ■

Carlos Landín, Urban Management Program, PO Box 17-17-1449, Quito, Ecuador.

Photo: Bo Ling.

Safe use of treated night soil

Human excreta, or night soil, has been used in China to fertilise crops and feed fish for thousands of years. Presently, some 164.25 million tonnes of night soil are produced every year by 300 million people in 479 cities. After a period of disinterest, night soil again gets the attention it deserves, being a valuable resource rather than a contaminant. However, to make safe handling possible, treatment of the raw night soil is necessary.

Bo Ling

Before 1979, urban night soil was cleared away jointly by farmers and environmental sanitation bodies. It was fermented in small-scale storage tanks in the rural areas. It could be applied to the farmland directly when needed. Sometimes, night soil was used together with urban domestic waste, which was transported to the rural areas too. After mixing both materials simple piles were made for composting.

In 1979 a drastic change of the rural economic system took place. The community system was replaced by the family responsibility system. This made it difficult for individuals to collect and transport night soil from cities. At a certain time, farmers also did not like to use night soil to fertilise their land. Especially the young generation preferred to use newly introduced chemical fertilisers to improve their living standard and working conditions. Hence, in some cities night soil had to be disposed of through sewers and this caused to environmental pollution. In recent years, as prices for vegetables and commercial fertiliser rose and the market remained stable, farmers became motivated to use night soil again. Also, farmers recognise more and more the advantages of using treated night soil in farm lands or fish ponds. But for sanitary reasons, the State now demands that night soil is treated before application.

Economic effects

Roughly estimated, at least 800 million kg nitrogen, 400 million kg phosphate and 500 million kg potash can be annually acquired from night soil produced in urban areas. This is equivalent to some 4 million tonnes of commercial fertiliser, which is about 4% of all commercial fertiliser used throughout the country. Some 30% of urban night soil and 2.6% of city waste are presently utilized. This means that still some 3 million tonnes of chemical fertiliser could be replaced if all night soil and urban waste were used. The reuse of night soil is officially stimulated by extension. Sanitation departments of local governments are responsible to collect and transport night soil from toilets to storage tanks located in the suburbs. All fees, 1.8 yuan per tonne-km, including labour, and costs of vehicle and gasoline are paid by local governments. Farmers pay 12 yuan per tonne and transport from storage tanks to farmland at an average cost of 0.2 yuan per tonne-km (1 US$ = 8.6 yuan). The price of commercial fertiliser is much higher (urea 1,400 yuan/tonne; Ammonia phosphate 2,500 yuan/tonne). Collecting, transporting and processing night soil is not very convenient and it takes much time as compared to handling commercial fertiliser. Statistics show that if 200-500 kg/mu (1 ha = 15 mu) night soil and 80 kg/mu commercial fertiliser (20-20-20) were used instead of 100 kg/mu commercial fertiliser, rice production could increase with 15 kg/mu, wheat with 30 kg/mu, high-quality onions by 20% and grape can reach 2000-2500 kg/mu. This will be profitable as long as transport distances are not too long.

Health effects

Night soil contains various kinds of pathogenetic bacteria, virus and parasitic ova, such as the pathogen of typhoid, dysentery, hepatitis A, poliomyelitis, schistosomiasis, anchylostomiasis and ascariasis. Therefore, a potential health risk exists in the practice of reusing excreta. In fact, excreta-related diseases, such as intestinal infectious diseases and parasitosis are very common in the countryside. For example, in the spring of 1988, hepatitis A struck approximately 2 million people in Shanghai, who had eaten shellfish con-

The construction site of a family size biogas digester in villages.

taminated by night soil. At present, diarrhoeic infectious disease accounts for over 70% of all kinds of infectious diseases. The number of typhoid cases surpasses 100,000 per year. About 490 million people have caught ascariasis, and 200 million have anchylostomiasis. Schistosomiasis is now reappearing in areas previously under control, especially in Hubei and Hunan provinces and a total of 1.5 million people have been affected.

Treatment of night soil

In order to prevent diseases, raise fertilising efficiency and protect the environment, night soil management and treatment are particularly important. In the past 20 years, several night soil treatment facilities have been built. Since the launching of the national campaign to become "Sanitary City", which means that a city has facilities such as running water, toilets, septic tanks, sewer systems as well as collection, transportation and treatment/disposal of night soil and city waste, this work has developed considerably. However, on the whole, urban night soil treatment is still in the primary stage and treatment coverage is very low. A sound system has not yet been developed and treatment processes has not been standardised. Treatment processes include mixed composting, ferment fertiliser manufacturing, storage tanks and biogas digesters.

Mixed composting. After pre-treatment, domestic waste is mixed with night soil for co-composting in windrows. Night soil can improve the fertilising quality of domestic waste by adjusting the compost humidity. When the compost temperature rises, most bacteria and worm eggs in the night soil will be killed. However, with this method only small amounts of night soil can be treated. Especially in the rain-ridden areas of the south, this method of treatment is difficult.

Ferment fertiliser-manufacturing. In some cities, after de-watering, night soil is mixed with waste or crop straw. Then, anaerobic fermenting takes place in containers during 20 days. After drying, the product is granulated, packed and sold to farmers. As it is easy to transport, farmers welcome it.

Storage tanks. Large storage tanks, 1,000 m3, have been built in Shanghai, Yantai, Chengde, Hefei, Qingdao, etc. for preliminary treatment of night soil and biogas production. The storage period is usually 2-3 months. Moderate-temperature ferment treatment is used in Qinhdao. It can achieve satisfying sanitary effects in a relatively short time, but costs a lot of energy. Normal-temperature anaerobic ferment treatment is used in Yantai. This saves energy and has good sanitation effects too.

Biogas digesting. The application of biogas technology in China dates back to the early 1950s, when electricity was not available in rural areas. But it did not last very long due to lack of experience in constructing and maintaining biogas digesters. Since the 1970s, the development of biogas digesters has entered a new phase. Numerous biogas digesters have been built throughout the country. Today, there are 6.5 million family-size digesters serving 3.8% of China's population. A preliminary target of some 20 million biogas digesters and 10,000 electricity generating stations based on biogas has been set. This would supply about 5% of total household energy in near future. The family digester is always connected with the latrine and the pigsty. Human excreta, pig dung, cowdung and crop residues are the main raw materials used as feed stock. For methane production, in volume as well as speed, human excreta are the best among various feed stock. The biogas digester, as a separate treatment method, is more suitable to be used in small townships and villages.

Although there are still many technical problems to be solved, appropriate technology of night soil treatment can provide a safe perspective for re-using night soil in agriculture and aquaculture.

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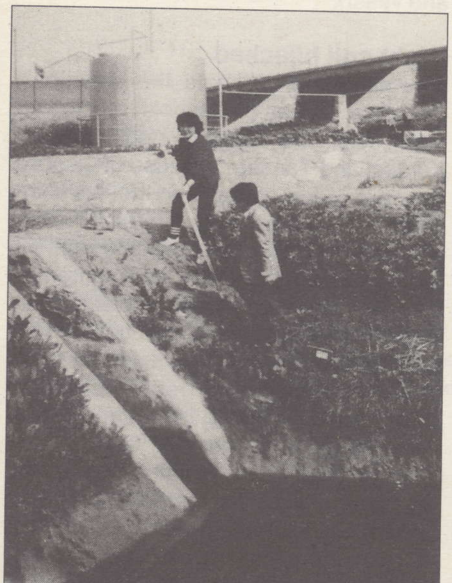


Photo: Bo Ling.

A pilot plant for treatment of night soil with anaerobic digestion, a biostabilization pond / fish pond.

Bo Ling, Associate Professor, Institute of Environmental Health & Engineering, Chinese Academy of Preventive Medicine, 29 Nan Wei Road, Beijing, People's Republic of China.

Reference

- Ling Bo, et al. 1993. **Use of night soil in agriculture & fish farming.** *World Health Forum*, Vol. 14, No. 1, p. 67.

Farmers of forty centuries

"One of the most remarkable agricultural practices adopted by any civilized people is the centuries long and wellnigh universal conservation of all human waste in China, Korea and Japan and its utilisation in the maintenance of soil fertility and the production of food. From the analyses of mixed human excreta made by Wolff in Europe and by Kellner in Japan, it appears that, as an average, these carry in every 2,000 pounds 12.7 pounds of nitrogen, 4.4 pounds of potassium and 1.7 pounds of phosphorus. In 1908 the city of Shanghai sold to one Chinese contractor for $31,000, gold, the privilege of collecting 78,000 tons of human waste, and of removing it to the fields. The storage of such [human] waste in China is largely in stoneware receptacles, which are hard-burned, glazed terra-cotta urns, having capacities ranging from 500 to 1,000 pounds.

Nowhere in the Shantung province, nor further north, did we see the large terra-cotta receptacles so extensively used in the south for storing human excreta. In these drier climates some method of dessication is practised. The greatest pains are taken, both in reducing the product to a fine powder and in spreading and incorporating it with the soil, for one of the maxims of soil management is to make each square foot of field or garden the equal of every other in its power to produce. In this manner each little holding is made to yield the highest possible under the conditions the husbandman is able to control.

It was on Honam Island that we saw fields, which had matured two crops of rice during the long summer, had been thrown into strong ridges to permit still a third winter crop of some vegetable to be taken from the land. There was abundant evidence of the most careful attention and laborious effort devoted to plant feeding. We saw a boat which had come from Canton in the early morning with two tons of human manure and men were busy applying it, in diluted form, to beds of leeks at the rate of 16,000 gallons per acre. They have other methods of 'manuring the soil'. Large amounts of canal mud are collected in boats, brought to the fields to be treated and left there to drain and dry before distributing. Both the material used to feed the crop and that used for manuring the land are waste products, hindrances to the industry of the region, but the Chinese make them do essential duty in maintaining its life. Human waste must be disposed of. We turn it into the sea. They return it to the soil.

Professor F.H. King, from University of Wisconsin, USA and chief of the department of Soil Management travelled early this century to China, Japan and Korea and wrote the book "Farmers of forty centuries" with over 200 pictures on the agricultural practices. First published in 1926.

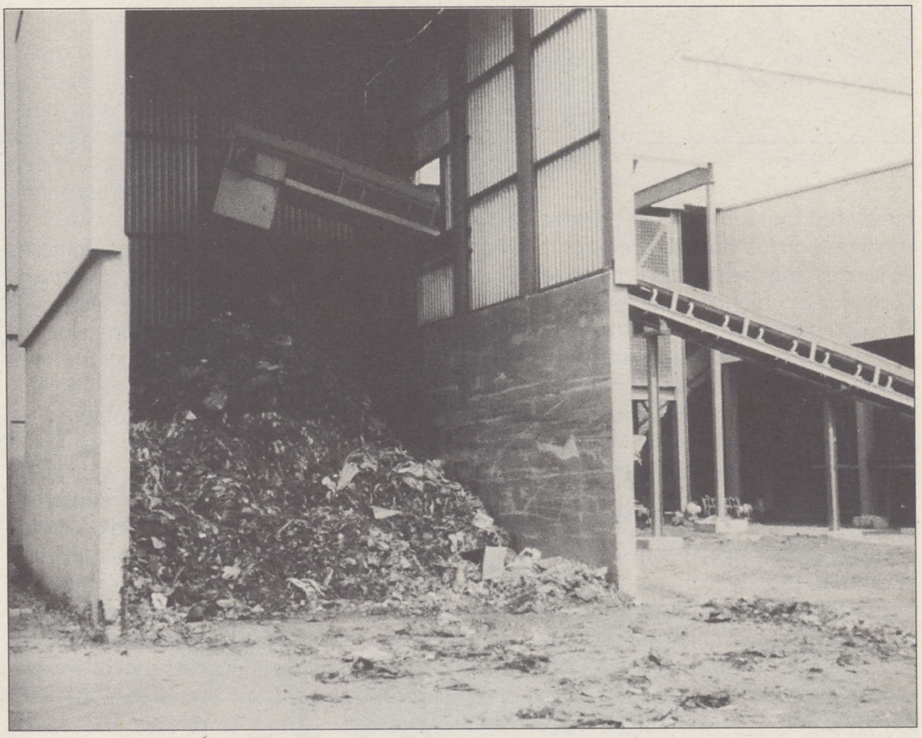


Photo: WASTE Consultants

A study was carried out in Ghana on the use and fertilising potential of organic waste from large-scale agro-industries and municipal waste. With present fertiliser prices, agro-industrial by-products that are sold as animal feed can never compete with imported fertiliser. Even subsidised compost cannot compete with imported fertiliser. But maybe the value of organic material is underestimated? A report from Ghana.

Organic wastes hijacked

E. Owusu-Bennoah
and Cinty Visker

In Ghana, ongoing devaluation of the cedi and ending agricultural subsidies increase the cost of imported fertiliser and thus lower farmers' returns. Population growth, increased food demand and decline in soil fertility call for increased use of fertiliser. A substantial part of the nutrients is removed with the harvest. Not all removed products are used, some are thrown away. If waste products could be recycled, brought back to the farms, the nutrient output from the field would diminish and and there would be less demand for expensive imported fertiliser.

The study focused on organic waste in two geographical areas, the triangle Accra-Akosombo-Tema and the northern provinces, where the main consumption areas for fertilisers are found. Some results are summarised in Table 1.

Organic materials can be obtained from by-products of large- or small-scale agro-industries as well as from domestic waste, at municipal level or at village and household level. In order to make agro-industrial by-products and domestic waste products attractive to farmers, the price of these products has to be favourable enough to compete with imported fertiliser. This means that organic waste should be cheaper and/or be of higher quality (i.e. higher nutrient content).

Varying demands

The use of organic waste depends on its nature, where it is generated and on the demand. In the Tamale region and in the palm oil plantations in the Accra-Akosombo-Tema triangle, the demand for alternative, cheap fertiliser has increased: In the last three to four years, farmers in the north started to use slaughterhouse waste products and cotton refuse as fertiliser. Since the last one to two years all by-products have been collected. The oil palm industry uses the by-products for their own consumption. The surplus is available to farmers, who only pay the costs of transporting and handling the materials. After decomposition the slurry is pumped over parts of the farm. By burning the shells and fibers, the palm oil industry is self-sufficient in energy. For the surplus, farmers pay 100 cedi per 25 kg bag of ash, which covers the handling costs.

Fertiliser demand in the Kumasi zone and the Accra-Akosombo-Tema triangle is less than in the Tamale region. In these regions, by-products of the juice industry and slaughterhouse are disposed of. The by-products of the timber industry, like sawdust and woodscraps are low in nutrients and decompose slowly. In Accra, a small part of the sawdust is used in the production of compost (from night soil) and to cover up the refuse disposal sites. In the Kumasi area all the sawdust is disposed of. Scrap wood is used in the timber industry to generate energy and it is locally used to produce charcoal. An attempt to use sawdust as briquets, to reduce firewood consumption, has never taken off. The supply of firewood seems to be sufficient.

However, the demand for animal feed is extensive. The supply of agro-industrial by-products cannot meet this demand. Depending on the nature and marketing possibilities of the by-products, the material is sold within Ghana (copra cake, wheat bran), exported to Europe (cocoa bean shells, cotton seeds), or bought by private people, who dry the material before selling it again (fish waste, brewers' spent grain and yeast).

