Agricultural chemicals – How much input is required, how much is too much?

More than 40 years after the onset of the Green Revolution, the use of chemicals in developing country agriculture continues to be intensively debated. How much chemical use is needed? Are there cost-effective alternatives that contribute to rural poverty reduction?

The use of chemicals is one of the most disputed issues in agricultural development. For some, modern technology including a package of synthetic fertilizer, chemical pesticides and high-yielding seed varieties are the key for sustainable development, providing enough food and agricultural raw material for the world's growing population. Increasing yields per unit of land additionally benefit the environment by limiting the encroachment of the agricultural frontier into pristine natural reserves.
For critics, chemicals are an unnecessary evil that damages human health and the environment, that accelerates trends to push small-scale farmers out of business, and that hence increases rural poverty. To them, the contribution of chemicals to global production of food and fiber is a myth and the continuous focus on farming methods that depend on high amounts of external inputs is irrelevant for achieving the Millennium Development Goals in general, and the reduction of rural poverty in particular. Resource-poor small-scale farmers in developing countries should rather rely on low external input agriculture to optimize the use of available, but limited resources.
How much chemical use is needed in developing country agriculture? Far from being a discussion between agricultural experts and advocates of environmental protection only, the debate goes to the heart of the current policy discussions about how to achieve the targets of the Millennium Development declaration. For example, the Copenhagen consensus – a forum of leading development experts – sees agricultural technology, as one of the key components for reducing hunger and malnutrition (www.copenhagenconsensus.com). Is there too little or too much emphasis on agricultural technology when we want to reduce hunger and alleviate poverty? And what kind of technology ist needed? Is a world without chemicals a solution?

Chemicals in agricultural intensification

The use of synthetic fertilizers and chemical pesticides in developing countries has grown substantially during the past four decades. Governments promoted the use of agrochemicals in order to achieve national food security and increase the production of export crops.
The OECD forecasts that the production and use of chemicals will continue to shift from developed to developing countries. Key developing country regions such as Asia and Latin America show increasingly high growth rates of pesticide use.
Meanwhile, the crop protection industry of the industrialized countries has witnessed a consolidation through acquisitions and mergers to lead to a few global research-based companies. In 1983 there were 27 large and medium-sized research based agrochemical companies, whereas the number has shrunk to eight in 2002. The six largest multinational corporations account for about 85 percent of the total worldwide pesticide sales, currently estimated at US$ 29 billion per year. Developing countries hold a share of 37 percent (see table).
Increasingly, generic, non-brand, off-patent pesticides become available in developing countries. Those pesticides,

Global market for plant protection products in 2000 (in million USD)

Origins	Herbicides	Insecticides	Fungicides	Others	Pesticides, total	GMOs*	Total
Industrialized nations	9 311	3 888	3 913	1 028	18 140	2 373	20 513
Developing countries	4 483	4 121	1 888	330	10 822	671	11 493
Total	13 794	8 009	5 801	1 358	28 962	3 044	32 006

*Genetically modified organisms with plant protection properties
Source: after FAO, 1999

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Case study 1: Unregulated pesticide use causes crop failure in Pakistan

From 1980 to the end of the 1990s, the amount of plant protection products used in Pakistan rose from 665 tonnes to over 44 000 tonnes. The markets had been liberalized and product standards relaxed. At the same time, aggressive marketing strategies for insecticides contributed to a sharp increase in the use of plant protection products in cotton production. But plant protection strategies which were not based on sustainable principles caused cotton yields to drop because of attacks by pests and diseases (see graph). Pests quickly built up resistance, which lead many unwitting growers to use more chemicals. Some insects not known as pests in 1980 developed into plagues which were hard to control. Cotton provides directly or indirectly employment for about 40 percent of the total workforce, including farmers, landless female labourers, and employees in textile mills. The negative effects of this «pesticide treadmill» were therefore felt throughout the entire rural economy.

Case study 2: Reform of pesticide policy in Thailand

The financial crisis in Asia in 1997 triggered the realization by the Thai government that the high-value export markets for agricultural products, on which the country was heavily dependent, could be at risk. Thai exports had already been rejected several times because they contained pesticide residues. At the same time, domestic consumer demand for food free from such residues rose markedly. Following intensive discussions with all the stakeholders, the government approved a master plan for a revision of the legislation on pesticides, drawn up with support from the GTZ. This master plan subjected the highly liberalized Thai market to stricter controls. Some of the most dangerous chemicals were banned altogether.

especially in the case of insecticides, tend to be broad-spectrum compounds which destruct the balance of the agro-ecosystem by killing beneficial insects that might have otherwise served as natural pest control. Generic pesticides tend to be inexpensive but more toxic for human health and the environment. A considerable share of agricultural pesticides in developing countries is classified as extremely, highly and moderately toxic (WHO Classification Ia, Ib and II). In Ghana, for example, the share of these chemicals in total pesticide use was about 75 percent in the period 1995 to 2000. Given the conditions of use among small scale farmers and workers in developing countries, international donor organizations such as the World Bank have adopted guidelines that effectively ban these pesticides or restrict the supply to trained personnel.

