Monocultures towards sustainability

Editorial

The prevailing global trends - improvement of crop varieties, increase in the use of agrochemicals, mechanisation, liberalisation and globalisation of agricultural trade, national economic growth, increase in the use of fossil energy, agricultural policies and subsidies favouring production of main and export commodities, development of biotechnology, hybrids and genetically modified organisms, and privatisation of research and extension - support the growth of monocultures, which are often seen as unsustainable. The productivity and sustainability of annual food crops is of extreme importance for feeding an ever-growing world population. In this issue, we look at the negative impact of monocultures, especially of annual food crops, and the alternatives that are being developed.

Photo: PMHE project

Monocultures of the main annual food crops urgently need to be made more productive and sustainable.

Expanding monocultures

Whenever farmers focus on market production and adopt the agrochemical model, high-input monocultures become predominant. Not only the number of different crops and animals but also the genetic diversity tends to decrease. The increased use of agrochemicals seriously affects the natural biodiversity in and above the soil, on the farm and in the wider environment. Expanding scale and levelling of land leads to the loss of natural micro-environments and to a further decrease in diversity. In extreme cases this leads to large-scale farming with near endless high-input monocultures, year-to-year production of single crops on the same land, as in many Western and in some Southern countries like Brazil (soybeans, p.6), Philippines (sugarcane, p.22), Bangladesh (rice, p.16) and India (rice and wheat, p.8).

Political and economic forces are driving agriculture towards monocultures. Such systems are rewarded by economies of scale and contribute significantly to the ability of national agricultures to compete on international markets. The case study on soybean monoculture in Brazil (p.6) provides a good example of how international trade reduces biological and economic diversity, degrades natural resources and affects small farmers.

Serious consequences

Although this type of agricultural development made it possible to increase production in excess of global population growth, there is increasing evidence that if continued its negative impact on food security, rural poverty, and the conservation of natural resources will outweigh the benefits. For example (Torres et al, 2000; Altieri, 2000):

- Evidence from a number of experimental and field sites indicate declining growth of yields for the main 'Green Revolution' cereals under intensive cropping on some of the better lands, e.g. the Indo-Gangetic plains (p.8). In some places (e.g. p.6 and p.22), yields are actually in decline.
- Most large-scale agricultural systems exhibit a poorly structured assemblage of farm components, with almost no linkages or complementary relationships between crop enterprises and among soils, crops, and animals. Cycles of nutrients, energy, water and wastes have become more open which makes it increasingly difficult to recycle nutrients. Hence, these systems are very inefficient in the use of their resources.
- Higher primary production is obtained by increasing the use of external inputs and is leading to a decrease in their efficiency.
- Use of pesticides in the developing countries is increasing exponentially, just as is their negative impact on the health of people and the environment.
- As specific crops are expanded beyond their "natural" ranges to areas of high pest potential, or with limited water, or low-fertility soils, intensified chemical controls are required to overcome the limiting factors.
- High-input monocultures depend increasingly on fossil energy and lead to depletion of soil organic matter, which in turn contributes strongly to climate change.
- Lower prices of agricultural products were particularly beneficial to urban populations, but have not had the same effect in rural areas. On an average, around 50% of the rural population in many places remain to be poor. The most affected regions are Sub-Saharan Africa and South Asia.
- Dietary consequences of monocultures are substantial. Reduced crop and natural biological diversity has resulted in decreased dietary diversity. Eating more maize, rice or wheat has actually increased micronutrient malnutrition, especially in Green Revolution areas, termed as 'hidden hunger' (IRRI, 1999).

About two-thirds of the agricultural lands have been degraded to some degree in the past 50 years by erosion, salinisation, compaction, nutrient depletion, biological degradation, or pollution; about 40% of these lands are strongly or very strongly degraded. Unlike more complex agro-ecosystems, high-input monocultures are not capable of providing multiple functions of ecological and economic value. If we choose to continue the current patterns of resource use, we will be faced with the decline in the ability of agro–ecosystems to yield their broad spectrum of benefits – from clean water to stable climate, fuelwood to food crops, timber to wildlife habitat (World Resources Report, 2000).

Sustainable alternatives possible

In many places in the world it is already happening! Out of economic and ecological necessity, farmers and development supporters are trying to move away from high-input monocultures. Different approaches are being followed, e.g. Resource Conserving Agriculture, Evergreen Revolution, Agroecology,

Permaculture, Regenerative or Organic Agriculture. There are important differences between these approaches but they all have a common denominator: resource conservation.

The transitions described in the articles lead to: reduced and more efficient use of agrochemicals, fossil energy, irrigation water and seeds; storage of carbon in soil organic matter and biomass (which reduces climate change); reduction of soil degradation. But at the same time they lead to higher production and lower costs and labour! This is true for zero tillage in rice-wheat production (p.8), ecological intensification of rice production (p.11 and 12), diversification of the production of rice (p.16), sugarcane (p.22), cotton (p.18) and maize (p.20), and is contrary to common belief!

Monoculture or polyculture?

But what type of biological diversity is needed for ecological sustainability? Wood (p.14) challenges polyculture as a means of sustainable production of annual cereals in the light of many natural grass monocultures. What can farmers learn from these natural monocultures to improve the productivity, stability and ecological sustainability of the present high-input monocultures? Wood states that single crops have self-regulation through high crop-associated biodiversity, in the soil as well as in the vegetation, in and outside the field. It is this associated biodiversity that is strongly influenced and reduced in high-input monocultures, due to agrochemicals, intensive tillage and the large-scale. The cases show that higher productivity and reduced losses and costs can be achieved by: combining different varieties of e.g. rice (p.12), intercropping, e.g. maize and tomatoes (p.20), rotation of soybean and wheat (p.7) or combining rice, fish, vegetables and trees (p.16).