Night soil hijacked

It is difficult to estimate the quantity of municipal waste (household refuse and night soil), that is generated in Accra, Kumasi and Tamale, because of disposal sites are widely spread and there is a limited collection capacity. In the Tamale municipality, 90% of the collected night soil is used as fertiliser. We were extremely surprised when we found out that farmers in this region hijacked the government trucks that emptied septic tanks. An illegal action! They paid the drivers around 2000 cedis, directed them to their farms and let the night soil pour over their fields. For us it meant that the need for nutrients was high because normally people have quite an aversion for human waste.

The municipal waste of Kumasi town is completely disposed of. In Accra, part of the collected municipal waste is converted into compost by the Accra Municipal

Authority (AMA). The refuse compost is mixed with night soil compost at ratios of 3:1 to 4:1. In 1992, 3,000 tonnes of compost were sold, for a subsidised price of 500 cedi per 20 kg bag, to horticulturalists, vegetable growers, and some private companies and farmers. The compost is produced in a large-scale centralised compost plant. Production of compost adds a lot to the running expenses of AMA. The continuation of the AMA compost plant is doubtful. A large-scale centralised compost plant is economically not viable. AMA is looking into possibilities of mobile composting units.

Nutrient transport

Though the nutrient content of different agro-industrial by-products is relatively low, the volume of waste generated in the system is substantial. By using of agro-industrial by-products and wastes, large quantities of nutrients are moved through the system. With, for example, the export of substandard cocoa beans and cotton seeds around 270 tonnes of N, 120 tonnes of P2O5 and 110 tonnes of K20 per year are exported out of the Ghanaian agricultural system. Ghanian soils are depleted more and more while European soils are enriched.

Can waste compete?

Depending on the type of the material, organic waste can be used for animal feed (copra cake, wheat bran, cotton seeds, spent grain, fish meal). The market for animal feed in Ghana is extensive. With the present fertiliser prices, however, agro-industrial by-products, now sold as animal feed, could never compete as fertiliser. Even with a subsidised price of 500 cedi per 20 kg, also compost cannot compete with imported fertiliser. Still farmers use it. The distance between industrial areas and farm lands is apparently, in the case of animal feed, not important. Animal rearers are willing to pay the price of transport. The transporting distance is, however, important for the use of organic material as fertiliser. The compost that is made in Accra is used only in a relatively small area.

Looking at organic waste only as a nutrient source is underestimating the value of it. Soil fertility has to be seen as a combination of soil physical (soil structure, pH, Cation-Exchange-Capacity, water retention capacity, etc), biological (micro-organisms) and chemical factors (nutrient content, nutrient balance). If soil fertility is to be maintained, it has to be looked at in this broader sense. This means a completely different valuing of organic matter.

■

E. Owusu-Bennoah and Cinty Visker, International Fertlizer Development Center (IFDC), BP 4483, Lomé, Togo.

Table 1:
Quantities, present use, present price and Nitrogen content of (some) agro-industrial by-products and waste products

Agro-industry	quantity	present use	present price	nitrogen content
fish processing	20 tonnes/day	animal feed	65 cedi/kg	
cocoa				
- chocolate processing	1980 tonnes/yr	animal feed[1]	unknown	
- substandard beans	500-1000 tonnes/yr	pharmaceutical industry[1]	25% WMP[2]	
oil mill (copra)	1240 tonnes/year	animal feed	80 cedi/kg	34,3 tonnes/year
cotton industry				
- cotton seeds	8736 tonne/year	animal feed[1]	90-120 USD/tonne	271,8 tonnes/year
- refuse	304-604 tonne/year	fertiliser	nothing	
timber industry				
- saw dust		some for compost		
- scrap wood		charcoal	not known	
		energy	nothing	
juice factory	9-18 tonnes/day	none		
slaughterhouse		some for fertiliser	nothing	
breweries				
- spent grain	15 tonnes/week	animal feed	not known	0.13 tonnes/week
- spent yeast	4 tonnes/week	animal feed	not known	
palm oil industry				
- bunch ash	630 tonnes/year	fertiliser	4 cedi/kg	
- slurry	29,610 tonnes/year	fertiliser	nothing	36.6 tonnes/year
- fibers/shells	28,350 tonnes/year	energy	nothing	
- fibers/ shell ash		road repair	nothing	
municipal waste				
- refuse compost		some for compost	25 cedi/kg	
- night soil compost				

[1] exported
[2] WMP = World Market Price

The oil palm, growing in the lowlands of the humid tropics is an ideal crop. It provides a permanent cover for the land, high quantities of organic matter and nutrients are returned to the field the whole year round. Agricultural waste can be used as source of energy for processing the product. But recycling of high amounts of crop residues is not an easy job and may be a threat to the environment.

Recycle or pollute?

Theo Guiking

The oil palm produces fruits that have the size of small eggs and that grow in bunches. A good palm may produce up to 20 bunches per year. When it is more than 4 years old annual yields can go up to 20 tonnes/ha with a dry matter content of about 10 tonnes. The fibrous flesh of the fruit contains the marketable product palm oil.

Processing

With steam the fruits are removed from the bunches. Loosened fruits are scraped and flesh and kernel are separated. For ease of transport within the processing plant water is added. The oil, pressed from the fibrous flesh, floats on water and can be decanted easily. What remains is water with organic particles, so called raw palm oil mill effluent. Direct disposal of effluent into rivers may kill all river life, since biological oxygen demand for fermentation is very high. Therefore, most processing plants have a fermentation pond or tank. The latter offers the possibility to harvest biogas.

Environmental effects

Empty bunches used to be free fuel for the production of steam. The remaining ash is a useful fertiliser, containing about 25% potash, with a liming effect as well. But burning empty bunches releases soot into the atmosphere. Therefore governments tend to forbid it nowadays. Alternative use is sought in carrying empty bunches, about 5.5 tonnes dry matter per hectare, back to the field as mulch. The bunches can be transported on return trips with the same trucks that pick up the harvest. In-field transport and spreading is a problem. Some companies try to make this easier by chipping the material, which makes mechanical spreading easier. Thick layers of mulch can cause fly problems. Single layers usually do not give such negative side effects. Composting this waste material would require very large sites near the mill and sometimes the housing area, which would create many problems with flies, rats and bad smell. It is therefore unacceptable.

Fermentation of effluent yields biogas. But who will use the gas? The factory is, or was self-supporting in fuel. Only in cases of non-continuous processing, some gas instead of diesel can be used to start the machines. The factories are usually far away from housing areas, which makes use as cooking gas also expensive. Compressing gas for use in trucks is - with the present prices of diesel and petrol - relatively expensive too. The remainder of digested effluent is sludge. This can be used in the plantation as soil ameliorant, or sold for use in horticulture or as feed for livestock. But in all cases saturation of the direct surroundings is quickly reached.

There is another important by-product: the pruned leaves or fronds, as they are called by oilpalm growers. To harvest the bunches from the axils, the suspending leaf must be cut first. Pruned leaves are placed in alternate rows, frond heaps, between the palms. Together with the decaying roots this provides an annual input of 10 tonnes dry matter per hectare. Besides being a source of organic material, all these crop residues, with a maximum dry matter content of 16.2 tonnes/ha, contribute to the recycling of a relatively high percentage of harvested nutrients (see table).

Conclusion

Perennial crops are relatively soil friendly. Compared with annual crops, removal of nutrients is less and return of organic matter is higher. But quantities of crop residues are high. This means that recycling is laborious and options to absorb these by-products are easily saturated. Methods to reduce the bulk, by burning or composting, may have harmful environmental effects. ■

Theo Guiking, Dept. of Agronomy, Wageningen Agricultural University, PO Box 341, 6700 AH Wageningen, Netherlands.

The nutrient cycle

The total uptake of nutrients by the oil palm is high, but most nutrients 60-70% (for P 50-60%) are returned through crop residues and decaying roots. Apart from that, 5-10% of the annual uptake is stored in the trunk, and will become available when the palms are felled after 15-20 years. Based on literature data, the following ranges for nutrient flows are found for a crop yielding 20 tonnes of bunches:

Table 1: Annual uptake and removal of nutrients (kg/ha) by 1 ha oil palm, yielding 20 tonnes fresh fruit bunches

	total uptake	stored in trunk	recycled (leaves + roots)	removed by bunches
N	185 - 395	11 - 32	122 - 269	52 - 94
P	18 - 52	2 - 6	9 - 31	7 -15
K	190 - 335	8 - 13	122 - 206	60 -116
Ca	47 - 162	6 - 14	32 -128	9 - 20
Mg	37 - 126	8	21 - 102	8 - 16

Use of bunch ash or empty bunches in the field will make the balance even better.

Effective Microorganisms

The concept of inoculating soils and plants with beneficial microorganisms to create a more favourable environment for plant growth has been discussed for decades by agricultural research scientists. However, the technology behind this concept and its practical application have now been significally advanced by Professor Teruo Higa, at the University of Ryukyus in Okinawa, Japan.

Tahir Hussain

Professor Higa has devoted much of his scientific career to isolating and selecting different microorganisms for their beneficial effects on soils and plants. He has found organisms that can coexist in mixed cultures and that are physiologically compatible with one another. When these cultures are introduced back into the natural environment, their individual beneficial effects are greatly magnified in a synergistic fashion. The mixed culture of these microbes is named Effective Microorganisms (EM). EM can be applied as inoculants to increase the microbial diversity of soils and plants which, in turn, can improve soil health and the growth, yield and quality of crops. EM is prepared from cultures of naturally occuring species of microorganisms that are found in natural environments worldwide. EM contains more than 100 species of coexisting microorganisms, but predominantly the genus streptomyces, photosynthetic N-fixers, Lactobacillus, yeasts and molds.

Beneficial effects

There is documented scientific evidence to indicate that EM cultures can suppress soil-borne pathogens, accelerate the decomposition of organic wastes and crop residues and increase the availability of mineral nutrients and useful organic compounds to plants. Moreover, it will enhance the activities of beneficial indigenous microorganisms, like Mycorrhizae, that fix atmospheric nitrogen, thereby replacing chemical fertiliser and pesticides. Actually, EM tends to stimulate the "Rotation Effect", a term used by agronomists to describe the regeneration of beneficial microorganisms and suppression of harmful ones which results from crop rotation. EM cultures have been used effectively to inoculate both farm wastes as well as urban wastes to suppress bad odours and hasten the treatment process. EM has also been used with great success as an inoculant for composting a wide variety of organic wastes.

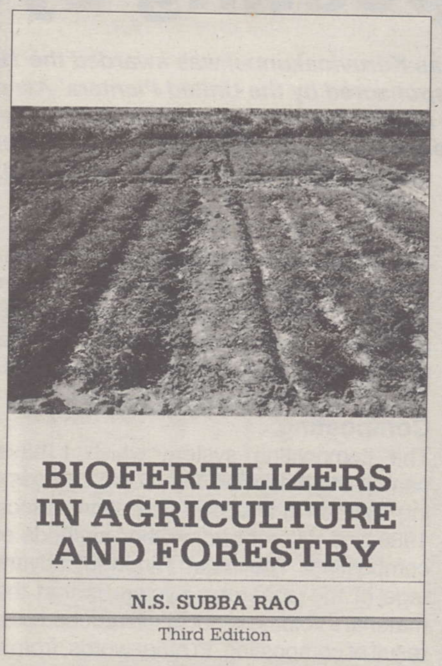
Further research and development is being coordinated by the Asia-Pacific Natural Agriculture Network (APNAN). Initially there were thirteen member countries, mainly in Asia but also USA and Brazil. Today, the introduction of EM-technology has also spread to many other countries, even in Europe.

EM-Technology in Pakistan

The author of this article is a member of the APNAN Steering Committee and is responsible for the promotion of EM-Technology in Pakistan. First trials with EM in Pakistan showed very promising results when compared to conventional cultivation. These results encouraged the foundation of the Nature Farming Research Centre (NFRC) at the University of Agriculture in Faisalabad. All technical staff of NFRC have been trained at the International Nature Farming Research Centre in Atami, Japan. Establishment of the Advanced EM-Technology Laboratory made it possible to converse liquid EM culture into a solid product, named "Biokasht", and to produce this product on small-scale. A Research Farm of 5 hectares is used for further trials and "Biokasht" is supplied to selected farmers to grow rice-wheat, cotton, sugarcane, corn and bamboo. Networking between national scientists involved in research and development of the EM-Technology is enhanced by the Nature Farming Research and Development Network.

In future, EM-Technology will be extended to the animal production sector, environmental pollution control and human health. For crop production a large-scale "Biokasht" production unit will also be established so that it can be supplied to every farmer in the country. All these developments indicate that there are very good prospects in EM-Technology for sustainable agriculture without destroying the natural agro-ecosystem by excessive use of chemicals. ■

Tahir Hussain, Professor and Chairman of the Dept. of Soil Science, University of Agriculture, Faisalabad - 38040, Pakistan.



Conference reports from India. Research findings on organic farming are exchanged intensively in India. Several conference reports have been published recently. Recyling of organic waste and biofertilisers get ample attention.

National seminar on organic farming edited by MM Rai and LN Verma, September 1992, College of Agriculture, Indore. Published by Department of Soil Science, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur 482 004, India.

National conference on bio-fertilizers & organic farming, November 1993. Department of Agriculture, Government of Tamil Nadu, Madras, India.

Fertilisers, organic manures, recyclable wastes and biofertilisers edited by HLS Tandon, 1992. Fertiliser Development and Consultation Organisation 204-204A Bhanot Corner, 1-2 Pamposh Enclave, New Delhi 110 048, India.

Biofertilizers in agriculture and forestry. NS Subba Rao, Third Edition, 1993. This is a standard work on biofertilisers in agriculture and it has been updated and extended to forestry. It gives a good state-of-the-art on biofertilisers and their use. Different microorganisms and green manures are dealt with. However, experiences with inoculation of combinations of microorganisms such as "Effective Microorganisms" as developed by Prof Higa in Japan (see p15 of this newsletter) are not yet included.

The modified anaerobic composting system

On 28 June 1994, Mr. K.T. Thomas Kuruvinakunnel was awarded the 1994 gold medal for innovations in sustainable farming techniques, sponsored by the United Planters' Association of Southern India (UPASI), the Indian Institute of Management in Ahmedabad and the central government organisation Coconut Development Board. In this article Mr. Thomas describes the compost-cum-biogas technique, which is part of an integrated rubber-based organic farming system.

K.T. Thomas Kuruvinakunnel

I am a farmer from the State of Kerala in south India. The soil is laterite in nature but fairly fertile. Rainfall is abundant, about 150 inches a year. However, more than three quarters of it falls down in the monsoon months of June to early September. I inherited a 19 acre farm monocropped with rubber, on which, in the name of modern agriculture, several unsustainable practices were followed. I had different ideas - I visualised a farm that would be totally selfsufficient. My idea evolved gradually and therefore also the various components of the system. Organic manuring was introduced gradually and increased till after several years chemical manuring was stopped altogether. I did not experience any drop in yields whatsoever. My underlying concept in farming is to encourage the growth of visible soil organisms like the earthworm and also fungi and bacteria that are not visible. The entire operation on the farm focuses on integrating various systems by which the productive capacity of the land could be utilised with minimum use of outside inputs.

