Chapter VII

# Transfer of North American Crop Protection Technology to the Developing World

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**The combination of control tactics in an ecologically oriented integrated system, known in the United States as "integrated pest management" (1PM), is being applied in the development of i&proved stable crop protection systems for U.S. agriculture and is widely accepted internationally; the term "integrated pest control" is used in most other countries for this holistic approach to pest control. The two terms are often used synonymously.**

**Considerable progress has been made in transferring the basic philosophy of 1PM to the developing world. This has been fostered by the Food and Agriculture Organization (FAO), World Health Organization (WHO), and certain bilateral assistance programs (especially those of Canada, France, the United Kingdom, and the United States). The Organization for Economic Cooperation and Development (OECD), the United Nations Environment Program, the World Bank, and the International Agriculture Research and Training Network of the Consultative Group for International Agricultural Research (CGIAR) have become involved in recent years.**

**The problem of actually implementing pest management systems in the developing world is not simply the transfer of the total 1PM concept, although certain components of the system have great potential for transfer. Much adaptive research on the potential component tactics of pest management and the development of entirely new systems adapted to local socioeconomic and ecological conditions will be required. Each candidate component to be considered for possible transfer will need to be evaluated separately in terms of its potential for use under the conditions that will be encountered. It must be compatible with and become part of the entire crop production process. Because production practices and environmental conditions vary widely within and between countries, the transfer of crop protection technology is most complicated. By applying the concept and the scientific methods by which crop protection technology is developed, in-country crop protectionists can produce a pest control procedure that is well-adapted ecologically to the local agroecosystem and is socially and economically acceptable as well.**

## PRESENT LEVEL OF PEST CONTROL TECHNOLOGY IN THE DEVELOPING WORLD

Pest **control technologies are used unevenly** in the developing world. Within any one area the ecological environment, social customs, political events, and economic milieu all interact to set the magnitude of a particular pest problem and further to constrain feasible solutions. Therefore, every situation must be evaluated and developed on a case-by-case basis.

In a similar way, the level of dependence on pesticides varies from country to country. In general, the more developed the country, the greater the use of pesticides, but there are often large differences between crops in the same country. Surveys by FAO a few years ago indicated that the entire developing world used only about 7 percent of the global consumption of pesticides. Lack of financial resources to purchase pesticides is only one reason for this low use of pesticides. The agricultural infrastructure taken for granted in developed countries may be only partially developed or entirely lacking in developing countries. The present marketing system stresses certain crops in certain countries and, thus, produces an uneven supply situation. In times of serious pest problems, pesticides often are not available, are in the wrong place, or arrive in the right place at the wrong time. Furthermore, an inadequate transportation network in many countries does not provide a way for pesticides to move from the capital city to the rural areas where they are needed. Finally, few developing countries have adequate equipment to apply pesticides, and even fewer have a pest-monitoring system to detect pest infestations while they are still at manageable levels.

In developing countries, the large estate crops such as rubber, cotton, and sugar cane tend to get a heavier use of pesticides than do the plots of small farmers. In many cotton-producing countries in the developing world, two-thirds or more of pesticide use is on this single crop. In some developing countries, use of insecticides to protect stored products is also of considerable importance. Overall, there is a slight trend for increased use of pesticides in these countries, but the percentage of the world's total use is not increasing.

In the developed world, insecticides have declined in relative position among pesticides from being the dominant class of pesticide before 1960 to representing currently only about one-third of total pesticide use. This change primarily resulted from the rapid growth in the use of herbicides, which now represent the major portion of pesticides used on a global basis. 1n the developing world, insecticides remain the dominant class of pesticides used, and their use is increasing at a rate that would appear to maintain their dominant position for some time. Herbicides use, however, is increasing as appropriate and economically feasible uses are found.

## OBSTACLES TO PEST MANAGEMENT SYSTEMS IN DEVELOPING COUNTRIES

1PM systems are developed through the careful ecological analysis of pest problems that exist in the growing crops. Research programs for 1PM systems must relate to the entire pest problem and the full complexity of the field situation. No amount of sophisticated laboratory research will produce an 1PM system. It is important to realize that research on field problems can be extremely complicated as it must deal with establishing the complex relationships that exist in the agroecosystem, such as those between the pest and the crop, among certain pests and noncrop plants, between the pest and its natural enemies and plant diversity, and among all of these considered together with

other crops and the climate and economic and political aspects. These are often overwhelmingly complex problems facing the isolated crop-protection specialist in a developing country, and the obstacles to their solutions seem insurmountable. Furthermore, there is often a lack of extension personnel or other paraprofessionals to train and encourage farmers to adopt new practices, The specialist may also find that farmers are often incapable of or unwilling to adopt a new practice because they lack the financial resources or proper motivation. The specialist may also have difficulties communicating with the farmer because of language barriers or illiteracy or even reaching the farmer because of inadequate roads or transport,

It is not surprising, then, that the isolated and frustrated pest control specialist may recommend an easy short-term solution such as the use of some pesticide. The recommendation may be made with little or no opportunity for consideration of the complications of undesirable side effects on people, important natural enemies, and the general environment, and the long-term effects of pesticide use.