While agricultural intensification is generally considered necessary to meet the projected increase of worldwide demand for food and fiber due to population and income growth, there is a less clear picture about the role of chemicals in these strategies. For example, reviewing available global evidence, researchers of the International Food Policy Research Institute (IFPRI) observed that there is a «paradox of increased pesticide use and increased losses from pests» (Yudelman et al., 1998). Intuitively, one would expect rather the contrary, i.e. a decrease of losses as a result of increased chemical use. Excessive pesticide use may even result in crop failure at national scale (see Case study 1 – Pakistan in box).

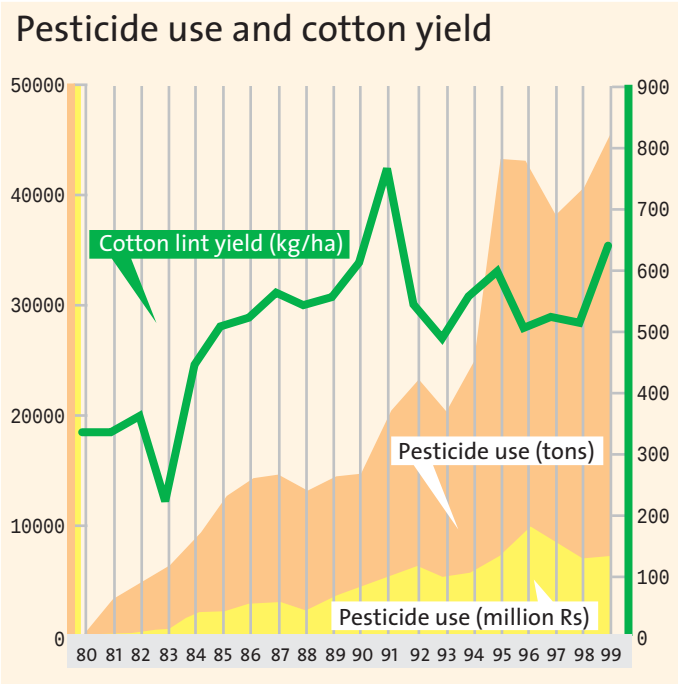
Excessive fertilizer use is widespread

Although, the excessive use of chemical fertilizer in developing countries often receives less attention than the use of pesticides, economic and ecological impacts can be dramatic. Bangladesh faces severe loss of topsoil fertility from overuse of chemical fertilizer and pesticides. Excessive use of nitrogen fertilizer is responsible for contamination of groundwater resources in many countries. Water supply for human consumption has to look for costly relocating of raw water extraction.

Among other emerging economies, China is rapidly moving towards the situation in many developed countries where agriculture has become the main source of water pollution. Seven provinces in the coastal region show a high risk to human and environmental health. It is expected that non-point pollution from crop production will continue to increase and become the major cause of poor water quality, and also an important cause of air pollution. Non-point pollution from crop production is much more difficult to control than point source pollution from livestock. The key issue for the Chinese government is neither the lack of knowledge about non-point pollution nor the lack of technologies to control it. A recent task force suggested to set up a policy framework and institutional mechanisms to encourage farmers to adopt available technologies and management practices (www.harbour.sfu.ca/dlam/newdevelopment.html).

Apart from the ecological damage, the excessive use of agrochemicals has two main negative economic impacts. First, by causing production costs to be much higher than they need to be, hence by reducing net farm incomes. Secondly, by damaging soil structure through secondary salinization and other forms of physical, chemical and biological degradation that reduce crop yields. Excessive fertilizer use is only one side of the coin. Soil fertility depletion is another major constraint. Research at Wageningen University in 37 African countries has shown that nutrients worth US$ 11 billion a year at current prices have been lost from cultivated land during the past 30 years. These include a total of 132 million tons of nitrogen, 15 million tons of phosphorus, and 90 million tons of potassium.