Composting

The composting system which I have named the "modified anaerobic composting system" (MACS) is operational since 1986 and different from other methods of composting. The most important advantage of the anaerobic system is that the material's volume is not much reduced as a result of composting. In other words, from a given quantity of raw material, a greater volume of compost can be obtained by the anaerobic process. This relative increase in compost volume means an increase in the population of microorganisms.

The system consists of a pit of 21 feet long, 16 feet wide and 17 feet deep. A well-like structure is built in the middle of the pit by lowering down precast concrete rings of 3 feet high, 5 feet in diameter and 3 inch thick. The well is constructed so that it rises 3 feet above the surrounding ground level. The floor of the pit is plastered and slanted towards the well. The well floor is also plastered and is 3 feet deeper than that of the pit. Large holes are made towards the bottom of the well to help the easy movement of liquids from the pit into the well. The pit is gradually filled with materials as shown in table 1, as and when they are available. Because from my neighbours organic materials are easily available, I use similar materials generated on the farm for mulch. The cost mentioned in the table is for the labour of weeding and transportation of materials to the MACS site. The ratio between carbonaceous and nitrogenous material thrown into the pit is kept at such a level that decomposition is not retarded. If too much carbonaceous material is added, decomposition will slow down. This optimum ratio I have learned through experience. It takes about a year to fill, but the time for decomposition is only about 30 days. Since all material is emptied out together, the lower layers lie in the pit decomposed for quite some time. This year, because of the large quantities of market wastes available, the pit has been filled a second time. Water is added periodically so that the height of the water column is always maintained at a level 3 to 4 feet below the surface of the material being put into the pit. The water passes through the many layers of material and rises up in the well with a dark brownish colour and a slightly viscous nature. A slurry pump operated by electricity is engaged to pump this liquid from the well back onto the material in the pit. The operation is carried out for 2 hours every day.

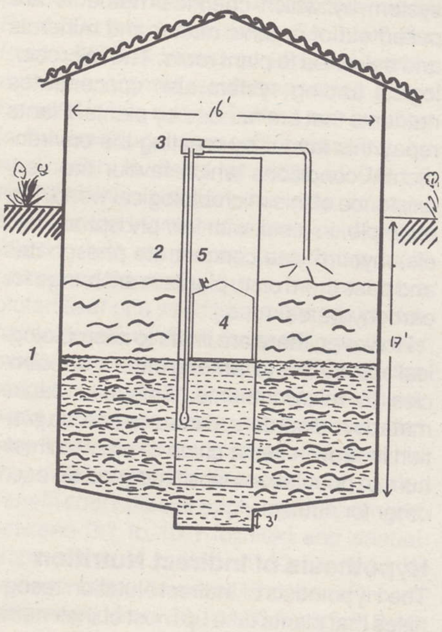
How does it work?

At any given point of time only the upper level of material in the pit undergoes aerobic decomposition while the rest of the material which is underneath and not in contact with air undergoes anaerobic decomposition. All material thrown into the pit undergoes aerobic microbial activity followed by anaerobic microbial activity. Aerobic as well as anaerobic bacterial activity is regulated as per requirements. For example, in case there is a long time gap between two fillings, the frequency of pumpings is increased thereby making the material soggy which in turn smothers aerobic organisms. The well was constructed mainly for collecting the liquid so that it can be pumped back on to the material. The liquid in the well is an ideal breeding ground for bacteria, they multiply at a faster rate. When pumped out on the material in the pit, this liquid rich in bacteria hastens the decomposition process. A modified chaffe cutter which can alternatively be run manually or by electricity is used to cut the material before it is thrown in. The basic requirement is that the liquids that ooze out of the material in the pit be collected and spread over the fresh material on top. The top layers are almost impermeable and hence do not allow gas to escape. Each time the pumping is done, the accumulated methane in the pit, along with the liquid is forced down through the large holes at the bottom into the well where it rises up and is collected in the dome.

The MACS in my farm is fairly large, producing about 80-100 tonnes of finished compost per filling. I was able to complete the whole system for Rs. 21,970 (US$ 1 = Rs. 32). The costs of the fibre glass reinforced gas holder (Rs. 8,000) are included in this. The cost of keeping it operational on a monthly basis is Rs. 50 for electricity charges and Rs. 200 for labour. A scaled down version will be cheaper. The slurry pump can be eliminated, instead the farmer can use a bucket, rope and pulley to pour the liquid over the material. Actually, there are a few small farmers who are using MACS successfully. I feel the main reason is that farmers here are not practising organic farming and hence do not need the compost.

Table 1:
Materials to fill the pit

Material	Pre-treatment, if any	Source	Percentage wght	cost
Weeds, twigs & green matter	cut into 1/2 inch size	own neighbours	6% 53%	nil 32%
Poultry manure	no	own & broiler farms	25%	25%
Fish manure	no	market	1.5%	13%
cow's dung cow's urine cow shed wash	no no no	own own own	2.5%	4%
Pineapple waste	cut into 1/2 inch size	market	3.0%	nil
Kitchen waste	no	own	0.3%	nil
Dead rats & snakes	no	own	0.2%	nil
Vegetable waste	cut into 1/2 inch size	market	8%	12%
Water weeds	no	own	0.5%	nil
Labour for pumping & excavating				14%



1 = water level
2 = well, concrete rings
3 = motor
4 = methane gas holder
5 = gas outlet

Community level composting?

Since the technology involved is quite simple, the system can be scaled down for use by very small farmers and scaled up to suit the requirements of a large farmer or garbage processing concern. Many farmers have told me that they find making compost very laborious when compared to using inorganic fertiliser. It should also be mentioned that all the small farmers who have constructed MACS are not interested in the gas production. MACS would be more suitable at a community level. The gas production would be much more cost effective in a large sized plant. I myself am trying to work out a deal with the local municipality wherein they would give me sorted decomposable wastes from the market. In return they would have the advantage of not requiring waste dump. I would also persuade the authorities to let the labourers involved in the scheme have the sale proceeds of the sorted iron, plastic and glass (there is a market for it). Further refinements are required, like shortening of composting time, improving nutrient content of the compost and making the system more mechanical so as to make handling easier. ■

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Farmers in Gujarat experiment with Micronutrient Fortified Compost. The results are promising: higher yields, more efficient use of farmyard manure, better payment of farm labourers and an improved hygienic conditions in villages.

Micronutrient Fortified Compost

Jagdish Nazareth

It is now more than 10 years since I first visited Jakhda village in Dholka Taluka, a semi-arid region in Gujarat, India. I was moved by the physical conditions and health status of a small community of Harijans in that remote village. I tried to work out some way of helping them develop their main occupation. This was the removal of *ukarda*, Farm Yard Manure (FYM) from the houses of the villagers and dumping it in piles on the outskirts of the village. There it remains to decompose for about one year until the houseowner applies it to his fields. This was the beginning of the work done by the Institute for Studies and Transformations (IST) that led to the invention of "Micronutrient Fortified Compost" (MFC) in 1987.

Not enough ukarda

The ukarda system is based on transfer of biomass from grazing land to the small fraction (30-50%) of the village land which is actively cultivated. This transfer of biomass is an important factor in degradation of the "common" land. To get acceptable results, farmers typically apply high rates of ukarda, from 12-15 tonnes/ha for field crops like wheat and rice to 30-40 tonnes/ha for flowers, vegetables and cash crops. For this rate of application there is not enough ukarda, which means that it can only be applied once in 2 to 3 years.

Most of the work involved with ukarda is done by the lower castes and the women. The work often pays less than other farm work. Due to low economic benefits to labourers as well as farmers, not enough care is taken to prevent nutrient losses. So the environment degrades, people are exploited, rural labour is underutilised, settlement hygiene is poor and an important agricultural input is underutilised.

Deficiencies in micronutrients

Plants can take up chemicals directly if they are supplied to them. But in natural conditions the microbiological world around a plant is a huge economic trading system by which chemical nutrients are pulled out of organic matter and minerals and delivered to plant roots. The microbiological trading system also concentrates nutrients that are needed by plants. Plants repay this favour by creating the environmental conditions which favour the very existence of this microbiological world. For example, in a soil with low phosphate levels, mycorrhizae concentrate phosphates and pass them on to plants in exchange for carbohydrates.

However, there are limits to microbiological activity due to, among others, deficiencies in micronutrients. This can cause metabolic disorders, diseases and stagnation in growth in the chain of plant-animal-human populations which depend on each other for nutrition.

Hypothesis of Indirect Nutrition

The Hypothesis of Indirect Nutrition recognises that plants take up most of their nutrients in a form conditioned by microorganisms and therefore external nutrients must be added essentially to provide nutrition to microorganisms, which will feed the plants. For example, if we want to boost the nitrogen fixing capacity of the soil, so that soil microorganisms can fix enough nitrogen for the plants, then we should ensure that the soil has all those nutrient elements available for nitrogen fixing organisms to thrive. Once the focus shifts from plant nutrition to microbial nutrition, we are dealing with a completely different vector of inputs. This microbiological enhancement theory has the advantage of being "homeopathic" in its use of external chemical nutrients. We are saying: do not

*This farmer has applied 3 tonnes of MFC on 4000 m^2 irrigated land. He obtained 400 kg more castor seeds (*Ricin communis*) than with a field that received 3 tonnes of Farm Yard Manure in an equivalent area.*

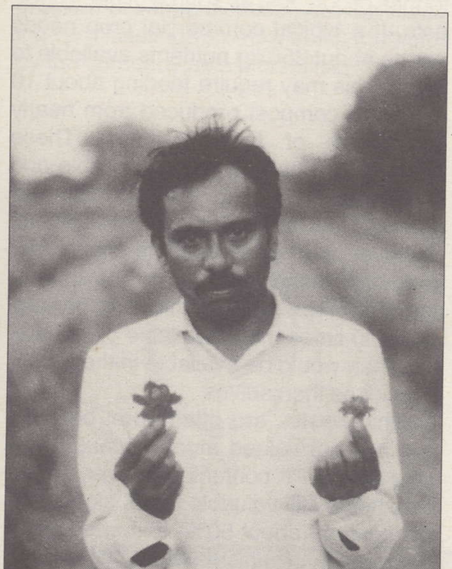
The fennel on the left of the photo was not fertilised with MFC but received water. The fennel on the right was fertilised with MFC but starved of water. Yet the MFC fennel has fruited while the non-MFC fennel is only in bloom.

add urea, it is not necessary. Do not add water soluble phosphates, they are too costly and not needed. Do not add 4 tonnes/ha chemical gypsum, but 100 kg. Do not add 50 kg/ha iron sulphate, but 2 kg. Do not add 25 kg/ha zinc sulphate, but 1 kg. Do not add 200 g of ammonium molybdate per ha, but 20 g.

Microorganisms need acceptable levels of 18 elements. These are all provided in basal doses to ensure adequate nutrition with booster supplements of those elements which are deficient in the soil and water of the fields where they are applied. So, compared to conventional methods of soil fertilisation, instead of adding large quantities of a few nutrient elements, we add small quantities of all essential elements, taking cognisance of the actual, prevailing soil and water concentrations of the 18 elements.

Micronutrient Fortified Compost

Several years ago a Maharashtrian farmer, N.A.D. Pandhuripande, developed a simple pit for composting agro-waste. This compost pit is built in brick above the ground. It is 10 ft long, 8 ft wide and 4 ft high. At regular intervals, 66 airholes are created in the masonry by leaving out a brick. Compost is prepared in this NADP Compost Pit by building layers of soil and agro-waste and topping them with cowdung slurry. This repeated ten times fills the pit about one foot above its top. Then the whole is plastered with cowdung. NADP Compost is ready in about 90 days without turning it around as this is too laborious. This can be compared with village ukarda which takes a year. However, NADP Compost provides too little economic return in Dholka. IST therefore started potentiating NADP Compost to raise it to the status of a biofertiliser by fortifying the compost with micronutrients. We called it Micronutrient Fortified Compost (MFC).



The rose in the right hand of Shri Balwant Lakum is from a field fertilised with MFC, the one in the left hand is from a control field. Over a period of 15 months there was a 200% increase in bloom production over control.

Experimentation by farmers

Initially we experimented in our nursery. After that the work was extended to 64 families in 35 villages in Dholka Taluka. Experiments were conducted by farmers on their own fields with 15 different crops, rice, wheat, millet, sorghum, gram, fennel, cumin, lucerne, castor, guavas, lemons, roses, pomegranates and a range of vegetables. Participants' controls were usually their existing local practice. Most have honoured our guidelines for experimenting but quite often there were deficiencies which turned their trials into interesting observations only. Though our quantification procedures may appear scientifically inadequate, all participants are convinced that they have experienced very beneficial results from MFC usage.

Economic returns

Under 1993 price conditions in Gujarat the farmer's cost of producing MFC is approximately Rs 200-250 per tonne. In this, the cost of added nutrients is approximately Rs 50-60 per tonne. The rest of the cost is local raw materials and labour. For comparison, Diammonium Phosphate costs Rs 4,500 per tonne, Urea Rs 2,500 per tonne. MFC is based on 98% renewable manures, organic residues and soil. It can be used in two ways. Firstly, it can be used in the traditional manner of compost, by application to fields at rates of 0.3-1.2 kg/m2. When used in this way, farmers experienced increases in crop yield by 15-200% when compared to existing local practices. Secondly, it can be used as a biofertiliser or a seed treatment or a germination media additive for seedlings. In this mode, between 30-100% MFC on the weight of seed can be used for treatment. Yield increases were experienced that vary from 10-60% from seeds treated this way. When used in the compost mode, benefit cost ratios of applying MFC ranged between 3:1 to 10:1 for field and annual crops within a period of 12 months. In orchard crops however, the benefit cost ratio ranged from 30:1 to 80:1 within 12-15 months. But when MFC is used in the biofertiliser mode, the benefit cost ratio ranged even from 80:1 to 150:1 within 12 months.

MFC reduces the recommended application rates of all fertilisers substantially. When ukarda is used as MFC the application rate typically comes down from 12-40 tonnes/ha to 3-10 tonnes/ha (= 7.5-25 tonnes/ha MFC) when used as a soil fertiliser and to 100-150 kgs/ha when used as a seed treatment. Crop yields on the other hand are generally better just as the quality of the crops in such parameters as size, weight, taste, fragrance, fibre length and strength. Crop resistance to drought, bacterial and fungal diseases also improved. We have a curiously fortunate situation where less gives more. Due to the better use of ukarda when used as MFC and quickening of the turn-around cycle of traditional composting from 12 to 4 months, also the hygienic conditions of the village settlement will improve.

Further development needed

The use of MFC requires a person skilled in plant and bacterial biochemistry to correctly interpret visual signs of nutrient deficiencies in plants. Or it needs a testing programme where the soil availability levels of all 18 essential elements are known at the same time. Or both. The technology is available but what remains to be done is to integrate testing capabilities and statistical procedures with geographic information and remote-sensing imageries to provide a cost-effective system of advising farmers. We are trying to devise a Farmer Information System for a block of 70 villages in an area of 1000 km2 in the Sabarmati River basin in Gujarat. When this FIS is in place it will also become a new research tool for examining linkages between plant, human and animal nutrition.

