Chapter 9

Integrating Integrated Pest Management and Sustainable Livelihoods in Central America

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Introduction

The whitefly (*Bemisia tabaci*) is a major crop problem in the lowlands and mid-altitude valleys of Central America, both as a direct pest and as a vector of numerous plant viruses. The socioeconomic importance of these pest problems has been magnified by the introduction of high-value crops, such as tomato (*Lycopersicon esculentum* Mill.), cucurbits (Cucurbitaceae), and peppers (*Capsicum* spp.), in agricultural regions planted to traditional food crops, such as maize (*Zea mays* L.) and common bean (*Phaseolus vulgaris* L.). The new crops are highly susceptible to both the whitefly pest and the viruses it transmits, and the small-scale farmers who are trying to maximize their income from their limited land resources do not have technical assistance for the new horticultural crops. As a result, agrochemical companies have been able to promote chemical control as the only crop protection alternative available. The intensive use and abuse of insecticides to control the whitefly problem has only aggravated crop losses due to the development of pesticide resistance in *B. tabaci* and the elimination of natural predators of the whitefly (e.g., spiders and beneficial insects). The Tropical Whitefly Project (TWFP) conducts collaborative research in Central America to implement integrated pest management (IPM) practices to control whitefly pests using environmentally friendly control measures. IPM is regarded as a sustainable approach to control pests in mixed cropping systems, and thus maximize the income of small-scale farmers.

This chapter presents partial results obtained during the development of the TWFP, which represents an advanced concept of “scaling out” considering that its research activities span 24 countries in the Americas, Africa, and Asia (IITA, 2000). The chapter also includes some personal observations regarding the contribution of this subproject to the

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Consultative Group on International Agricultural Research (CGIAR) goals of alleviating hunger and poverty in developing nations. The work conducted in Central America has been financed by the Danish International Development Agency (DANIDA), the United States Department of Agriculture (USDA) and, currently, by the United Kingdom's Department for International Development (DFID). The DFID Crop Protection Program considers IPM practices "an essential part of a holistic approach to crop improvement, which substantially contributes to poverty elimination, enhanced livelihood security, and reduced environmental degradation" (Sweetmore et al., 2000).

One of the central discussion points at the International Center for Tropical Agriculture (CIAT, the Spanish acronym) 2002 Annual Review was: How can we can bring about a lasting impact on the lives of the rural poor, knowing that even relevant technology may fail to accomplish this objective because of low levels of adoption. Indeed, one of the main obstacles to improving the livelihood of the rural poor has been the implementation of "top-down" approaches to research and development (R&D), which often fail to take into consideration the end-users. Also, it is desirable to follow a "systems approach", to include the socioeconomic and biophysical factors that affect small-scale farmers (Menter et al., this volume).

Perhaps the main challenge faced by the international centers located in Latin America is to evolve from the founding R&D goals of the 1960s, when traditional crops (e.g., maize, cassava [*Manihot esculenta* Crantz], potato [*Solanum tuberosum* L.], and bean) occupied most of the agricultural land. For the past 2 decades, most small-scale farmers have been trying to transform their marginal subsistence agriculture into more market-oriented mixed cropping systems. Examples are eggplant [*Solanum melongena* L.] and sorghum (*Sorghum bicolor* [L.] Moench) in Haiti; peppers and maize in El Salvador; or tomato, bean, and maize in Guatemala. Figure 1 shows that the area devoted to traditional food crops (i.e., maize, rice [*Oryza sativa* L.], bean, cassava, and potato) in Latin America has not significantly increased (FAO, 1970-2000), despite the fact that (1) the population of this region has more than doubled in the same period, and (2) the increases in productivity achieved do not compensate for the stagnant production trends.

To aggravate this situation, prices for traditional export commodities in Latin America, such as coffee (*Coffea* L.), cotton (*Gossypium hirsutum* L.), and banana (*Musa* spp. L.), have been steadily decreasing over time (Figure 2). In the absence of any significant industrial capacity, Latin America has developed a negative trade balance, only offset by an exponentially growing foreign debt that has been consistently associated with increasing levels of misery in Latin America and other developing nations (CEPAL, 2001).

