Input substitution or ecological agriculture?

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In the fifteen years since the agricultural crisis struck, Cuba has gained extensive experience in how to change towards a more sustainable agriculture. The basis for this agricultural transition was already laid at the beginning of the 1980s when some of the national agricultural research focused on finding ways to substitute agrochemicals with organic inputs. The main objective at this time was to reduce production costs in commercial agriculture as agrochemicals were expensive and therefore unsustainable from an economic point of view. As a result, a wide range of bio-fertilizers were developed. These efforts were later complemented with more focused research and action, leading to extraordinary results at a national level.

Bio-fertilizers

Most of the bio-fertilizers developed were bacteria such as *Rhizobium*, *Azotobacter* and *Azospirillum* which fix nitrogen in association with legumes and thereby could replace inorganic nitrogen. In some cases the use of these bacteria replaced up to 80 percent of the inorganic nitrogen usually applied. Other technologies later developed to substitute for the use of agro-chemicals included mycorrhiza, bacteria which increase the availability of phosphorus, and the use of green manures and leguminous cover crops. Some traditional practices were also revived: oxen teams were used for soil cultivation, to avoid soil compaction, and which also replaced herbicides through mechanical weeding.

Worm humus and compost are currently applied on a large scale. By 1998, the national production of these two organic fertilizers had reached a total of almost 700 000 tons. *Cachaza* or "filter cake" (a by-product from the sugar industry containing impurities removed from cane juice) is now used instead of chemical fertilizers in most of the important commercial crops, especially sugar cane. With one application of 120 to 160 t/ha, this organic fertilizer can completely replace chemical fertilizers for three years in sandy soils.

Biological pest control

Research on biological pest control had been going on in Cuba since the 1960s. The knowledge generated made it possible to shift to a biological pest control strategy on a national scale in response to the crisis. More than 270 biological control reproduction centres (known as CREEs) were established throughout the country. The production of bio-control agents (fungus, bacteria, nematodes, and beneficial insects) is small scale and decentralised, resulting in, among others, the production of 1300 t/year of *Bacillus thuringiensis* sprays (used to control lepidoptera), 780 t/year of *Beauveria* sprays (for controlling beetles), and 200 tons of *Verticillium* (for whitefly control). Integrated pest management (IPM), combining biological and limited chemical pest control together with cultural management, has been the most commonly applied strategy. Nationally, applications of pesticides to cash crops were reduced twenty fold in a 15-year period, from 20,000 tons in 1989 to around one 1,000 tons in 2004. Today the use of pesticides continues to decrease and many biological control methods have proved more efficient than inorganic pesticides.

Animal traction

Since 1989, the number of tractors in Cuba dropped dramatically due to a lack of spare parts, maintenance, and fuel to keep them working. This stimulated the revival of the traditional practice of using oxen for ploughing and transport. About 300 000 oxen teams were trained, leading to a much reduced fuel dependency in the new production systems. The traditional knowledge, skills and practice of oxen management has been largely recovered, contributing to achieving many agroecological goals.

The sustained use of oxen therefore led to changes in land use patterns, requiring more integrated systems. Many livestock farms that previously specialized in milk or meat production started using oxen to transport fresh forage and plough land that would grow crops. Many cooperatives previously dedicated to specialised crops such as potatoes, sweet potatoes or vegetables created "livestock modules", using dual purpose bovines to produce milk for farmers and their families, as well as to replace oxen teams over time.

Cropping practices

Crop rotations and polycultures (mixed or multiple cropping) have been used increasingly in order to stimulate natural soil fertility, to control pests and to restore the productive capacity. Research results, as well as actual production figures, showed an increase in the yield of the majority of the economically important crops. Experiments confirmed that the use of soya bean in rotation with sugar cane increased sugar cane yields from 84.4 to 90.6 t/ha with an additional production of 1.7 t/ha of soya bean. Polycrops of cassava and common beans under different cropping systems also resulted in higher total production when compared to cassava or beans grown as a single crop.

Beyond the input-substitution strategy

These examples of input substitution in Cuba had a very positive effect on national food self-sufficiency as well as on the environment. The experience is considered the first nation-wide attempt at converting a national food system. However, the resulting production systems may still have many of the same problems that occur in conventional systems (i.e. the monoculture patterns). In order to achieve a sustainable production system, the input substitution strategy needs to evolve into an agroecological production systems approach. Only by making more far-reaching changes towards regenerative agricultural systems than those based on inputs –even if these inputs are biological or organic– will it be possible to increase sustainability in the longer term. The integration of crops and livestock into a more diversified production system is one example of a system based on agroecology which allows for increasing food production while regenerating the environment.

The strategy followed by Cuba created conditions such as better infrastructure and knowledge about more sustainable low input and input substitution technologies. This provides an exceptional starting point for the development of an integrated, sustainable agriculture. Even more important is the high level of awareness and understanding of ecological agriculture developed among the population and the organisational and human capacities developed for innovation and exchange of experiences. Never before has Cuba (or any other country) had such opportunities for developing and implementing a nationwide agroecological model for rural development. ■

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