MFC is still in the experimental stage. More experiences are needed in different agroecological conditions. A start was made by two NGOs. Both have reported favourable results in rice and wheat. But we need research on long-term effects on the fertility status of soils. We are hoping to create a partnership in sustainable agriculture that will help other NGOs and farmer groups learn and experiment with these methods. We invite ILEIA readers to join us in this effort to create an alternative paradigm of sustainable agriculture. ■

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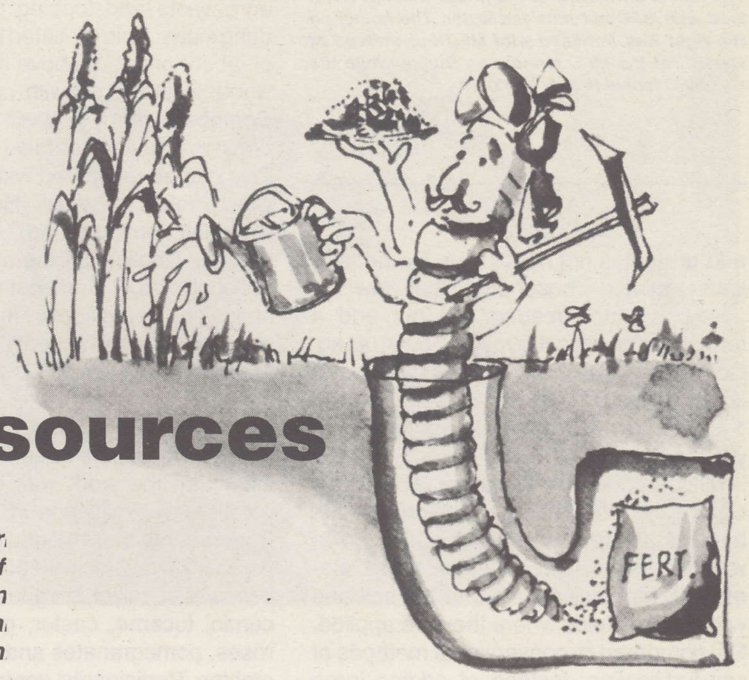
vermiculture biotechnology

Converting wastes into resources



Vermiculture, as propagated by the Bhawalkar Earthwor Institute (BERI), is a form of appropriate biotechnology f of organic wastes into valuable humus and plant nutrien agriculture, vermiculture also enhances soil formation a tion and hence creates optimal benefits for plant growth

Uday S. Bhawalkar

India alone produces about 750 million tonnes of organic wastes every year. Although an important part of these wastes are recycled in agriculture, conversion is, however, not very efficient and high losses of valuable nutrients occur. Organic wastes from cities and agricultural processing are often dumped, causing serious pollution. Though poor in nitrogen, phosphorus, potassium and other plant nutrients, as compared to commercial mineral fertiliser, organic wastes consist for 50% of biocarbon, which feeds the soil processes that make nutrients available to plants. They can also be applied as mulch which feeds as well as protects the living soil from sun and rain. Therefore, organic wastes are too valuable to be wasted.

Earthworms farm bacteria

There are about 3,000 different earthworm species known to man which can be divided into two main classes: "compost worms" and "earthworms". Compost worms thrive in decomposting organic matter above the soil surface. They do not process the soil and do not survive in harsh field conditions. It is somewhat inaccurate to call them "earthworms". The real earthworms burrow inside the soil. They consume organic matter as well as a large proportion of soil. The vermiculture technology developed by BERI over the past 12 years is based on one such species of burrowing earthworms called *Pheretima elongata*, which has been found to be especially efficient in breaking down the toughest of organic wastes like sugarcane trash.

Earthworms take organic litter from the soil surface into the soil. They grind organic matter together with soil particles and leave their castings throughout the soil profile. Through their burrowing activities earthworms not only increase the water holding capacity of the soil but also provide ideal aerobic growth conditions for bacteria as well as plant roots. Fortunately, both bacteria and plant roots thrive under similar conditions of moisture, temperature and pH. Earthworms enhance the growth of beneficial soil bacteria, the most diverse and speediest agents for decomposting organic wastes. Earthworms, on their turn, graze selectively on microorganisms and soil pathogens. By reducing their population density earthworms stimulate bacteria to continue their growth.

Earthworms maintain their population in spite of predators. They do not run away and have no diseases reported so far. Hence one can sustain one's earthworm population with just feeding. Absence of feed and moisture for a period forces them to go underground and hibernate. They become active soon when conditions improve.

Bacteria build humus

Bacteria are the smallest creatures in the soil. They are mostly beneficial and use organic waste as food to produce plant nutrients, vitamins, hormones and antibiotics. Without earthworms, however, bacteria may be restricted to the thin top soil and may operate at a low speed due to improper conditions of moisture, air, pH, temperature and nutrients. Healthy soil is teeming with bacteria and earthworms. Under low moisture or acidic conditions fungi and soil insects replace bacteria and earthworms. These organisms carry out the decompostіng processes at a lower speed.

While sugar, protein, starch, cellulose, chitin and other substances are biodegraded by bacteria, lignins are only partially modified by soil bacteria to form humus. Humus gives structure to the soil by keeping soil particles together. This enhances the ability of the soil to hold water and nutrients. A good humus reservoir is essential for producing fertile top soil which can boost plant productivity. This humus reservoir can be mined with excessive soil cultivation, exposing the soil surface to sun and use of excessive chemical fertiliser. This may produce bumper yields on a short term, but these practices are not sustainable.

Nutrient magnification

Organic farming often involves feeding tonnes of compost as source of plant nutrients. If a typical commercial crop needs per ha about 250 kg nutrients available to plants, this may require feeding about 10 tonnes of compost produced from nearly 30 tonnes of farm residues. These amounts are unlikely to be available and such organic farming may be achieved only by a few farmers at the cost of others. However, our experience is that under favourable conditions, by in-situ application of farm residues, vermiculture produces 10-20 times more available plant nutrients than would be available in the organic residues themselves.

Organic wastes are often burnt because they are not valued much because they have a low NPK content. However, organic matter is still valuable for its high bicarbon content (about 50%). Bicarbon feeds the soil microorganisms which, in turn, can get nitrogen from the air and other nutrients from the mineralisation of soil and rock particles. Earthworms not only enhance the activities of soil microorganisms but, by grinding tonnes of soil they also speed up the mineralisation process by which nutrients are released. In this way "nutrient magnification" can take place.

Starting vermiculture

Earthworms are thus ideal managers whom man can employ to maximise growth of aerobic bacteria for waste processing. To achieve this, all farmers need to do is rear earthworms by providing them with proper living conditions and then feeding them with organic wastes. Where earthworms disappeared, due to application of chemical fertiliser or erosion of the land, farmers can start vermiculture by applying vermicastings on their land to add life into their soils. These vermicastings contain cocoons with worm eggs. Farm residues are then applied directly as mulch. These are in-situ processed by the beneficial soil bacteria which are "farmed" by the earthworms hatched from the cocoons in the vermicastings. Where the original earthworms are still present in sufficient quantities this inoculation process is not necessary.

The box on this page compares the results of two ways of vegetable production, conventional farming and vermiculture. The results explain why so many farmers are interested in the many benefits of vermiculture.

Agro-industrial and city wastes

An other important application of BERI's vermiculture technology is in the large-scale processing of agro-industrial waste and city refuse. A unique example of this can be found at Venkateshwara Hatcheries, where a vermiculture facility has successfully begun processing poultry residues. The feathers, claws and other residues of ten thousand birds, amounting to over four tonnes daily, are converted by earthworms to produce vermicastings. This not only provided a tidy solution to the problem of waste disposal, but the resulting vermicastings are now being marketed by the company as a biofertiliser.

Why farmers are interested in vermiculture

A successful vegetable farmer planted tondali (*Coccinia cordifolia*) on saline soil and irrigated his crop with saline groundwater. His experiments with vermiculture had quite some results on the soil. Its pH improved from 8.2 to 7.3 in one year, its water holding capacity increased, the soil structure improved and salt-crustation on the surface disappeared. The produce was of better quality, fetching a 30% higher price. Although he had to pay Rs 4000 for 1 m3 of vermicastings, which is the amount BERI advises to use on 1 acre, profits where higher. The comparison of performance of a chemical plot (3 years) and a vermiculture plot (2 years) can be summarised as follows:

Chemical plot inputs for 1 acre	Rs/year	Vermiculture plot inputs for 1 acre	Rs/year
chemical fertiliser	2,700	vermicastings (divided over 5 years)	800
organic fertiliser	2,340	FYM, 15 cartloads	450
		organic fertiliser	980
		mulching	500
pesticide sprays (18 Nos. x 100)	1,800	pesticide sprays (6 Nos x 100)	600
weeding (6 times 250)	1,500	weeding	--
cultivation (3 times 300)	900	cultivation	--
irrigation (33 times 15)	495	irrigation (23 times 15)	345
total inputs	9,735	total inputs	3,675
soil depreciates	+1,000	soil appreciates	-1,000
real expenditure	10,735	real expenditure	2,675
average yield: 23,800 kg		yield: 22,710 kg	
returns (at Rs 2/kg)	47,600	returns (at Rs 2.6/kg)	59,046
expenditure	10,735	expenditure	2,675
profit	36,865	profit	56,371

Experiments

On an experimental scale, vermiculture is being harnessed to set up organic wastes bioconversion facilities in the cities and food industries. Individual gardeners and farmers are using vermiculture for swift changeover to low-external-input or organic farming without loss of yield. Also Redworms (*Eisenia foetida*) are used to produce vermicompost from organic waste. But as Redworms are "compost worms" they do not have the same benefits of nutrient magnification and feedback from the roots as with "earthworms". Redworms do not survive in harsh field conditions. Hence they are not useful for inoculation of farm land.

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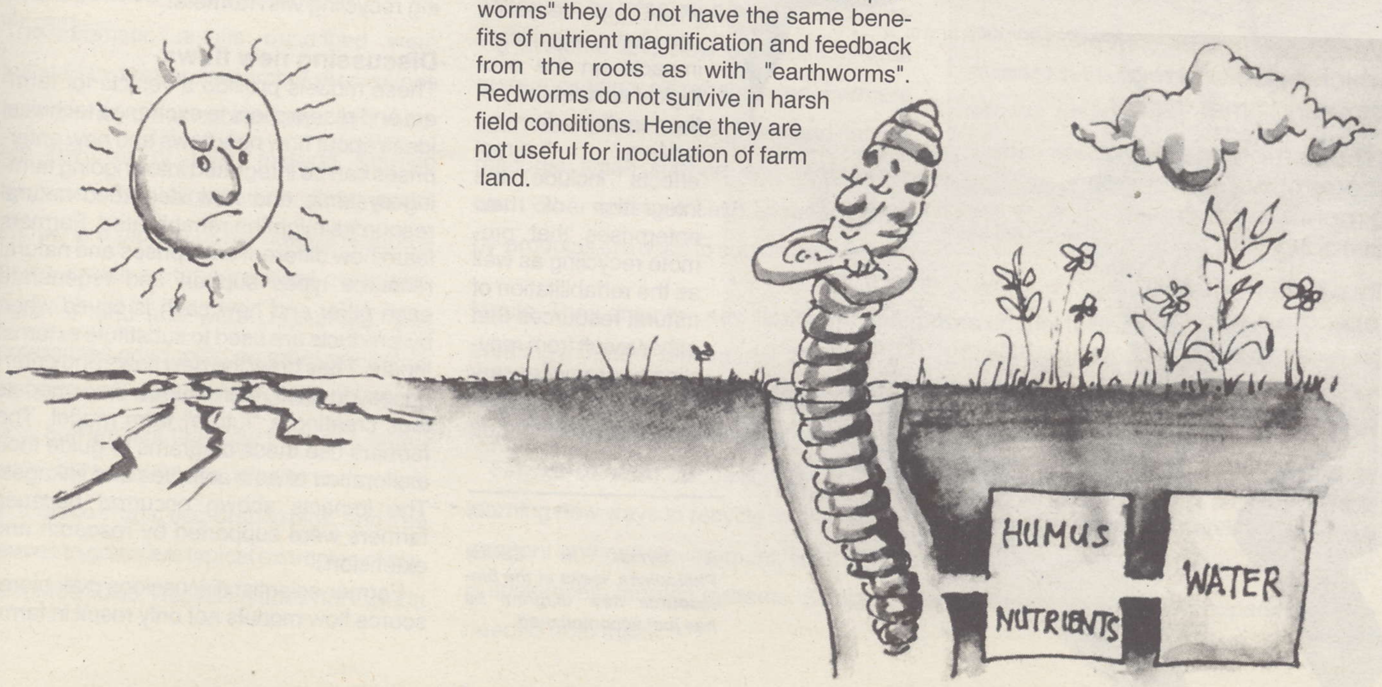
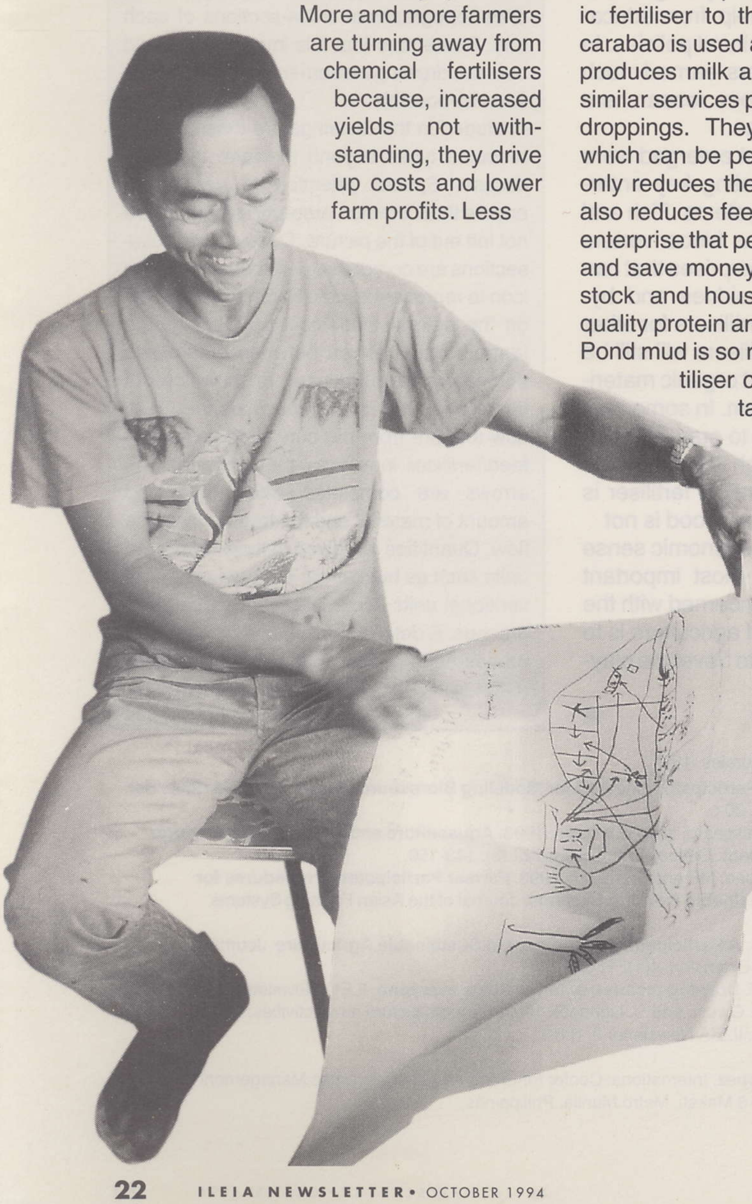


Bioresource flow modeling with farmers

Visualising the relation between farm enterprises and natural resource types enables farmers to explore new ways of recycling. But under which conditions does it economically make sense to recycle? A contribution from the Philippines.