In spite of the difficult odds, sound 1PM systems have been developed under such circumstances. Indeed, every operational 1PM system in developing countries has had a relatively simple beginning. The first step in these programs was to develop an ecological perspective and then to design the best possible action based on available knowledge. This design, at best, approximated an ideal system which was then tested in the field. Where difficulties were encountered they were posed as questions for parallel solution-seeking research. In this way, even where resources may be limited, an effective 1PM system can often be developed and adapted to the local situation. This has been accomplished in Peru, Nicaragua, Malaysia, and certain other countries with modest financial inputs for the development of the programs.

## PROBLEMS ASSOCIATED WITH TECHNOLOGY TRANSFER TO DEVELOPING COUNTRIES

Pest management systems developed for the temperate part of the world, as stressed earlier in this discussion, may be completely inappropriate to tropical and subtropical conditions of the developing world. This is because of not only the greatly contrasting physical and biotic conditions but also the contrasting problems of modern intensive high-energy agriculture and those of traditional subsistence agriculture involving multiple cropping and mixed cropping.

In the absence of adequate crop protection programs in many developing nations, there is an over-reliance on the reactive use of pesticides for pest control. There are numerous well-documented examples of the inadequacy of this approach in both developed and developing countries. Unless pest management or integrated pest control programs are initiated, additional “pesticide abuse” situations will occur. Complete dependence on pesticides over a period of time not only fails to control the pests in question but may actually aggravate pest problems and endanger human health and environmental quality. Pesticides misuse also imposes an additional cost on production.

The developing world must deal with an array of crops and pests that is not generally grown in temperate countries. These crops include avocados, bananas, breadfruit, cacao, cassava, coconuts, coffee, guava, mango, papaya, pineapple, plantains, sugarcane, tare, and yams. Many of these crops are of great importance in world commerce and contribute much to the world’s food supply. Because a bank of technological knowledge on their culture and the management of their pests is not available in temperate countries, it must be developed in-place in the tropical developing world. Nevertheless, some component tactics from temperate 1PM systems can

be adapted to these tropical and subtropical crops.

In any attempt to transfer the latest developments in pest control technology to the developing world it will be important to reach the decisionmakers in these countries, many of whom received their technological training prior to the resurrection of the ecological approach to pest control. As a result, considerable reeducation will be necessary and new approaches to communicate with the decisionmakers will be required to achieve satisfactory results. In addition, different social and economic values placed on the importance of food, environment, human life, individual rights, etc., in developing countries require considerable adaptations of pest management systems to accommodate these values.

## POTENTIAL IMPACT OF PEST CONTROL TECHNOLOGY TRANSFER

The losses of food crops to pests in the developing world are enormous. Although detailed documentation is lacking, estimates of losses run between 25 and 50 percent of the food produced. Conservative estimates indicate that at least 50 percent of the losses can be recovered, At the same time, the need for enhanced protection from crop pests is further emphasized by the fact that other methods of crop improvement that result in an increased production of food will require additional pest protection for the high yields to be fully realized. For example, new, low-growing wheats and rice require considerably more weed control than long-stemmed varieties to prevent intolerable economic production losses.

However, it is difficult to translate the savings in crop yields that would result from improved pest control into economic terms that reflect the probable distribution of that savings to the population of the country. If the supply of a particular commodity is increased in an area as the result of the adoption of improved pest control practices, the price of that commodity may fall, and the effect of the lower price on small farmers may be severe. For example, nonadopters and late adopters of improved practices are particularly vulnerable because their production costs and yields will remain the same while the price they receive for their produce will decline. Unless additional concomitant measures are taken, the incomes and nutritional status of such farmers are likely to deteriorate over the short term. This prospect puts a special premium on selecting methods that are suited for adoption by small farmers. Over the long term, however, the economy of the country as a whole and the general welfare of the people will be improved.

Increases in yield are important, but increased production stability from year to year with improved pest control practices can be equally important. Without a sense of stability, investments in agriculture are not likely to be made that require more than one growing season for amortization.