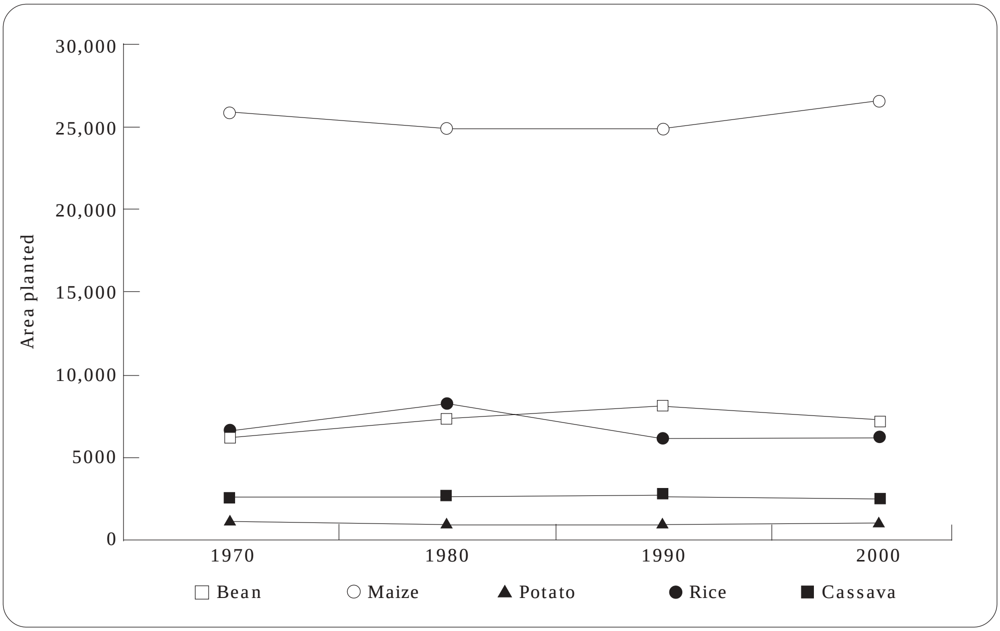

Figure 1. Area ('000 ha) planted to International Agricultural Research Center (IARC) commodities in Latin America.

Figure 2. International price (US$/t) of agricultural commodities, 1978-98.

Since the late 1970s, the main strategy adopted by most Latin and Central American countries to revert this trend has been the promotion of non-traditional export crops, for example, soybean (*Glycine max* [L.] Merr.) in South America, and horticultural crops in Mesoamerica (Thrupp, 1995). Although this effort was initially led by the agro-export sector, many small-scale farmers adopted some of these high-value crops to increase the profitability of their smallholdings. The agro-export companies soon noticed the comparative advantage that small-scale farmers had regarding the availability of family labor, and proceeded to subcontract the production of vegetables with them.

In order to better document this process, a case study (Morales et al., 2000) was conducted in two localities of the Department of Baja Verapaz, Guatemala: San Miguel Chicaj, a predominantly indigenous community with a 50% illiteracy rate, and San Jerónimo, a more progressive *mestizo* community with a 25% illiteracy rate. Figure 3 shows the predominant type of “subsistence” agriculture practiced in the community of San Miguel Chicaj, based on two main staples, maize and bean, and other crops that either enhance their food security (e.g., sorghum) or their income (e.g., peanut [*Arachis hypogaea* L.]). Additionally, this community was beginning to experiment with a high-value crop, tomato, albeit at a very low scale.