C. Lightfoot, M. Prein and T. Lopez

Recycling of biological resources, wastes and by-products can improve farm natural resources and incomes. A common observation among farmers is that soil fertility is improved when organic matter is returned to the soil. Farmers estimate that compost materials can replace basal applications of NPK to reduce fertiliser costs by up to 50%. More and more farmers are turning away from chemical fertilisers because, increased yields not withstanding, they drive up costs and lower farm profits. Less well-known farmer's knowledge is that pig manure stops seepage from ponds and that mud dredged up from ponds can considerably increase vegetable yields.



A farmer in Cavite, Philippines, looks at the bioresource flow diagram he has just accomplished.

Indeed, when recycling flows are given cash values the gross incomes of farms increase dramatically. The value of all recycled materials can be up to 40% of gross farm income. Recycling is a bigger part of the farm economy than we might think. High value flows are often snails to feed fish, chickens and ducks, and rice grain to feed chickens. Lower value flows, though high in volume, are those for rice straw, which is utilised both as compost material and livestock feeds, and napier grass which is used as feed for cows, carabao and goats.

Recycling enterprises

There are some enterprises that are particularly good at promoting recycling. For example, a carabao eats grass and crop residues and produces manure for organic fertiliser to the crops. Moreover, the carabao is used as a draft animal and also produces milk and meat. Ducks perform similar services producing eggs, meat and droppings. They also eat some snails which can be pests in ricefields. This not only reduces the need for pesticides, but also reduces feed costs. Fish are another enterprise that perform ecological services and save money. Fish convert crop, livestock and household wastes into high quality protein and nutrient rich pond mud. Pond mud is so rich that it can replace fertiliser completely in small vegetable gardens.

Taken together the direct and indirect effects of recycling can have significant impacts on the ecological sustainabilty of the entire farming system. Indirect effects include the integration of new enterprises that promote recycling as well as the rehabilitation of natural resources that either result from recycling or are necessary to enterprise integration. For example, a farm had six enterprises and two flows before integration. These increased to 11 enterprises and six flows upon integration. The newly introduced fish pond opened opportunities for the culture of fish and water spinach using on-farm inputs. Existing by-products are used to a greater extent. These low-value flows led to the production of high-value products. Diversification and integration brought about an increase in net income from US$ 350 to US$ 750 and biomass production from 7 to 8 tons/ha.

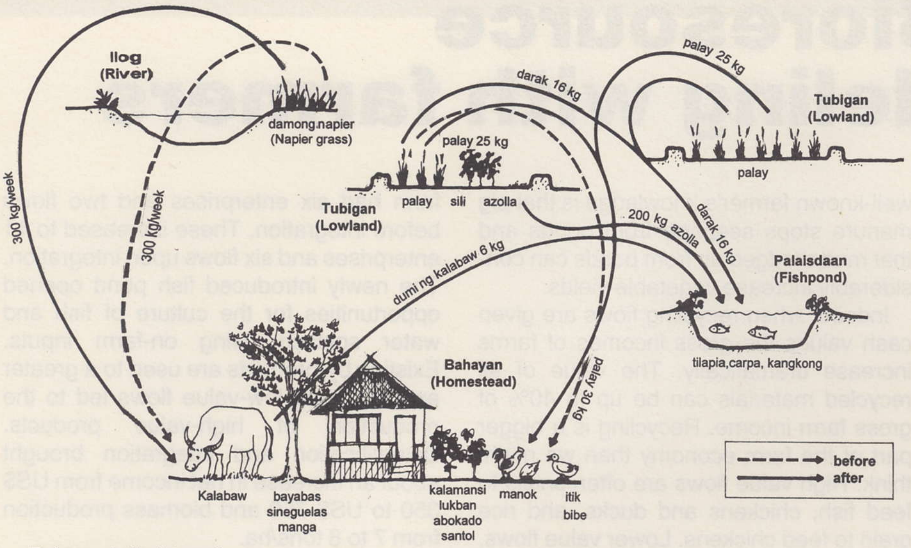
Bioresource flow models

The dramatic results described were initiated by farmer-researcher discussions over farmer-drawn bioresource flow models (BRFM) of their existing farming systems. The bioresource flow model shown is a picture of the natural resource types, drawn as topographical cross-sections of land and water resources. The enterprises conducted on them are drawn as icons and the farm generated by-products and wastes that flow from one enterprise to another are drawn as arrows. Manure to crops, rice-bran to pigs, and tree leaves to goats are typical examples of bioresource flows. Recycling does not include product (grain) flows to market or to household consumption except where household wastes, i.e. kitchen waste, cooking ash and night soil are recycled. Likewise, external inputs to fields like inorganic fertiliser are not included. These flows are omitted because they do not depict recycling. Bioresource flows can be expressed in several "currencies", like biomass, nitrogen, energy and cash. We have found biomass to be the most useful when discussing recycling with farmers.

Discussing new flows

These models provide a vehicle for farmers and researchers to exchange technical ideas about how new flows and new enterprises can be integrated into ongoing farming systems and how degraded natural resources might be rehabilitated. Farmers learn how different enterprises and natural resource types support and regenerate each other and how cash is saved when by-products are used to substitute external inputs. They draw the new flows and enterprises on their bioresource flow models thus creating a "future" farm model. The farmers use these diagrams to guide their exploration of new activities and linkages. The impacts shown occurred because farmers were supported by research and extension.

Farmer-scientist discussions over bioresource flow models not only result in farm-



Before and after integration:

Bioresource flows between natural resources, Philippines

ers learning new ways to recycle materials, but also inform the extension services, both government and non-government, what kinds of inputs farmers need to develop ecologically sustainable farming systems. Similarly, researchers learn what new experiments are needed from them.

BRFM puts a demand on research and extension from the farmer. This is the strength of the models, they help people learn about recycling. They do, however, have weaknesses. During discussions, farmers often ask how they should split up their meagre supplies of manure among enterprises. BRFM cannot provide a complete answer. Farmers can be helped visiting other farmers' plots or experiment station plots. It is, however, very difficult to generate the conversion coefficients for many wastes, particularly manures and composts, because they are so variable. This difficulty is increased by problems in trying to evaluate bioresources that do not have a market value. Somehow, using costs of labour involved in making the transfers, or using equivalent costs of chemical fertilisers underestimates the true value of these materials and all the services they offer.

Who can benefit

Given the benefits that can be achieved by recycling far fewer farmers recycle than could. Farmers give a wide range of reasons why they or their neighbours do not recycle. Cultural taboos may inhibit the handling of manures. Manure for fertiliser may compete with other domestic uses for manure, such as for fuel. Lack of access and tenure can keep people who need nutrients out of the recycling option. Not being able to grow fodder trees or graze animals on the "commons" are typical examples. Some farmers do not recycle because it is not part of their farming tradition. Other farmers do not recycle because it is not seen as modern or progressive farming. But, perhaps the most common reason given for not recycling materials like manure is that buying inputs is quicker than recycling, which is time-consuming and labour demanding. Simply, the returns are either too uncertain or too modest. Clearly, in many cases, recycling is not going to happen without help: from education and supportive agricultural policies. In the examples given, farmers learned much from each other and from researchers during the BRFM exercises.

Many of the new flows that emerged were made possible by integrating key enterprises into their farming systems. Fish and many other animals act as bioconverters of wastes on the farm. Enterprises that can turn low quality plant residues and byproducts into feeds and fertilisers for other enterprises are vital. Fertilisers will still be needed, but to supplement organic materials rather than replace them. In some cases this will not be enough to provide satisfactory returns to the high labour inputs required. As long as chemical fertiliser is cheap and organically grown food is not subsidised, it makes little economic sense to recycle. Perhaps the most important challenge facing those concerned with the ecological sustainability of agriculture is to demonstrate that policies to "level the playing field" are needed. ■

How to undertake BRFM

Bioresource flow models are constructed using participatory rural appraisal (PRA) techniques. This means that appropriate steps have been taken to ensure that you are talking to members of your target group and that all members of the research team are in listening mode. This is the time to elicit the household's knowledge. Prior to the PRA described here researchers must have identified the indigenous categories of natural resource types. These are the land and water resource types often found in agroecosystem transects.

While the example here describes a process with one household, the process works for groups as well. The PRA starts with a walk around the farm. During the walk: a) reaffirm the natural resource type categories; b) identify as many enterprises as possible, not forgetting to include off season enterprises, and c) remark on obvious evidence of flows, ie presence of a compost pit. On returning to the household explain to the household that there is too much going on for you to remember and ask them to recall what has been seen. Have the farmer indicate on the ground or on a large sheet of paper the natural resource types visited. Help them to draw topographical cross-sections of each one. Remember that it is important to hand over the drawing instrument to the farmer as soon as possible.

Included in the drawings are those natural resource types beyond the farm that they access. Special attention is needed to ensure that common property resources are not left out of the picture. Once all the cross-sections are completed, ask them to draw an icon to represent each enterprise conducted on the natural resource types. Lastly, the farmers draw arrows between enterprises and natural resource types to show flows of farm-generated biological materials, e.g. cow manure from the cow shed used as a feed/fertiliser input into the fishpond. The arrows are completed with name and amount of material and the frequency of the flow. Quantities are given in local terms and units such as bucketful's or bundles or conventional units according to individual preferences. A detailed description of this method has been published in ILEIA Newsletter (Ofori et al. 1993, Lightfoot and Tuan 1990).

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C. Lightfoot, M. Prein and T. Lopez, International Center for Living Aquatic Resources Management (ICLARM), MCPO Box 2631, 0718 Makati, Metro Manila, Philippines.

Nutrient flows calculated

On the black cotton soils of South Gujarat, sugar cane has been a major cash crop for the last 15 years. It has developed because of a good cooperative establishment and a good demand for sugar. The sugar cane farming system is, however, also an example of the imbalance of the modern agricultural system.

Dilip Chinnakonda

Fertilisers and pesticides are indiscriminately used. Pest and disease problems have increased over the years, the water table has gone up, causing salt coming up. Nitrogen is used at a rate of 450 kg/ha/yr, phosphorus 125 kg/ha/yr and potash 125 kg/ha/yr, without the supplement of organic manure. It is estimated that 10 to 15 tonnes of dry weight tops are burnt every year, an equivalent of 75-100 kg N/ha/yr. It is not surprising that micronutrient application has become necessary during the past years and some farmers are trying to adopt ecological techniques.

A thesis research was done to study the question: what changes can be made in the conventional sugar cane farming system, based on the experience of ecological farmers? Part of the study was to calculate nutrient balances. Nutrient balances can identify nutrient deficits from farm operations and clarify the differences between conventional and ecological farming practices. They can also be used to assess flows of nutrients entering and leaving the farm. They give an overall indication of nutrient cycles and show the result of farm management decisions. Nutrients enter the farm with bringing in organic material (manure, fodder, concentrates, wastes), N-deposition from the air, symbiotic N-fixation and through mineral fertilisers. Manure produced on the farm is assumed to be returned to the land. Nutrients are exported with farm products sold. Other nutrients are lost through unused farm wastes and residues, which are either burnt, sold, disposed of or "disappear" into soil, water or air. Fodder, straw or residues produced on the farm can be fed to cattle or mulched in which case nutrients are recycled.

Comparing farms

Two farms in Bharuch district of South Gujarat have been observed. Mr. Praful Pandya has a 9.1 ha sugarcane-sugarcane-rice based conventional farm system, using 10 to 25% less chemicals than recommended by the university and sugar factory. Besides paddy, cotton and sugarcane, he grows wheat, gram (*Cicer arietinum*), safflower (*Carthamus tintorius*), rajko (*Medicago sativa*, a fodder crop) for a cattle herd of 11, Sesbania and pigeon pea. Paddy straw is sold and wheat straw is fed to the cattle, as well as purchased concentrates. The farm is under permanent irrigation, manure is stored in the open and not always applied to the land.

Mr. Satish Patel has a 35 ha ecological farm in the same village. The crop rotation strategy is guided by soil management and before the Kharif (monsoon season) crop, he takes a green manure crop like Sesbania and he fertilises the plot. On the total farm, 1.5 tonnes of chicken manure (purchased externally) and 1.5 tonnes of oil cake are applied for fertilisation. Mr. Patel brings back the oil cake from the oil mill where he gets his oil seeds crushed for oil. After the Kharif crop, he takes a crop with minimum water requirement, which builds up organic matter, adding to the nutrient pool of the soil and breaking the pest and disease cycle: safflower. Safflower is a deep rooted crop bringing up the nutrients deep down, which otherwise would not be available to the crops. Other crops grown are paddy, mulberry for silkworm rearing, soybean, peanuts, pigeon pea, bajri (*Pennisetum typhoides*) and rajko. Without chemical fertiliser, he harvests a very good paddy crop (4000 kg/ha). Labourers come to his fields first as they get rice instead of money. They say the rice from his field tastes better, even as it gets old. Seed buyers come to him first as they are sure of 100% germination. There are 37 cattle and all manure is used on the farm. The slurry from the biogas digester is led into a closed pit. All harvest wastes are composted. The yields of the ecological farm are about 20% to 25% lower when compared to the conventional farm. However, Mr. Patel uses farm resources only and, moreover, he finds quality more important than just high yields. If labour, economics and even energy were to be calculated, a comparison would give quite a different outcome.

NPK balance

The nutrient balance is calculated for major nutrients in kg per ha in table 1. The NPK-balance has been calculated per three cropping seasons (one year). The nutrient content of crops and inputs are

Table 1: Nutrient balances in kg/ha/yr

	Mr. Pandya's farm			Mr. Satish Patel's farm		
input	**N**	**P**	**K**	**N**	**P**	**K**
fodder & straw	26.3	3.6	26.2	0.8	0.1	0.3
fertiliser/ manure	131.9	49.0	52.7	20.0	0.9	5.7
deposition	10.0	1.0	3.0	10.0	1.0	3.0
N-fixation	34.4			99.6		
total input	202.6	53.6	81.9	130.4	2.0	9.0
output						
milk	6.9	1.3	1.5	8.4	1.4	2.3
food, fodder	107.9	40.4	108.1	81.2	9.6	32.9
total output	114.8	41.7	109.6	89.6	11.0	35.2
input/output (losses/accumulation/gain)	87.8	11.9	-27.7	40.8	-9.0	-26.2
efficiency %	56.7	77.8	133.8	68.7	550.0	391.1

standard data, taken from literature. The percentage of utilisation is calculated as total output of the system / total input of the system. Total N output = N in food, fodder & straw + milk & meat. Total N input = N in purchased feed and fodder + N-fixation + N-deposition + N in additional fertiliser or manure.

Human and animal excreta are added to the manure. Part of its N is returned to the land and part of its N is lost through volatisation. Some straw and fodder is also added to the manure. For example, the N-utilisation for Mr. Pandya's farm is calculated to be 57%. This means that 57% of the total N-input in the farm is used for production or, in other words, 43% (87 kg/ha) is lost or accumulated in the soil. This rate is not obtained by on-farm resources alone. For Mr. Patel's farm, N-utilisation is calculated to be 69%. This is obtained by proper nutrient and soil management and crop rotation. The only input is purchased chicken manure. But as the farm has a deficit of both P and K, in the long run an extra input of P and K will be needed.