The differential effects of successful innovation in pest control on different economic classes of agricultural people are the most difficult and yet perhaps the most important to analyze, New pesticides are likely to be adopted only by the wealthier and more progressive farmers because they have better access to credit for purchasing the necessary materials and machinery. If the new practices require more labor to be successful, wealthy, capitalized farmers may be at a disadvantage compared to poorer farmers using labor-intensive methods. On the other hand, if the new practices require the purchase of new machinery or the acquisition of new skills, the wealthier farmers may be at a relative advantage. Biological control, the breeding of resistant varieties, and other genetic methods of control usually will be operations performed with a high degree of public sector effort, and each will require the farmer to contribute little in purchases above and beyond that which is normal for the crop he is

raising. Hence these technologies, which depend on enlightened levels of government support, have less chance of favoring one class of farmer over another.

When any proposed new technology is assessed, a crucial question is its effect on the labor requirements for agriculture. This is particularly important in the nonindustrialized market economies in which unemployment and underemployment are frequently endemic and in which no alternative industrial employment possibilities exist.

The emergence of resistance to insecticides dramatizes the point that new technologies are not necessarily permanent additions to options in crop protection. There are no theoretical reasons why resistance will not emerge eventually for any control practices directed against any pest or any crop. Thus, a high premium should be given to improved technologies that offer the potential of longer use before resistance develops.

Innovations in biological control, breeding for resistant varieties, and other genetic controls are not likely to create any direct adverse environmental impacts. Elimination of a pest like the tsetse fly from Central Africa might create indirect environmental effects by opening up areas to crop agriculture or to grazing that until now have been unused.

Cultural control will, in general, have little adverse effect on the environment unless the particular practices involve cultivation. In such cases, soil may be lost through wind or water erosion. Substituting herbicides for tillage may markedly reduce soil losses during crop production. In Kenya, herbicides may allow continued crop production in areas where "slash and burn, " followed by abandonment after several years, is the traditional agricultural practice on small plots in the jungle.

Herbicides can be used not only to replace cultivation for weed removal but also to replace plowing for crops such as corn. In addition to savings in labor and energy, the "no-till" practice reduces erosion and increases soil organic matter, The technology of "no-till" agriculture may be widely applicable in the developing world where problems of erosion are severe.

The use of certain pesticides has had an adverse effect on the environment when the pesticides have entered the food chains of ecosystems or when they had direct toxic effects on nontarget organisms—e.g., birds and fish. Integrated pest control, because it depends on chemical pesticides only as a supplement to other means of control, is likely to have smaller adverse effects on the environment.

The developing world is on the threshold of a large increase in the use of pesticides. If these pesticide inputs are made unwisely, pest problems can be greatly exacerbated and there can be adverse effects on the environment and on agricultural workers. Properly developed pest management systems using pesticides as only one component of many can help avoid these problems.

Agromedical teams can play an important role in encouraging the safe and efficient use of pesticides. Timely education on safe handling of pesticides, monitoring of worker and environmental safety, and the training of medical personnel in developing countries to cope with pesticide-related health problems can greatly reduce the adverse impacts of pesticides.

## STRATEGIES IN THE ADAPTION OF IMPROVED PEST MANAGEMENT PROGRAMS IN THE DEVELOPING WORLD

Education and training must be a core element in any program to develop improved pest management in developing countries. Fundamental training will be required in all aspects of pest management and at all levels to create and strengthen an adequate infra-

structure to receive and adapt pest management technology. This should involve the decisionmaking administrators as well as the lower level technicians. Research, training, and extension, particularly adaptive research and on-the-farm demonstration, will be required at a significant level to develop the required knowledge base and to implement pest management systems successfully in the developing world.

A large number of agencies and institutions are involved in developing improved pest management in the developing world. These involve multilateral international agencies such as FAO, WHO, OECD, bilateral development assistance programs of many nations, and a number of other institutions. At times there has been an unfortunate lack of coordination and collaboration among these bodies. Recently steps have been taken by FAO and OECD to assure more coordination, and this should be reinforced and encouraged.

## U.S. PROGRAMS

The U.S. Agency for International Development (AID), or its predecessors, have over the years had extensive and varied programs aimed at strengthening plant protection programs in developing countries. Many of these programs are developed in cooperation with U.S. universities, experiment stations, the U.S. Department of Agriculture (USDA), and other U.S. institutions. Most of these programs are directed toward individual countries and are supported directly by the local U.S. AID missions. AID also provides more than 25 percent of the funding for the CGIAR Agricultural Research and Training Network, whose programs contain considerable plant protection research.