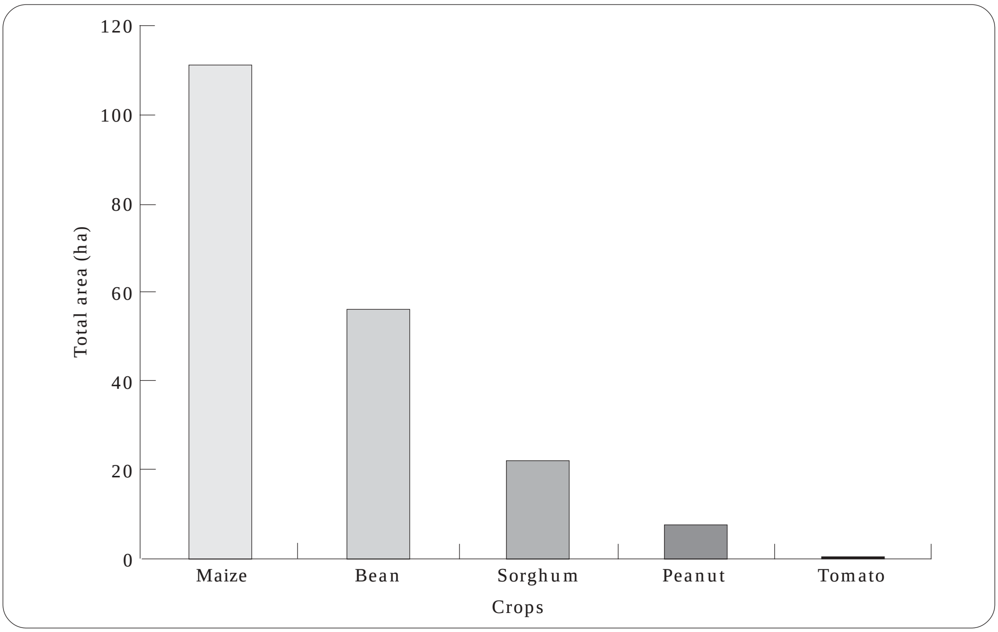

Figure 3. Total area (ha) of predominant crops surveyed in San Miguel Chicaj, Guatemala.

In San Jerónimo (Figure 4), we observe a more market-oriented approach, where high-value crops, namely tomato and cucumber (*Cucumis sativus* L. var. *sativus*), make up a significant proportion of their mixed cropping systems. However, the community does not neglect its food security based on maize and, to a lesser but still significant extent, bean. Chili (*Capsicum annuum* L.) and sweet corn (*Zea mays* L. subsp. *mays*) are also part of their cropping systems as cash crops.

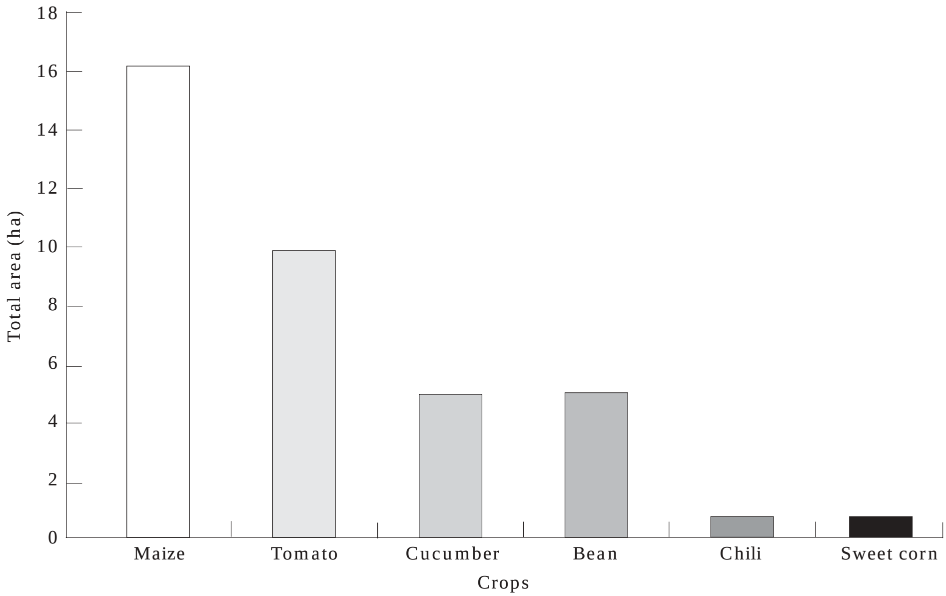

Figure 4. Total area (ha) of predominant crops surveyed in San Jerónimo, Guatemala.

Table 1 shows that even the very conservative strategy of mixed cropping systems adopted by farmers in San Miguel Chicaj places them above the poverty line, even assuming one cropping cycle per year. If they had planted the same area to maize and/or bean, their monthly income would not have exceeded $US70 per month.

Table 1. Revenues (US$) expected from mixed cropping system in two communities of Baja Verapaz, Guatemala.

