



## Africa's soils are being mined

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

### Eric Smaling

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

#### Calculating the nutrient balance

To calculate nutrient balances, the arable land of 38 countries was partitioned into units of similar production

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

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

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

greatly among and within countries. Other loss mechanisms are leaching (OUT 3) of nitrogen and potassium, the anaerobic process of denitrification (OUT 4) and erosion (OUT 5).

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

#### Nutrient mining in all countries

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

The main conclusions of the study were that sum of inputs minus sum of outputs of nutrients is negative in all countries, and that the net removal of



Photo: Hans Hu

## Local economies: framework for assessment

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

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

### Market economics

The current, nonsustainable state of the world can be blamed on the market-economy perception of reality which is the basis of conventional development policies. The market is seen as the main instrument to regulate supply and demand and hence the flow of materials. Profit-making is the main driving force. The market economy is based on a linear concept: using huge quantities of energy and raw materials (mainly from the South) as inputs, processing and transporting them around the globe, and selling them (mainly in the North) to consum-

ers. In the end, they are excreted as waste at "the other end of the pipe". The "free" market with its invisible hand cannot guarantee that social and ecological needs are met, as the market economy is a power-play ruled by those who can pay the best prices. As vulnerable social groups and the environment have no clout on the market, they can be exploited at low costs. Real costs are externalised, leaving the burden of social and environmental damage on vulnerable groups and future generations. There is some danger that this is occurring even in the global trade in organic produce.

### Market agriculture

This economic concept, translated to agriculture, has favoured:

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

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

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

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

#### Low-external-input agriculture

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

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

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

#### Assessing LEISA technology

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

#### Nature's economy

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

and major links are still obscure. Nevertheless, millennia of experience with survival in the natural environment permit certain important principles to be derived:

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

#### Survival economy

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

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

#### Objectives for sustainable agriculture

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

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

and the farm household itself are subject to change, another important aspect of security is adaptability: the local capacity to innovate, to develop new technology and new options for survival.

– **continuity.** The short-term as well as the long-term interest of the household is to conserve or, if possible, enhance the available resources: natural, human and capital. Different strategies can be used such as keeping as much biomass as possible in and on the soil (e.g. by fallowing, agroforestry, intercropping, recycling organic matter), applying fertiliser, conserving water and soil, keeping trees and livestock as savings, transferring experience from generation to generation, observing rules of inheritance and maximising returns to cash.

– **identity.** Most farming systems are also shaped by social and cultural objectives such as status, prestige, ideology (farming should be, e.g., natural, organic, scientific), leisure, nature conservation, social relations, and division of labour between men and women.

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

### Strengthening local economies

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

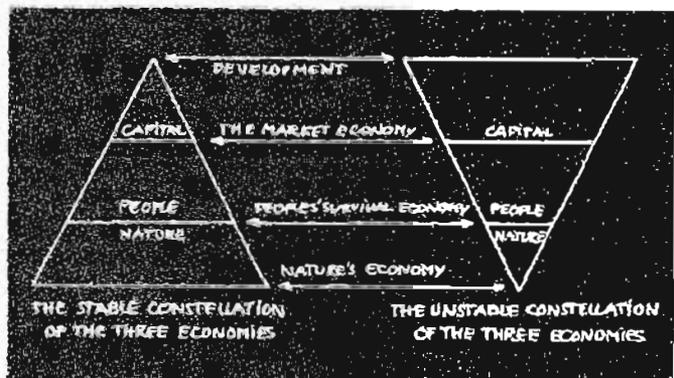
- local food self-sufficiency should be enhanced;
- resources should be better distributed;
- natural resource management should be the responsibility of the local community, for which a high level of local autonomy is needed;
- renewable resources should be used as much as possible;
- diversification and recycling, especially of nutrients, should be key strategies;
- indigenous knowledge and culture should be rein-

forced to enable rural communities to determine their own development path.

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

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

The ecological approach to conservation.



## Three economies

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

Preserving the sanctity of development and economic growth through sustainable development is based on a false interpretation of sustainability. Economic growth takes place through over-exploitation of natural resources and people's survival economy. Further economic growth cannot help in the regeneration of the very spheres which must be destroyed for economic growth to take place. Nature shrinks as cap-

ital grows. Natural resources can be turned into cash, cash cannot be turned into nature's ecological processes. Those who offer market solutions to the ecological crisis limit themselves to the market and look for substitutes to the commercial function of natural resources as commodities and raw material. However, in nature's economy, the currency is not money, it's life! Real sustainability therefore demands that market and production processes be reshaped on the nature's law of return, not on the laws of financial profit.

### Redressing the balance

Today, in addition to the industry-oriented agricultural policies of the past three decades, sustainable agriculture faces a new threat from the trade liberalization regime being pushed through the General Agreement for Trade and Tariff (GATT). The free market for transnational agribusiness translates into a total lack of freedom for local farmers to adopt sustainable agriculture practices. While big business depends en-

tirely on public subsidies of all kinds for its profits and markets, there is much din and noise in GATT on removal of subsidies.

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

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

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