Since 1971 AID has had a contract with the University of California (UC) for a global project in pest management and related environmental protection. This is a general technical services contract intended to develop improved pest management in the developing countries. The objectives of the project are:

- to provide research and technical assistance in AID's involvement with pesticides,
- to improve less developed countries' (LDC) regulation and pesticide-monitoring capabilities,
- to develop country- and international-based 1PM and environmental protection systems,
- to train competent LDC personnel to develop scientific skills and pest management expertise,
- to assist AID in developing networks of institutions relating to pest management expertise, and
- to assist in the development of a series of coordinated pest management research projects.

In this project, the University of California is cooperating with Oregon State University, University of Hawaii, Texas A&M University, University of Florida, University of Miami, Cornell University, University of Minnesota, and North Carolina State University to provide these services.

Oregon State University has had a research project on weed control in developing countries supported by AID since 1966. Much of their research has been carried out in developing countries of Latin America, with backup research in Oregon and Hawaii. They have done outstanding work in producing and disseminating information of value not only to weed scientists but also to other pest control disciplines.

The 1975 title XII amendment to the Foreign Assistance Act established a Board for International Food and Agricultural Development (BIFAD). One of the basic objectives of

BIFAD was to involve the U.S. universities with AID in sound long-term programs. Recently the Joint Research Committee of BIFAD identified "crop protection" as a priority area for a planning grant to develop plans for a collaborative research support program.

In the past 3 or 4 years a large number of documents have been developed by the U.S. National Academy of Sciences, U.S. AID, OECD, and others which give valuable background information on the subjects discussed in this report.

## OPTIONS FOR CONGRESS TO IMPROVE CROP PROTECTION IN THE DEVELOPING WORLD

### Support Education and Training of LDC Crop Protection Scientists

U.S. experience over the past 35 years in international efforts to increase food production in LDCs clearly indicates that short-term technical assistance is not productive. The key to success in agriculture is to support advanced education to those who will return to staff the universities, research institutes, and agricultural ministries in their own countries. Without such in-country scientists and specialists, few long-term improvements can be achieved.

To maintain trained staffs in universities and research institutions in LDCs, continuing efforts are required because of the attrition to administration, industry, and international organizations. Because advanced-degree training in LDCs is variable and tends towards inbreeding, it is important that overseas advanced educational programs be continued.

Congress should ensure that AID in cooperation with USDA and the land-grant universities supports a program of graduate training adequate to meet the needs of developing countries. This program should be coordinated with those of other nations and institutions to provide optimum results with available resources.

In addition to degree training, middle-career scientists need opportunities to have updating educational or work experience at an institution where advanced work in pest management is underway. Congress could ensure that there are adequate fellowships to fulfill these needs.

The two most serious problems encountered in educating and training foreign personnel are: 1) the reluctance of some people to return home and 2) learning to do research in sophisticated, well-equipped laboratories. Both of these problems are alleviated when scientists are permitted to carry out their thesis research at home or in a comparable situation under the direction of appropriate faculty advisors. This procedure has the advantage of training under realistic conditions, helping to solve local problems, and starting scientists on research that can be continued after completion of their advanced degree.

### Agromedical Training for In-Country Personnel

Pesticides, especially insecticides, can be very hazardous to man, animals, and the environment. Some very unfortunate experiences have occurred in some LDCs as a result of misuse of pesticides. There is need for education in pesticide management, including their proper use, monitoring for residues in food and the environment, and the recognition and treatment of pesticide poisoning. The UC/AID pest management project has sponsored some successful pesticide management workshops in several parts of the developing world. This is an effective approach to reducing the hazards of pesticide use in LDCs.

### Integrated Pest Management Workshop

In addition to the education and training of top-level scientists in the philosophy and methodology of pest management, there is a

great need to provide practical short-term training for agriculturalists who are working directly with farmers in an advisory capacity. Six- to eight-week training workshops sponsored jointly by in-country institutions and AID with instruction by both local and foreign experts have proven to be very effective.

### Provide the Less-Developed Countries With Pest Management Information

An almost universal problem for crop protection scientists in LDCs is lack of adequate libraries and up-to-date information. One solution may be to provide foreign literature or to subsidize the preparation and publication of books and bulletins by local scientists.

### Establish Research Projects and Develop Pest Management Systems

The United States has the option of establishing appropriate research projects designed to develop practical pest management systems for local and regional situations. These projects could involve local scientists with cooperative inputs from U.S. scientists. Some projects might be designed for a local problem; others could involve scientists on a regional or even global basis, Care must be exercised to ensure that such projects are complementary with ongoing research in crop protection.

### Provide Support for Crop Protection in the Title XII Program

A most important option is to develop a vigorous effective program in crop protection under the title XII amendment to the Foreign Assistance Act. The reduction of pest-induced losses provides one of the most promising approaches to increasing the world's food supply.