Discussion

What is the use of these types of calculations? The nutrient balances of the farms were calculated with a computer model developed at the Department of Ecological Agriculture in Wageningen. However, Indian farmers, researchers and policy makers are not using it, as the tool is not available and the concept not present. Only a few farmers analyse their soil on the basis of nutrient deficiencies and pest problems. Then they use the recommended dose of fertiliser. But crop rotation and soil fertility management is not taken into account.

Mr. Patel sees the nutrient balance calculation as a powerful tool to analyse a farm. To solve the deficiency in P, he started an experiment with phosphate solubilizing bacteria for better phosphorus uptake as the soils in South Gujarat contain high amounts of available P. P deficiency can be further reduced by purchasing leguminous concentrates for cattle and reinforcing bio-gas slurry with bone meal or superphoshate. K-deficit can be reduced by proper handling of liquid manure. Mr. Pandya sees it as an additional promising method of analysing the nutrient requirements of the farm. In addition to this, he would also get the soils tested to confirm the soil reserves.

The future

The farming system in South Gujarat is specialises more and more towards monocropping of sugar cane, thereby undermining the long-term sustainability of farms. Nutrient balance analysis is an alternative for the conventional crop-oriented fertilisation approach. It will give farmers more insight in the nutrient flows on their farms and therefore it enables them to reduce both costs of fertilisation and environmental pollution. Livestock integration provides better waste recycling thereby achieving a better nutrient balance. Milk cooperatives could stimulate integration of livestock.

The nutrient balance calculation as a tool for better farm management should be developed by the sugar co-operatives. Also, NGOs can be involved in developing this tool further. They can calculate the nutrient balance of farms. The farmer's involvement is necessary and will not be left out as his farm management decisions are important for a proper nutrient balance of the farm.

■

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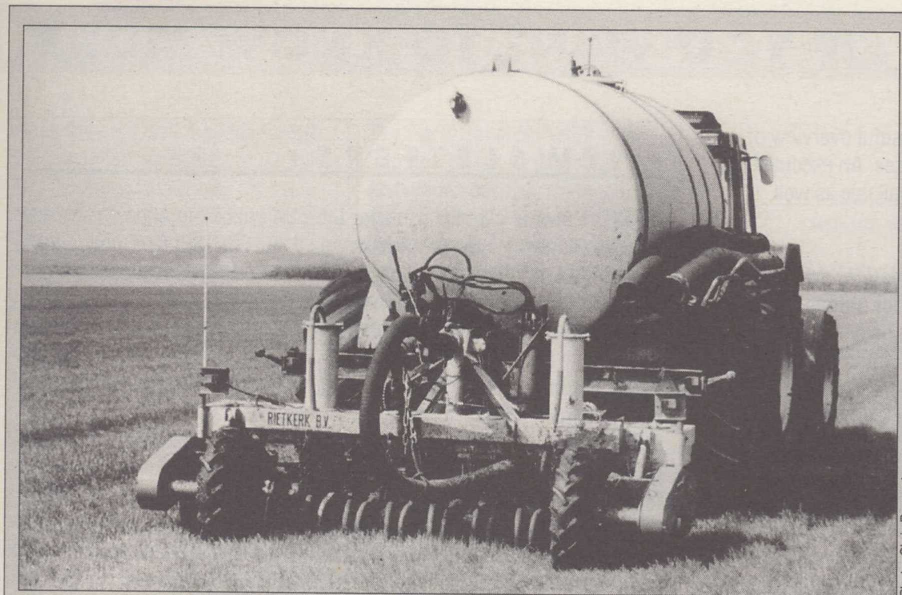


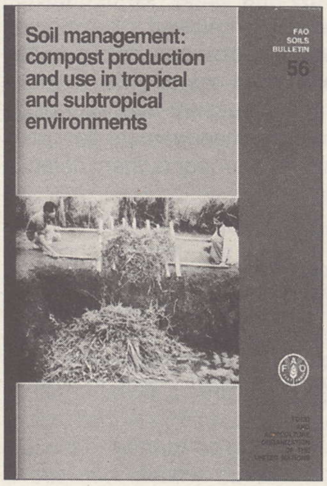
Photo: Chris Pennarts

Nutrients in the Netherlands

Nutrient balances are not new in Dutch agriculture. As of 1 January 1995, the Ministry of Agriculture is making nutrient balance calculation obligatory for dairy farmers. A standard will be given, indicating what surplus of kg N, P or K is acceptable per ha grazing land. For nitrogen, this might be 350 kg/ha. If the balance shows a figure beyond that standard surplus, the farmer has to pay a levy. For example, a farmer has 25 ha and the surplus per ha is 470 kg N, or 120 kg over the accepted surplus. With a levy of Dfl. 2/kg N, he has to pay Dfl. 240 per ha or Dfl. 6000 in total (USD 3.500).

Farmers are joining study groups to learn how to calculate nutrient balances. Fokke Benedictus, a dairy farmer states: "It is important to know the figures to find room for improvement. Ten years ago, I applied 400 kg N per ha. Now only 255 kg, because the organic manure is better used. Our cows also have less feeding problems." One way to make better use of nutrients is through a so-called manure injector. In the barn, the liquid manure is pumped into the tank and in the fields it is directly injected into the soil (see photo). Today, 983 million kg pure N are imported into the Netherlands, of which only 274 million kg is used. Consequently, 709 million kg disappears into soil, water and air. There is still room for improvement!

Health aspects of nightsoil and sludge use in agriculture and aquaculture. IRCWD Reports Nos. 4 and 5, 1985.
These two reports are part of the output of a project of IRCWD and the World Health Organisation (-WHO) on the actual health risks related to the use of human excreta. The two reports are state-of-knowledge reviews. Report No. 4 deals with existing practices and beliefs in the utilisation of human excreta and pathogen survival. Report No. 5 deals with the epidemiological perspective. The publications are of interest from a health perspective. (CR)



Soil management: compost production and use in tropical and subtropical environments by Dalzell et al, FAO Soils Bulletin 56, Rome 1987. 178 pp. The classical book on practical compost production and use.

Human waste use in agriculture and aquaculture, utilisation practices and health perspectives, IRCWD Report No. 9, 1990. This report of the IRCWD/WHO project is a compilation of case studies on the use of human excreta and waste water from Latin America and Asia. Each case is accompanied by an in-dept discussion on the health implications of the particular practice. The different cases are compared in discussion chapters. An important message is that health protection may be achieved not by waste treatment alone, but by a combination of measures, including crop restriction, choice of the irrigation or application method, exposure control and waste treatment. A very useful overview of existing practices. An executive summary is available as well. (CR)

Anaerobic digestion, principles and practices for biogas systems by CG Gunnerson and DC Stuckey, 1986. Integrated Resource Recovery Series No.5, Washington DC, The World Bank. This report summarizes the current and potential status and practice of biogas systems in developing countries and provides practical data for building an anaerobic digester. It gives an overview at a highly technical level. (CR)

Alternative feedstock for biogas. Published by the Consortium on Rural Technology in 1992. CORT, D-320, Laxmi Nagar, New Delhi 110 092, India.
This report contains research experiences with the use of a wide range of organic waste resources for the production of biogas. Traditionally cattle dung is used in more than one million biogas plants in India. Alternative sources, for example from processing industries, provide valuable sources of feedstock which, in general, are still underutilised. There seems to be a need for evaluation of practical field experiences. (CR)

Refuse isn't rubbish is the title of an article by Stocking and Albaladejo in *Ambio* Vol.23 No.3, May 1994, p.229-232. Mr. J. Albaladejo is head of the Natural Resources and Environmental Protection Department, Centro de Edafologia y Biologia Aplicada del Segura, Apartado 4195, 30080 Murcia, Spain. The article reports on a research programme to use city refuse for rehabilitation of severely degraded semiarid land in the Mediterranean coastal zone of Spain. After 3 years of research it seems to be clear that this option can be a success strategy for large-scale rehabilitation of degraded land. However, direct costs, mainly of transport, are still a problem. Further research will be focused on the off-site impacts and the overall societal cost-benefit equation.

Indigenous management systems as a basis for community forestry in Tanzania: a case study of Dodoma urban and Lushoto districts by GC Kajembe. 1994. Wageningen Agricultural University, Department of Forestry, PO Box 342, 6700 AH Wageningen, The Netherlands. 194 p. US$ 12.00. (Tropical resource management papers / WAU, ISSN 0926 9495; 6).

Describes the lack of success of various projects dealing with indigenous forest management systems in Tanzania. The author argues that community-generated management is based on a different idea of participation than is the case with externally sponsored projects, where the community is invited to participate in the project rather than the other way round. People's participation can only be achieved if community initiatives are taken into account. If not, what remains is only fashionable rhetoric. In the areas under study, forest management traditionally consisted mainly of sets of recognised use-rights. The assumption, by the projects, of uniformity in household farming was too simplistic. As a result of the mixed results the author suggests there are three actor categories to be considered in community forestry development projects: farmers, village extension workers and supervisors, who are -or ought to be- interacting on some "middle ground". Finally, the author speaks out against the current forest policy of Tanzania, based on restrictive and punitive measures and not involving farmers enough. Proper government policy is a must for more successful resource management projects. (WB)

The wonderful worm: agricultural and industrial applications. C. Ashok Kumar, 1994. Development alternatives B-32 TARA Crescent, Qutab Institutional Area, New Delhi 110 016, India. The author made a study on the application of vermiculture in India. An article on this study has been published in *Development Alternatives*, Vol.4 No.7. The article provides information on technical aspects as well on organisations involved in research and development.

Closing linear flows of carbon through a sectoral society: diagnosis and implementation by Maurice Strong and Erik Arrhenius, in *Ambio* Vol.22 No.7, Nov. 1993, presents the results of the Royal Colloquium 1993 on "Tropical and subtropical coastal zone management: a question of carbon flow in a sectoral society". In the same issue of *Ambio* several other papers presented on the Colloquium are included. Based on practical cases, the linear flows of organic matter, nutrients and

• NEWSLETTERS •

IRCWD News is a bulletin of the International Reference Centre for Waste Disposal, Ueberlandstrasse 133, CH-8600 Duebendorf, Switzerland. It informs about activities of the IRCWD team, important studies and new publications on waste disposal in developing countries. IRCWD News is published on an irregular basis.

Development and Ecology is a quarterly magazine published by Action For Food Production (AFPRO), 25/1A Institutional Area, Pankha Road, D-Block Janakpuri, New Delhi 110 058, India. The magazine presents the experiences of AFPRO, one of the larger NGOs working on agricultural development in India. Subjects regularly dealt with are watershed management, biogas, vermicomposting, water supply, participatory appraisal and sustainable development. The magazine reflects the wide and rich experiences gained by AFPRO and is easy to read. (CR)

WARMER (World Action for Recycling Materials & Energy from Rubbish) is an international bulletin published by The Warmer Campaign, 83 Mount Ephraim, Tunbridge Wells, Kent TN4 8BS, UK. The bulletin presents practical experiences with waste recycling, mainly in industrialised countries but sometimes also in less industrialised countries.

water are analysed. Experiences to reverse these flows are presented and discussed in articles on e.g. tropical soils, dryland agriculture, water supply and waste disposal, sanitation, coastal ecosystem management, seawater-based agriculture and aquaculture. Highly recommended for think-tanks on sustainable land use. (CR)

Arbres et agricultures multiétagées d'Afrique by H Dupriez, P de Leener. 1993. Terres et Vie, 13 rue Laurent Delvaux, B-1400 Nivelles, Belgium. 280 p. ISBN 2 87105 012 0. Free for ACP countries. Technical Centre for Agricultural and Rural Co-operation (CTA), PO Box 380, 6700 AJ Wageningen, The Netherlands. Practically oriented, this manual deals with tree management in Africa. The first part of the book examines the role of trees in African rural societies and studies to which extent trees have receded from the countryside as well as the consequences of this. The second part deals with agroforestry issues, or multi-storey agriculture, as the authors prefer to call the mixed cropping of trees and arable crops. The often applied division of agriculture, livestock-keeping and forestry is artificial in the case of smallholders, it is argued. Much of the content of the books is illustrations with comments, which make it pleasant reading and browsing. The manual definitely fills a gap in francophone literature on agroforestry. I have slightly regretted the tendency of the text to become too much a set of prescriptions, which does not seem to take into account the enormous variety of African settings. (WB)

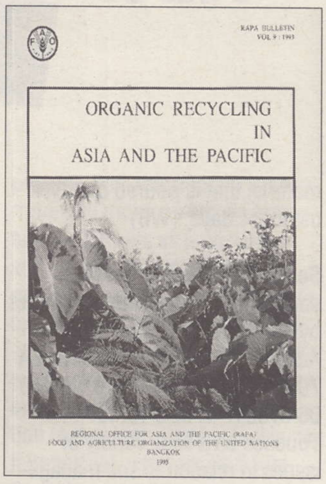
•NETWORKS•

The **African Compost Network** will be founded at the inaugural workshop, organised at the Ecole Nationale Superieure Universitaire de Technologie (ENSUT), 7-10 November. The francophone workshop presents lectures to exchange experiences with various composting methods.

For more information: Dr. Mamadou Seck, Département Génie Chimique et Biologie Appliquée, ENSUT, Université Cheikh Anta Diop, BP 5085, Dakar, Sénégal.

The Earthworm Network was founded by research institutes involved in earthworm research in Europe, Latin America and Africa. Experiences are exchanged and information is put together in databases. Experiments to determine the effects of the introduction of earthworms by members of the network are very interesting. For example at Yurimaguas, Peru a 40-78% increase in grain production of rice and maize crops was recorded. In other places yield increase was less spectacular but still interesting. Effects on the soil are also very positive.

Contact: Tropical Soil Biology and Fertility Programme (TSBF) c/o UNESCO-ROSTA, PO Box 30592, Nairobi, Kenya.



The Regional Organic Recycling Institution Network of FAO's Regional Office for Asia and Pacific (RAPA) produces a continuous flow of information in its annual bulletin **Organic Recycling in Asia and the Pacific**. Vol. 9:1993 consists of 108 pages with abstracts of papers on mainly research trials. The bulletin deals with N- and P-biofertilisers, compost and industrial wastes, green manures and mulches, biogas, sewage and night soil and integrated farming. The publication reflects the increasing interest in these subjects.

Write to: RAPA, Maliwan Mansion, Phra Atit Road, Bangkok 10200, Thailand.

•WANTED•

IPNS computer programme

I would like to get into contact with colleagues from various agro-climatical zones (wet-tropical, dry-tropical, subtropical irrigated and temperate zones), who are willing to test my IPNS computer programme for the calculation of integrated plant nutrition of cropping systems. Also co-operative managers and extensionists, for whom the programme is actually being developed, are kindly invited to indicate their interest.

Why a computer programme? Calculation of recommendations for plant nutrition of agroforestry and multiple cropping systems may cause extension and research workers real headaches. The easiest way to solve the problem - just apply what is available at the nearest market or outlet - usually causes waste of nutrients, due to imbalance between nutrients applied and required. This may lead to leaching, pollution, low production and low quality. For these reasons integration of organic, biological and mineral fertilisers is a necessity. Judicious application of plant nutrients (timing, split, depth, etc) should lead to synchronous nutrient uptake by crops and availability in the soil solution.