Crop	San Miguel Chicaj		San Jerónimo	
	Area (ha)	Profit	Area (ha)	Profit
Maize	1.0	147	0.7	103
Bean	0.6	150	0.6	90
Sorghum	0.7	112	0	0
Peanut	0.4	134	0	0
Tomato	0.2	1486	0.5	3714
Cucumber	0	0	0.4	560
Total	2.9	2029	2.2	4467

Unfortunately, this new Green Revolution, in which the international centers did not participate, took place in the middle of the austerity measures imposed by the International Monetary Fund (IMF) in Latin America, which contributed to the financial collapse of most national programs and, consequently, to the ending of free technical assistance. Once small-scale farmers found themselves on their own, they had to resort to the only source of “technical assistance” available to them—the agro-chemical companies. The outcome has been:

(1) The indiscriminate abuse of highly toxic pesticides, often applied to crops on a daily basis until harvest time, and,
(2) The end of the contracts subscribed between exporters and small-scale farmers, because of the high amounts of pesticide residues detected in most of the agricultural produce destined for the US market.

Fortunately for growers who found a more profitable set of crops, and unfortunately for Latin American consumers, the internal market has absorbed this produce because of a significant increase in the consumption of horticultural crops in this region. The widespread abuse of insecticides had additional negative consequences. Whiteflies developed resistance to these chemicals, and soon tomato, pepper, and common bean crops were suffering severe damage from whitefly-transmitted viruses. Table 2 shows what happened to these susceptible crops in our current pilot site, the valley of Zapotitán, El Salvador, particularly during the dry semester of the year, when whitefly populations reach a peak. Basically, a drastic reduction occurred in the total area planted to common bean and horticultural crops, from 1350 ha in the early 1980s, to less than 78 ha in 1999 (Coto, 2000). Currently, up to 55% of the production costs for horticultural crops in Central America corresponds to crop protection. Consequently, one of the main objectives of the whitefly project has been to promote the rational use of pesticides.

Table 2. Dry season land use (ha), Zapotitán, El Salvador.

Crop	1989	1999
Maize	456	780
Bean	175	3
Tomato	153	3
Pepper	35	3
Cucumber	64	68

Methodology and Results

A series of meetings was held with selected farmers to explore the possibility of growing basic food and horticultural crops with minimum pesticide inputs during the dry season and take advantage of:

(1) Higher market prices for most agricultural commodities at the end of the dry season,

(2) The availability of irrigation water (point) in the valley of Zapotitán, and
(3) The availability of land during the 5-month dry period.

In the case of tomato, we introduced the concept of physical barriers, in the form of "micro-tunnels", which consist of fine whitefly-proof mesh over a homemade wire structure. Farmers in El Salvador made different modifications to the micro-tunnels—added pieces of plastic fertilizer bags to lower their cost, and made some tunnels bigger to protect plants longer than the 24 days usually recommended before the removal of the net.

A preliminary analysis of the results showed that:

(1) The unprotected tomato plants were destroyed;
(2) Those plants coming out of the tunnels covered during 24 days survived, but only produced 13 t/ha (60% of the national average); and
(3) The plants in the big tunnels that farmers designed showed excellent development and yields, over 60 t/ha (three times the national average with only two insecticide applications). Discounting the cost of the net and other production costs, the bigger tunnel would have yielded a profit in excess of US$10,000/ha.

Another simple IPM strategy was designed for a native food crop known as *loroco* (*Fernaldia pandurata*) (Apocynaceae) in El Salvador and Guatemala. This vine produces inflorescences that are consumed at the button stage in filled tortillas and even pizzas, and which have a high price in local and international markets (over $US10/lb). A hectare of *loroco* can produce up to US$15,000/year. More important, *loroco* is usually grown in backyards where women mostly tend it as a source of additional income. Unfortunately, *loroco* can also be severely damaged by whiteflies and viruses, which can devastate a *loroco* plantation within a year. However, a virus characterization study conducted at CIAT showed that two different viruses affect this crop in El Salvador, both of which are transmitted by aphids and not by whiteflies. Consequently, whiteflies are being managed as pests and not as virus vectors using biodegradable household soaps dissolved in water, which keep whitefly populations below the damage threshold. Aphid-borne viruses cannot be controlled with pesticides because they are transmitted within seconds. Fortunately, unlike the ground-level-flying whiteflies, aphids select their target plants by flying above crops. Thus, we decided to cover the *loroco* with locally available dry coconut palm leaves as camouflage against aphids. This practice reduced virus incidence and improved plant development, as compared to the uncovered control. Preliminary results show average yield increases of 40% compared to the uncovered controls. With these simple IPM measures, agrochemicals for virus vector control are no longer required in this food crop. We already have a request from the national program of El Salvador to replicate this simple experiment in other regions of the country.