Investment in maintaining soil fertility is therefore a priority. An integrated nutrient management strategy is needed that combines soil erosion control, water management, returning crop residues to the soil and additional fertilizer input. A focus on access to chemical fertilizer only will not improve the situation, neither from biophysical nor from economic point of view. The costs of moving chemical fertilizer from a port city to farms in the hinterland are often prohibitively high. It is tempting to call for subsidies to lower the transaction costs for resource-poor farmers who can not afford to pay for fertilizer at the current rate. But it has been shown in many locations that smallholder farmers in Africa can access nutrients at lower



Source: NARC/FAO/UNDP (2001)

cost, e.g. through agroforestry techniques. Biomass can be transferred from hedges into fields. Leguminous crops in mixed cropping systems make additional nitrogen available.

Problem identified – what can be done?

A range of policy interventions is necessary to create an enabling environment for the adoption of environmentally friendly technologies and practices by farmers. Regulatory policies play an important role in restricting access to the most toxic and damaging chemicals and regulating its use. Developing countries are increasingly pressed to adopt more stringent regulations in order to secure access of their products to global markets (see box: Case study 2 – Thailand).

Farmers' access to information about sustainable agriculture technologies and practices need to be improved. However, there is often a wide gap between knowledge and actual adoption of enhanced practices. On the one hand agricultural extension services need to be strengthened; on the other hand they might encounter a challenge to change their mission. The same services that were established or reinforced during the period of the Green Revolution to promote the use of agrochemicals among small-scale farmers unfamiliar with modern technology packages, will be used to wean off farmers from excessive use.

Economic incentives can play a major role in stimulating adoption of environmentally friendly technologies. In many developing countries, pesticides still carry implicit subsidies and are artificially cheap. Subsidies for chemical inputs distort markets, induce inefficient use, burden government budgets, and increase environmental and health damage.

Changing consumer demands also contribute to the adoption of sustainable agriculture practices. Producing and marketing high-value, «sustainable» commodities, i.e. by using less or no fertilizer and pesticide, has become an important market for many developing countries. It is considered as a practical way to capture the willingness-to-pay of consumers for environmental and social services of agricultural production through market-based mechanisms.

Food safety and quality standards by importers and retailers have become important driving forces for reducing excessive chemical use in agriculture. The European coffee industry, for example, agreed on a code of conduct for sustainability in coffee production, trade and processing. The code bans the most toxic pesticides from use and aims at progressive implementation of integrated pest management in worldwide coffee production (www.sustainable-coffee.net). The organic movement spearheaded the development of non-chemical, but nevertheless highly productive agriculture. Growing consumer demand has contributed to the fact that organic agriculture is a commercial reality, but nevertheless still a niche market. However, a full conversion of developing countries' agriculture to organic practices seems out of reach at present (see box on East Timor).

Conclusions

Agrochemicals can contribute to increased agricultural productivity if their use is limited and targeted. But considerable damage may be the result when users have limited knowledge or where there are incentives for excessive use. When using chemicals, positive impacts should clearly outweigh the negative ones. This calls for the «optimal» level of chemical use which is subject to local circumstances. In any case appropriate framework conditions are needed to support it.

Unfortunately, many farmers in developing countries, especially the emerging economies tend to emulate the practices of their colleagues in the developed world who continue to strive for short-term maximum yields with the help of excessive chemical use instead of focusing on more sustainable practices.

According to the UN Food and Agricultural Organization, however, it seems possible that the overuse of pesticides and fertilizers will diminish as will their environmental impacts, because of better technologies, regulatory measures and the growing emphasis on organic agriculture (FAO 2000). To fulfil this promising scenario, a set of policies and institutional changes to facilitate dissemination and uptake of environmentally friendly technologies and practices by the rural population is required. In recent years, consumer market changes have proven to be effective triggers for policy reform.

East Timor: Organic farming on a national scale?

In September 1999, following the end of Indonesian rule, agriculture in the former Portuguese colony of East Timor reached a crossroads. The distribution of production inputs such as seeds, fertilizers and plant protection products had broken down, and the markets for agricultural products lay dormant. Farmers were returning to pure subsistence farming. During the subsequent period under UN administration, the idea emerged of focussing the whole country's agriculture permanently on the principles of organic farming. The country was to position itself on the world market under the brand name «East Timor Organic». However, these plans to go without chemical fertilizers and plant protection products were not taken up in this country, which experiences significant food shortages and has only very limited alternatives for generating revenue outside the agricultural sphere. Nevertheless, East Timor did succeed in selling increasing volumes of organic coffee, the country's main foreign currency earner, on markets in North America, Japan and Europe. This was made possible by long-term support from foreign donors, which helped among other things to provide training for producers.