Users of the IPNS calculation programme may select their own strategy, making use of organic and mineral fertilisers, biological N-fixation and release of fixed phosphorus with the help of mycorrhizae, recycling of crop residues and human and animal excrements. They may include biogas installations, Azolla production in paddy fields or farm ponds. Without the use of mineral fertilisers, the area required for production of nutrients to obtain optimal crop production on 1 ha is about 3 to 4 hectares, depending on the soil mineral composition and chemical weathering as well as decay of organic matter. The resulting soil nutrient availability does not normally show the same ratio in nutrient release as is required by the crops to be grown. This ratio may however be balanced, if also mineral fertilisers are applied - a necessity in densely populated areas. The big questions are however, how do you know how much and which nutrient is needed and when is its carrier to be added?

The IPNS computer programme, which is applicable for all cropping systems between latitudes 50° N and S, contains a database including the nutrient requirements of over 600 crops produced world wide. Users of the programme may compose their own cropping pattern and fertilisation strategy over a period of four years. The farm may contain up to 20 fields and each field may be planted with 4 crops simultaneously.

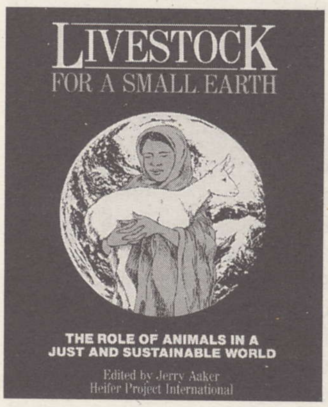
Basic inputs required are soil analysis data, average daily temperatures, average rainfall data, data concerning the farm and its fields, cropping pattern and crops to be grown. At any time during planning stage, the user may check his results by either making graphical or tabular presentations, including nutrient balance, for each of the macro-nutrients and water availability and pH. The IPNS programme is interactive and has an educational help function.

The idea of a computer based programme was developed during 16 years of experience in crop production extension in tropical countries in various agro-climatical zones. In 1991 FAO considered the idea of such importance, that it supported further development with a grant and the use of its facilities, data and library. The simulation is now ready to be released, though not yet complete. It has been tested with data from farms in the Netherlands, Niger and India.

Write to: Albert Hekstra, Oranjelaan 29, 3843 AA Harderwijk, The Netherlands. Tel: +31 3410 12629, Fax: +31 3410 30602.

NEW IN PRINT

Looking back and looking forward: a participatory approach to evaluation by J Aaker, J Shumaker. 1994. Heifer Project International, PO Box 808, Little Rock, Arkansas 72203, USA. 106 p. US$ 10.00.
A very practical step-by-step manual on how to evaluate small-scale development programmes of NGOs. Key issue is that project evaluation is an ongoing process -as is project planning- in which all actors involved should learn how to look at their experiences in a systematic manner in order to better cope with future challenges. Project evaluation is a difficult task when looking at such hard-to-measure phenomena as empowerment and participation. There are a number of annexes with elaborate examples. A clear presentation of a difficult subject. (WB)



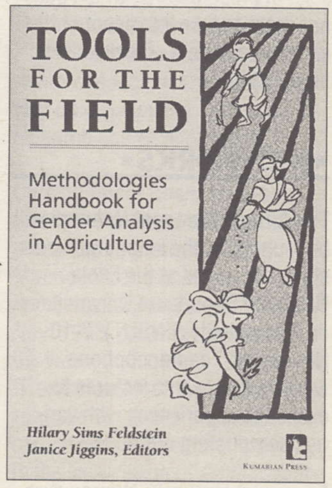
Livestock for a small earth: the role of animals in a just and sustainable world by J Aaker. 1994. Heifer Project International, PO Box 808, Little Rock, Arkansas 72203, USA. 111 p. ISBN 0 929765.28 1. US$ 10.00.
"A primer on development assistance using animals." Many issues are brought into this guide: sustainable development, environmental concern, social participation, technology transformation, indigenous knowledge. Obviously, not everything can be said on just 111 pages, but the tone of the book is pleasant: it is a pastiche of concepts, practical facts and stories. One cannot help but think that in these cases such an impressionistic and eclectic approach is the best way to convey the message. By using clear language and many drawings (often so much easier to interpret than photos) the message really comes across. So refreshing amidst all learned material that is poured out over us, these days. (WB)

Secrets of the soil: new age solutions for restoring our planet by P Tompkins, C Bird. 1990. Acres, PO Box 8800, Metairie, LA 70011-8800, USA. 444 p. ISBN 0 06 015817 4. US$ 15.00.
Touches on a wide variety of issues in relation to soil management, from an anthroposophic point of view. In some 450 pages we learn about rock dusting on soils with mineral deficiencies, fluid dynamics as the basis for the vortex of life, sowing with the moon calendar, the usefulness of weeds as soil conservation agents, the causes of the dying forests in Europe, and incantations for improved crop productivity. Afterwards, one feels completely dazzled but not unpleasantly so. (WB)

Sustainability of land use systems: the potential of indigenous measures for the maintenance of soil productivity in Sub-Sahara African agriculture: a review of methodologies and research results by Z Hailu, A Runge-Metzger. 1991. Institute of Agricultural Economics, University of Goettingen, Germany. 168 p. ISBN 3 8236 1219 0. DM 32.00. (Tropical agroecology, ISSN 0935 9109; 7). Verlag Josef Margraf, PO Box 105, D-97985 Weikersheim, Germany.
Attempts to design a multidisciplinary research approach to examine the sustainability of prevailing landuse systems in sub-Saharan Africa. Special attention is paid to the systems' dynamics and the potentials embodied in indigenous measures by which farmers try to adjust to changing situations. According to the authors' definition of sustainability, a sound methodology has to consider the environment, as well as economic and social aspects. In sub-Saharan Africa productivity decline due to increased population pressure and soil exhaustion were countered not by intensifying cultivation methods but by clearing new lands. Land degradation is not due to shifting cultivation as such but to the shortening of the fallow period. Historical examples like irrigation canals, extensive terraces, farmer-managed shadoff systems and community-managed hill furrow systems testify of the existence of precolonial intensive agriculture. Few of these systems have survived though, and little is known to explain their disappearance. Changes in the political set-up (e.g. colonial rule) often led to the destruction of the traditional socio-political institutions resulting in abandoning adapted systems that depended on these institutions. Although a literature overview of indigenous agronomic practices is given, the paper fails to give insight in the result of soil conservation. (AG)

Natural resource management in pastoral Africa by R Behnke. 1994. Overseas Development Institute (ODI), Regent's College, Regent's Park, Inner Circle, London NW1 4NS, UK; International Institute for Environment and Development (IIED), 3 Endsleigh Street, London WC1H 0DD, UK. 19 p. Price unknown. Export and Industrial Development Division, Commonwealth Secretariat, Marlborough House, Pall Mall, London SW1Y 5HX, UK.
Deals with land tenure issues of communal rangelands. The author argues that ill effects of pastoralism need not be feared as much as is often the case in view of the resilience of Africa's rangelands. Still, some regulation of pastoral activity may be necessary in specific circumstances, but interventions will not have to take place to such an extent as to modify almost every aspect of pastoral land use. Rather than stock numbers, rainfall determines the biomass quantity and in non-equilibrium situations, with erratic rainfall patterns, it is impossible to adapt livestock numbers to the feed supply. This is in sharp contrast with equilibrium situations, with a more dependable climate, where the herd manager can adjust livestock numbers much more precisely. What happens in the African situation is not adapting livestock numbers but rather seeking to increase access to resources, either politically or in a military manner. Land tenure systems in Africa are the outcome of this flexibility and are vital for the survival of the system. The problem is that they are hard to accommodate within a central administrative context. This paper and the connected proceedings of various workshops on the subject could lead to a rethinking in range management in Africa. (WB)

Tools for the field: methodologies handbook for gender analysis in agriculture by HS Feldstein, J Jiggins (eds). 1994. Kumarian Press, 630 Oakwood Avenue, Suite 119, West Hartford, CT 06110-1529, USA. 270 p. ISBN 1 56549 028 2 (pbk). US$ 24.95. (Kumarian Press library of management for development).
A collection of papers, many of which originated in the context of the symposia by the International Association for Farming Systems Research and Extension (AFSRE). Gender refers to socially or culturally established roles of women and men. It is not about women's issues, as is often thought. The past 30 years have given more insight in small-scale farmers' rationality in decision making. Now, the editors argue, changes have become so numerous and fundamental that development can no longer take place without modern science. What is needed is scientists taking into account



farmers' knowledge while designing new technologies. If new technologies are to strike root, one

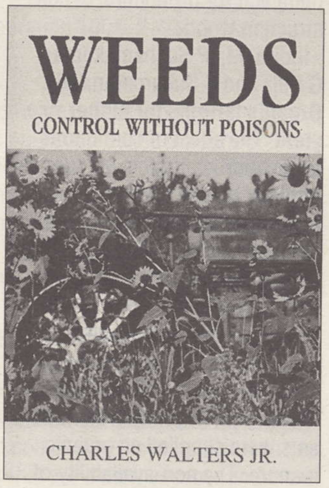
must understand gender differences.
A central theme in gender differentiation is farm labour performance. Household decisions are not a cohesive phenomenon but the result of interaction of individual interests between men, women and children. Gender analysis concentrates here on 3 issues: Who does what, when, and where? Who has access to or control over resources for production? Who benefits from each enterprise? (WB)

Useful farming practices by S Hirose ... [et al.] (eds.). 1993. 163 p. Price unknown. Association for International Cooperation of Agriculture and Forestry (AICAF), 19 Ichibancho, Chiyoda-ku, Tokyo, 102 Japan.
A very practical manual on cultivation practices in South East Asia. Deals with rice cultivation, upland cropping (mainly rice), vegetable growing and fruit trees. Presented are 109 systematic descriptions of technologies in South East Asia. All these technologies have been described by Japanese, mostly volunteers. Many descriptions have an editor's comment, very useful to temper the sometimes overoptimistic descriptions. (WB)

Local knowledge, global science and plant genetic resources: towards a partnership by GD Prain, CP Bagalanon (eds). 1994. User's Perspective with Agricultural Research and Development (UPWARD), IRRI, PO Box 933, Manila, Philippines. 298 p. ISBN 971 614 002 9. Price unknown.
Proceedings of a workshop dealing with plant genetic resources. It pleads for incorporating the user's perspective into research on genetic resources. The message is clear: local knowledge should be used together with global agricultural research much more than is the case now. In this particular instance it means that farmers must be consulted about the varieties they grow, that they must give their opinion about the various genetic materials tested out by themselves, that it is them who should disseminate these materials, and that they should also act as keepers of the genetic materials: in-situ conservation. All these ways have been worked out and illustrated in the text. The contributions deal with sweet potato in South-East Asia, but conclusions can easily be extended to other plant species. (WB)

NEW IN PRINT

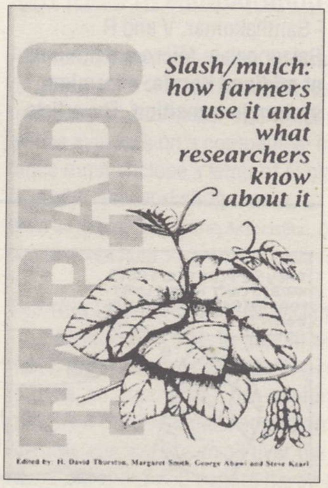
Weeds: control without poison by C Walters. 1991. Acres, PO Box 8800, Metairie, LA 70011-8800, USA. 320 p. ISBN 0 911311 25 4. US$ 17.00.
Advocates, in an easy style, the seeking of a natural balance in soil



management to keep weeds in check. Where weeds are abundant, there is some imbalance in soil elements: different weeds are an index of what exactly is wrong in the soil. This publication is about the USA, and so a number of the weeds mentioned are not of global importance. Still, the approach is valid: preventive crop husbandry and soil management and not curative interventions. By maintaining a proper and stable level of soil fertility weeds will not become a problem, though they will remain present, in low numbers. (WB)

Improving the transfer and use of agricultural information: a guide to information technology by W Zijp. 1994. World Bank, 1818 H Street, NW, Washington, DC 20433, USA. 105 p. ISBN 0 8213 2868 9. Price unknown. (World Bank discussion papers, ISSN 0259 210X; 247).
Argues, not surprisingly, that farmers in developing countries have hardly benefited from the new information technology until present. Still, information is seen, more and more, as just as important for farmers as land, labour and capital. Therefore, more money should be invested in new technology applications for agricultural development in developing countries. This paper gives an overview of the role of information technology: what is it, why is it important, what are its limitations, how can it be used, what are preconditions for its use. There are a number of annexes giving useful practical information about things like computer networks, desktop publishing, CD-ROM, geographic information systems (GIS), multimedia, rural radio, satellite communications, and video. The text is clear, the presentation somewhat austere: no drawings to make these complicated technologies any clearer. (WB)

Slash - mulch: how farmers use it and what researchers know about it by HD Thurston, M Smith, G Abawi, S Kearl (eds.). 1994. Cornell International Institute for Food, Agriculture and Development (CIIFAD), Box 14, Kennedy Hall, Cornell University, Ithaca, New York 14853-5901, USA; Centro Agronómico Tropical de Investigación y Enseñanza (CATIE), 7170 Turrialba, Costa Rica. 302 p. Price unknown.



Proceedings of a workshop on slash & mulch farming systems, traditionally practised in Central and South America in humid zones where burning is impossible. Slash & mulch means that forest vegetation, or alternatively a cover crop such as velvet bean, is slashed. Crops planted in the resulting mulch receive their nutrients from the decomposing vegetation. Such a cropping system is very environmentally friendly, when compared to slash & burn and can enhance crop productivity by making more organic material available. Labour, at least at peak times, is reduced because of less weeding. Though practised and adapted by Central American farmers for a long time, researchers have given little attention to the system. The underlying proceedings compile the information available. An interesting subject, and well presented. (WB)

Surveys, plans and people: a review of land resource information and its use in developing countries by B Dalal-Clayton, D Dent. 1993. International Institute for Environment and Development (IIED), 3 Endsleigh Street, London WC1H 0DD, UK. 148 p. £ 8.00. (Environmental planning issues; 2).
Studies the ways in which natural resources are assessed and how subsequent landuse planning is influenced by the quality of such studies. There is no development planning without proper assessment of available natural resources. Making such an evaluation without clear terms of reference or without having an idea of the final users of such information can mean a lot of unnecessary work, though. This is aggravated by the fact that landuse planning is often divided in sectors and top-down. The authors trace assessment methods back to colonial times. A multitude of different techniques are presented. They conclude these are not much good without participation. Quality and use of information are the limiting factors in designing proper landuse policies. So, both data collection and data interpretation ought to be improved. Although one could fear the subject would lead to a high level of abstraction, the text is clear and well written. Development planners and researchers could highly benefit from reading this paper. (WB)

ILEIA NEWS

ILEIA continues!