In the case of common bean, we chose an advanced breeding line produced by the Pan American School in Honduras, using sources of virus resistance identified at CIAT. Local farmers had previously evaluated and selected this line as a potential new cultivar. The objective was to show farmers that it is possible to grow beans again in the dry season, with minimum pesticide applications; basically, one vs. up to 20 applications farmers used to apply before they gave up growing beans because of the high incidence of bean golden yellow mosaic virus.

Figure 5 shows the significant potential impact of improved germplasm on the alleviation of hunger and poverty when compared with the last CIAT-bred variety released in El Salvador over a decade ago and the local landrace. This occurred even though we experienced some seed quality problems because of the intense drought conditions and high virus pressure under which this experiment was conducted this year. This new bean line is expected to be rapidly adopted and grown in about one quarter of a million hectares in Central America within the next couple of years.

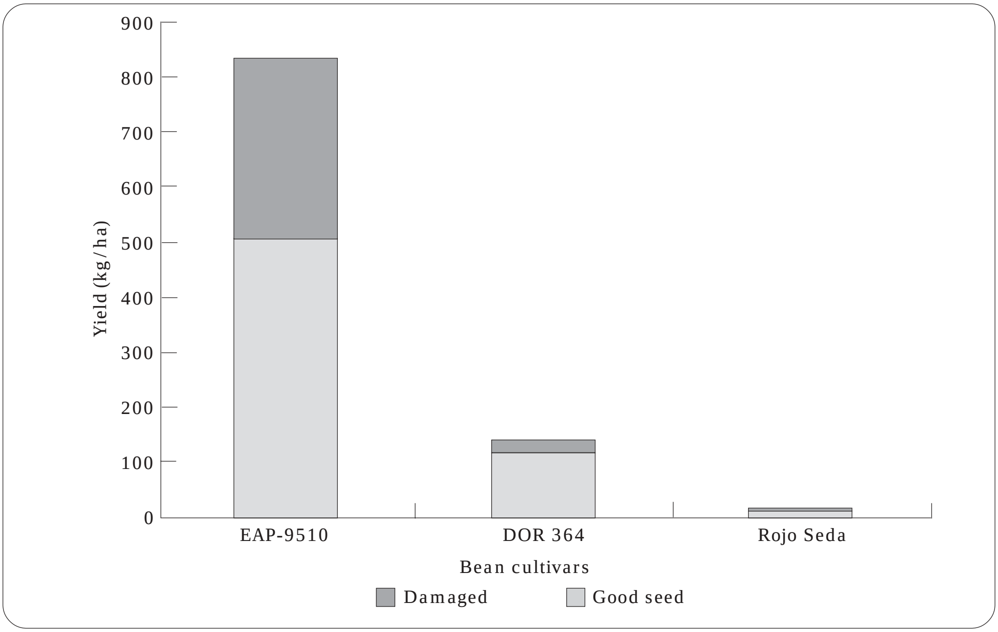

Figure 5. Yield (kg/ha) of three bean cultivars under bean golden yellow mosaic virus in Zapotitán, El Salvador.

Conclusions

These examples show that it is possible to respond to the multiple production problems that small-scale farmers are currently facing without technical assistance, to help them develop sustainable mixed cropping systems that satisfy both their needs to achieve food security and to increase the income derived from their smallholdings. To this end, we have to adopt an integrated "systems" approach, to which scientists from all programs, projects, or disciplines could contribute their expertise in order to improve the livelihoods of over 200 million poor people in Latin America.

Those international centers that still conduct research towards the improvement of major food crops should continue to do so, because this constitutes the basis of food security in developing countries. However, these centers should also reactivate their multi-disciplinary groups to solve production problems specific to the various cropping systems in the regions where these international centers operate, in a sustainable manner. These tasks can be more easily accomplished with the collaboration of national agricultural research programs or other similar organizations active in the R&D arena.

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