It may also be possible to learn from the experiences of traditional and ecological farmers, e.g. how do they manage their annual cereals? Do they mimic natural monocropping or do they consciously combine annual cereals with other crops to enhance productivity, stability and sustainability? It may be interesting to look at these in terms of crop management, e.g. How do ecological farmers in Madagascar get higher rice yields than Green Revolution farmers? (p.12). Their System of Rice Intensification (SRI), is now being successfully tried out in many countries. Other cereals can be produced in a similar way, as in the example of the Bonfils/ Fukuoka approach for winter wheat (p.13). Clover or other leguminous cover crops used in wheat (p.13) and in rice-wheat production (p.11) may be an interesting additional element to zero-tillage, among others, in the Indo-Gangetic Plains (p.8).

Ecosystem approach needed

A shift to resource conservation requires, first and foremost, a reorientation on how we look at (agro-) ecosystems - we need to view their sustainability as essential to our own. Adopting an "ecosystem approach" means that we evaluate our decisions on land and resource use in terms of how they affect the capacity of ecosystems to sustain life - not only human well-being, but also the health and productive potential of plants, animals, and natural systems (World Resources Report, 2000). 'Agroecology' is based on a detailed understanding of ecosystems and the complex interactions of soil, water, plants, animals and farmers; it involves the whole farm and landscape system, and is far more holistic than the conventional crop ecology approach. This requires a scientific re-orientation as well.

In essence, the optimal behaviour of agroecosystems depends on the level of interactions between the various biotic and abiotic components. By assembling a functional diversity it is possible to initiate synergisms which support agroecosystem processes by providing ecological services such as the activation of soil biology, the recycling of nutrients, the enhancement of beneficial arthropods and antagonists, and so on. Today, there is a diverse selection of practices and technologies available, although they vary in effectiveness as well as in strategic value. (Altieri, 2000; Gliessman, 1999). Making monocultures sustainable is not just replacing chemical inputs by organic equivalents, but a systematic farmer-led conversion process. It requires gradual re-modelling of the agro-ecosystem by testing various options to improve ecological and economic performance as in conversion to organic agriculture (pg.21).

The design of farm implements adapted to ecological practices, such as zero-tillage (p.8) and polyculture is often very important, not only for conditions where mechanisation is needed, but also for those in which hand labour and animal traction prevail.

Old truths to be revised

The acceptance of the narrow scientific logic of conventional agriculture restricts the real possibility of implementing alternatives that challenge this logic. Some opposing practices are:

- Intensive seedbed preparation – zero-tillage (p.8).
- Use of herbicides – use of mulches and cover crops (p.11).
- Continuous irrigation – rice production in aerated soil conditions (p.12).
- Practices that inhibit tillering in cereals – practices that stimulate tillering e.g. in rice (p.12) and wheat (p.13).
- High density row planting in grains – low density planting e.g. in rice (p.12) and wheat (p.13).
- Use of agrochemicals to fertilise the soil and control pests and weeds – use of cover crops, mulches, and functional biodiversity (p.22).

The time is ripe to revise such old truths as the alternatives are resource conserving and have the potential to increase production in a competitive way. Yet, much remains to be learned about sustainable agriculture, thus further research is essential and urgent (Global Forum for Agricultural Research, 2000).

The experiences show that there is great potential in agriculture based on resource conservation and agroecology. Unleashing this potential may reduce the need to introduce genetically modified varieties, before taking the time to analyse and discuss possible risks.

Towards biodiversity based agriculture

Merely introducing alternative agricultural designs will do little to change the underlying forces that lead to high-input monoculture production, and will not improve the situation long-term. Ecological degradation is not only an ecological process, but also a political, economic and social process. Many national and international policy changes, e.g. regarding pricing and incentives, research and extension, agricultural trade and education are necessary to create favourable conditions for development of sustainable agriculture (Altieri, 2000).

Transforming monocultures needs large-scale and intensive involvement of all stakeholders. Participatory learning, research and extension programmes that can reach and mobilise large and diverse groups of farmers are needed. Supporting farmer learning and experimentation through, for example, Farmer Field Schools (p.24), Farm Planning (p.26), Sustainability Analysis (p.28), Participatory Research (p.8) and Farmer-to-Farmer approaches and the use of mass communication and information technology can be important elements of a large-scale, cost-effective strategy to make the shift.

A mass movement needed!

However, this cannot happen without a mass movement of farmers and consumers convinced of the dead-end road of high-input monocultures. Broad coalitions of development workers, researchers, policy makers and funders who support such a movement and create a critical mass against prevailing economic and conventional scientific forces are needed. ■

References:

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- Global Forum on Agricultural Research (GFAR). 2000. **Proceedings of the GFAR-2000 Conference "Strengthening partnership in agricultural research for development in the context of globalization"** also CD-ROM. GFAR Secretariat, c/o FAO/SDR, Viale delle Termi di Caracalla, 00100 Rome, Italy. Fax: +39 06 5705 3898, GFAR-Secretariat@fao.org .

Other references see p.31