We are happy to announce that the ILEIA Project will continue for another 4.5 years! This assures the continuation of the ILEIA Newsletter and creates new opportunities to cooperate with members of the LEISA Network to deepen insight in and develop methodologies for sustainable agriculture. In the coming year, ILEIA will identify three regions, representing different ecozones, to concentrate on. In cooperation with local counterparts, a participatory diagnosis will be executed, plans will be formulated and implemented for supporting field research, networking and training. In the new phase, ILEIA is to establish formalised relationships with research institutes in the above zones as well as in the North.

The ILEIA Newsletter, while gradually focusing more on the outcomes of regional activities, will retain its global orientation and distribution. More than before, the Newsletter will try to provide comparative and quantitative data on different agricultural technologies and development situations. In the next Newsletter the new programme of ILEIA will be presented in more detail.

Farming for the future

This ILEIA/Macmillan publication is now in its third printing. Over 8,000 copies have already been sold and the book is still available at a very reasonable price of £6.95 directly from Macmillan. Both the French version "Une Agriculture pour l'Avenir" and the Portuguese version 'Agricultura para o futuro' are due to appear before the end of the year. A Spanish version will be published in 1995 and translations in Hindi, Telugu and Chinese are being prepared. We'll keep you informed.

Visit Peru and Mexico

Bertus Haverkort was invited to represent ILEIA at a workshop of CONDESAN (Consorcio para el Desarollo Sostenible de la Ecoregion Andino), held in Cajamarca, Peru, to identify priorities of research and development for the watershed of Cajamarquino. CONDESAN was established in 1992, realising that the problems of poverty and ecological deterioration can not be solved by the isolated activities of specialised research and development organisations. In the Cajamarca workshop various international, governmental and non-governmental organisations and the university work together. The workshop took five days and was very successful: it led to a good atmosphere between the different partners and an integrated planning framework was formulated.

During the same trip, Bertus Haverkort met with several interesting people and organisations in Mexico. Together with Professor Jesus Arias Chavez, he visited his instute Xochicalli. Prof. Arias is an expert in bio-digersters and has developed integrated systems of housing, animal production, waste treatment and use of its products as fertiliser, irrigation and drinking water. The International Centre for Research on Agroforestry (ICRAF) was also visited in Mexico. Possibilities for cooperation with this programme to develop alternatives for shifting cultivation were explored.

Contributions

- Santhakumar, V and R Rajagopalan. **Micro-catchments of midland Kerala: a farming system in transition**. The article describes agricultural change in the Nellaya watershed. It was found that higher plant diversity is needed in the watershed to increase the availability of organic manure, for moisture management and for production of construction wood.
- Indira, M, P Sushamakumari, G Suja and S Sukumaran Nair. **Organic farming for higher rice yield**. The effect of continuous application of organic manure and fertiliser on rice production has been studied since 1964. The highest yield was recorded when the nutrients were supplied as cattle manure followed by fertiliser plus cattle manure and fertiliser alone. Incidence of earhead blackening, a major problem, was found to be least when all nutrients were supplied as organic manure. The non-availability of sufficient amounts and the high costs of manure make that cattle manure alone is not used. The authors propose to cultivate green manures in garden lands.
- Sthapit, BR. **Potential research areas of local green manure Asuro in the rice ecosystem: blending farmers knowledge with technology generation**.. A research report from Nepal on Asuro (*Adhatoda vasica*). It was found that paddy rice treated by Asuro 10 t/ha of green leaves outyielded rice to which chemical fertiliser was applied. To fertilise 500 m^2 of paddy field about 100 bushes will be needed. Many questions still need to be answered.
- Min Kuanhong. **Sustainable development of integrated fish farming**. In China, integrated fish farming in ponds is a very old practice to recycle organic waste. If not well managed, there can be adverse impacts due to over application of waste and accumulation of pond mud which affect the fish's health, erosion of the embankment may leave too less space for deposition of pond mud. Work is being done on genetics and disease control.
- Anikwe, M. **Earthworms, rice straw, rock phosphate, poultry dropping and rice production in low-external-input agriculture**. Practical experiments were conducted to develop vermiculture.

Photocopies of these articles can be ordered free of charge from ILEIA.

Future issues

The first issue of the ILEIA Newsletter in 1995 will again be a "Keep Rolling" issue. We invite you to send us articles describing your experiences with any of the subjects dealt with in earlier newsletters. Please note that your article should be accompanied by at least two illustrations, preferably black and white photos. Contributions should reach us before 1 December so that we have ample time to discuss the article with you.

NETWORKING is open for (short) contributions from readers. If you wish to ask advice from other readers, or if you wish to announce a workshop or training course or if you just want to react on articles that appeared in the ILEIA newsletter or other hot news items related to sustainable agriculture, please write. We may have to shorten submitted contributions.

The proceedings of the first regional IFOAM workshops in Africa and Asia have been published. The reports give a good overview of the activities of the members of the International Federation of Organic Agriculture Movements in the two continents. The African report can be ordered by the Kenya Institute of Organic Farming, PO Box 34972, Nairobi, Kenya (costs DM 35) and the Asian report by the Japan Organic Agriculture Organisation, Hongo Corporation 1001, 2-40-13, Hongo, Bunkyo-ku, Tokyo 113, Japan.

North Indian Hindi speaking practitioners of sustainable agriculture are described in a directory compiled and published by the Gorakhpur Environmental Action Group. The directory lists over 60 individuals and organsiations, indicating their specialism, the problems they encounter and trainings they offer. An index with keywords of sustainable agriculture is included.

Contact: GEAG, Post Box 60, Gorakhpur 273 001, India.

Greetings from the South Pacific! I have spent my entire working life (40 years) in the tropics, learning my "trade" on plantations run by large Corporations, and finally working all over the world with the problems of developing countries. One of the most frustrating aspects of my experience in developing countries has been convincing the "establishment" to accept new ideas or new technologies that are better, cheaper and more sustainable. I developed the "Vetiver system of soil and moisture conservation" and in my last five years with the World Bank, perfected this system in India on our Watershed Management Projects. Since then, the World Bank has been able to spread the "message" of the value of vetiver grass hedges and the multitude of uses they can be put to in land stabilisation. They established the "Vetiver Newsletter" which has over 3,000 correspondents worldwide. I am surprised that in your Newsletter, you still support soil conservation practices that we have clearly shown to be nonsustainable and uneconomic throughout the tropics. In your July '94 issue, you show a bamboo check dam backed by Napier grass. I am afraid such interventions are only a bandaid on the problem - the bamboo rots, the Napier grass will not persist under the pressures of grazing, drought of fire, and once the check fails, the silt that has been trapped is washed down the drainage line. On the other hand, the vetiver system of hedges across the slope (they do not need to be on the contour as they do not convey runoff, they spread it out and filter it before it passes through the base of the hedge) slows the runoff down giving it longer to soak in to the soil, replenish the aquifers, revitalising perennial streams and drought proofing farmers crops. The vetiver system is the farmers' system. They can afford it and it never lets them down. The oldest vetiver terrace we have recorded is in Karnataka in Southern India: 200 years old and still working. The World Bank has a package of data it will send you free, which will bring you right up to date with the current work. (letter shortened by the editors)

John C. Greenfield, 21 Reinga Road, Kerikeri 0470, New Zealand.

An MSc Programme in Ecological Agriculture is offered by Wageningen Agricultural University, the Netherlands. The 17-months programme starts every year in September. In the first year, students study advance courses in ecological agriculture such as Phenomenology, Design and Analysis of Mixed Farming Systems, System Analysis in Agriculture and Socioeconomic Aspects of Ecological Agriculture. The programme is very flexible: participants are asked to compose their own study programme. The advanced courses are a preparation on the thesis research. To get the Master's degree students have to finish with a 6-months research project resulting in a thesis. The subject of the thesis is determined in consultation with the course staff. Applicants need to have a BSc-degree in agriculture (or any other relevant subject), a proven knowledge of the english language and a well described thesis subject. The costs are around US$ 20,000 including fees, housing, food, books, etc.

For more information: Dept of Ecological Agriculture, Ir. C. van Veluw, Haarweg 333, 6709 RZ Wageningen, Netherlands. Fax: +31 8370 84995.

The **Tanzania Popular Media Association** (TMPA) is a local NGO that promotes and encourages the use of cartoons and campaign comics. They organise seminars and trainings for comic artists to improve their skills in the media, they provide information and training to other professionals and institutions interested in using the media, they provide comic books and professional reference library services and they arrange comic and cartoon exhibition festivals. TMPA further publishes books, magazines and other printed matter.

Contact: Katti Ka-Batembo, TMPA, PO Box 420, Morogoro, Tanzania.

Conflict Resolution is the theme of a training course organised by the Regional Community Forestry Training Center (RECOFTC) in Thailand. The course is held from 12-20 December in Bangkok and aimed at middle level officials and NGO personnel involved in forest management and conservation. The course will teach participants to analyse sources of conflict to understand the opposing interests, set goals and plan strategy, decide on negotiating strategy, make best use of their own negotiating style, enhance communication ability, and how to avoid an impasse. The course will consist of lectures combined with role playing exercises, interactive discussion, group work and presentations. Course fee: US$ 1,550.

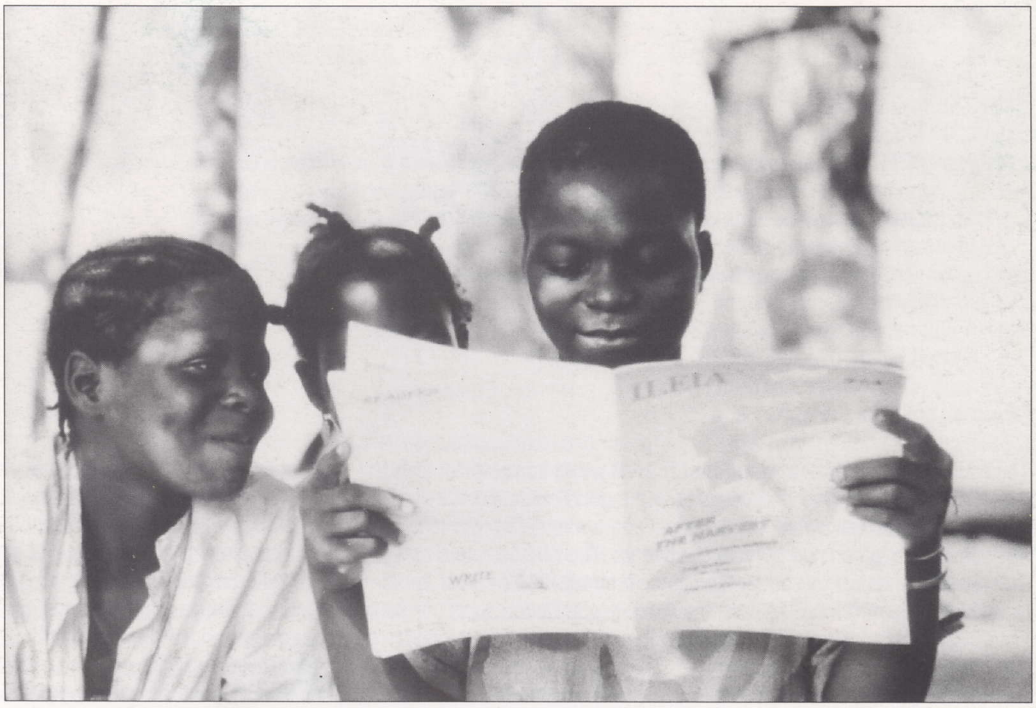
Contact: Dr. Somsak Sukwong, RECOFTC, Kasetsart University, PO Box 1111, Bangkok 10903, Thailand. Fax: +66 2 561 4880.

An **International workshop on Nitrogen Fixing Trees for Fodder** is organised in Pune, India, 20-25 March 1995. Abstracts should be submitted by 30 November 1994. A limited amount of financial assistance will be available on a competitive basis. Those requesting financial assistance must enclose a letter of explanation and details of published work related to the workshop theme.

Write to: Nitorgen Fixing Tree Association, Dr. Joshua N. Daniel, c/o BAIF, Kamdhenu, Senapati Bapat Road, Pune 411 016, India. Fax: +91 212 349806.

The **10th International IFOAM Conference** will be held in New Zealand, 10-14 December. This bi-annual worldwide gathering of the organic movement promises outstanding events including the international conference, an organic fair, pre-conference tours and the general assembly of IFOAM (International Federation of Organic Agriculture Movements). Keynote speakers from all over the world have confirmed their presentations and about 250 papers have been submitted.

Ask for a conference brochure from: Conference secretariat, PO Box 84, Lincoln University, Christchurch, New Zealand. Fax: +64 3 325 3840.



Did you know that the ILEIA Newsletter is printed on 100% recycled paper, called "Cyclus"?

I was in back in Ivory Coast to visit the oil press project in Dozéré, to know how it continues after the devaluation of the franc CFA. Everybody was very happy about the article in ILEIA and proud that their village was mentioned. I think, it passed through all hands in the village! Best regards, Barbara Böni.

Open for your contribution

The first ILEIA Newsletter of 1995 will not have a special theme. So, take your opportunity to get your experiences published, preferably backed up with data! Deadline for contributions: 1 December 1994

Recycling cartoons

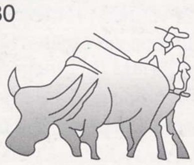
Jef Nieuwenhuis was the cartoonist in the first issues of the ILEIA Newsletter (1984). This earthworm did not survive the eco-bombing as s/he did not come back.

Compost for sale

As of 1 January 1994, all Dutch municipalities have to collect organic and non-organic wastes separately. In 1990, only 9% of the housholds separated their wastes, which will have increased to 84% by the end of 1994. But there is no market for the compost! With its low phosphorus content, up to 30 tonnes per ha can be used on agricultural lands without surpassing the government limit of 125 kg P/ha. Yet farmers are hesitant. It's a new product and they fear diseases and heavy metals. They have to be proven wrong by research.

ILEIA continues!

See page 30



We are still open to receive pictures related to topics planned for upcoming ILEIA Newsletters. This photo was sent in by Cleophas Tumwineho from Kasese, Uganda, on waste recycling.

Next issue

Vol.10 No.4 "Farming at Close Quarters" is scheduled to appear 5 December.

BACK COPIES of the ILEIA Newsletter are available: (US$ 5)

Vol.3/No.2:	Diversity
Vol.4/No.3:	Participatory technology devt
Vol.4/No.4:	Enhancing dryland agriculture
Vol.5/No.1:	Discussion on sustaining agriculture
Vol.5/No.2:	Intensifying agriculture in humid area
Vol.5/No.4:	Local varieties
Vol.7/No.1/2:	Assessing farming techniques
Vol.7/No.3:	Learning for sustainable agriculture
Vol.7/No.4:	Searching for synergy
Vol.8/No.2:	(reprint) Let's work together
Vol.8/No.3:	Livestock sustaining livelihoods
Vol.9/No.1:	Keep rolling
Vol.9/No.2:	Cutting back on chemicals
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Vol.9/No4:	A strong case for diversity
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Vol.10/No.2:	Caring for our land

(issues not listed are out of print)
Please do not order more than four back copies

Also available: **Participatory Technology Development in sustainable agriculture: an introduction**. 1989. 40 pp. US$7.50. **Le développement participatif de technologies,** a translation into French of ILEIA Newsletter Vol.4/No.3 (US$). Third World readers may request a free copy.

ILEIA PO Box 64 NL-3830 AB Leusden Netherlands