# Globalizing Integrated Pest Management




## A Participatory Research Process

Edited by George W. Norton, E. A. Heinrichs,
Gregory C. Luther, and Michael E. Irwin

Blackwell
Publishing

The center photo on the cover is a view of Africa, the Red Sea, and the Arabian peninsula from Apollo 17, taken on December 7, 1972. Courtesy of the National Aeronautics and Space Administration (NASA), National Space Science Data Center (NSSDC).

http://nssdc.gsfc.nasa.gov/photo_gallery/photogallery-earth.html

# Globalizing Integrated Pest Management

## A Participatory Research Process

*edited by*


**George W. Norton**
Department of Agricultural and Applied Economics,
Virginia Polytechnic Institute and State University,
Blacksburg, Virginia, U.S.A.

**E. A. Heinrichs**
Office of International Research, Education, and Development
Virginia Polytechnic Institute and State University,
Blacksburg, Virginia, U.S.A.

**Gregory C. Luther**
The World Vegetable Center
Taiwan

**Michael E. Irwin**
Entomology Department
University of Illinois
Urbana-Champaign, Illinois, U.S.A.



Blackwell Publishing

*Globalizing Integrated Pest Management — A Participatory Research Process*, edited by George W. Norton, E.A. Heinrichs, Gregory C. Luther, and Michael E. Irwin



Blackwell Publishing Professional
2121 State Avenue, Ames, Iowa 50014, USA

| | |
|---|---|
| Orders: | 1-800-862-6657 |
| Office: | 1-515-292-0140 |
| Fax: | 1-515-292-3348 |
| Web site: | www.blackwellprofessional.com |

Blackwell Publishing Ltd
9600 Garsington Road, Oxford OX4 2DQ, UK
Tel.: +44 (0)1865 776868

Blackwell Publishing Asia
550 Swanston Street, Carlton, Victoria 3053, Australia
Tel.: +61 (0)3 8359 1011



This book was produced from camera-ready copy supplied by the authors.

First edition, 2005

ISBN-10: 0-8138-0490-6
ISBN-13: 978-0-8138-0490-3

Library of Congress Cataloging-in-Publication Data available on request

The last digit is the print number: 9 8 7 6 5 4 3 2 1

# — 8 —

# IPM Transfer and Adoption

Edwin G. Rajotte, George W. Norton, Gregory C. Luther,
Victor Barrera, and K. L. Heong

## Introduction

Participatory IPM research, through its involvement of farmers, marketing agents, and public agencies, is designed to facilitate diffusion of IPM strategies. However, widespread IPM adoption requires careful attention to a host of factors that can spell the difference between a few hundred farmers adopting IPM locally and millions adopting it over a large area. A number of strategies have been implemented over time in efforts to speed diffusion of IPM around the world. These strategies include working with traditional public extension agencies and approaches and relying on private for-profit and not-for-profit entities that use a variety of specialized training and technology-transfer methods. The complexities of IPM programs; vast differences in local public-extension capabilities; resources, education, and socio-economic differences among farmers; and the need to cost-effectively match IPM strategies to IPM solutions dictates a multi-faceted approach to IPM diffusion if adoption is to be maximized. Given that public resources are scarce, a central issue is how to engage farmers in IPM in a way that maximizes the amount of learning for the resources expended. The purpose of this chapter is to identify some of the lessons learned about how to maximize the depth and breadth of farmer engagement in IPM.

## Translating IPM Research Results into Practice

A fundamental difficulty in diffusing IPM knowledge within developing countries is that public-sector extension systems in those countries tend to be weak or non-existent, while the private sector involved in pest management is primarily interested in selling as many pesticides as possible. In areas where farmers can not afford pesticides and are not informed about alternative IPM practices, pest losses are often endemic, and where they can afford them, pesticides tend to be over-used and abused.

Weaknesses in public extension systems have their roots in many factors: low budgets and salaries, poor organization and training, stifling bureaucracies, politicization, inadequate research results to extend, difficulties in distinguishing between public and private goods, and lack of understanding of the potential for extension to accelerate technology diffusion (Anderson and Feder, 2004). In part because of these weaknesses, many public extension systems have shrunk, been eliminated, or been given multiple functions in addition to technology diffusion. In addition, extension duties have been devolved to local governmental units. This devolvement results in a lack of regional and national collaboration in extension programming, and it puts local extension personnel under the authority of locally elected politicians who often divert efforts away from extension programming. In many countries, non-governmental institutions (NGOs) have picked up some extension responsibilities, including IPM, but their programs are usually piecemeal and/or temporary.

The two primary questions that must be addressed in any country hoping to increase the adoption of IPM practices are: (1) which public and private institutional mechanisms can be strengthened and used to speed up the diffusion of IPM knowledge, and (2) what is the optimal mix of approaches for spreading IPM knowledge? Because some IPM knowledge can be conveyed in simple messages (Heong et al., 1998), while other IPM knowledge requires more complex engagement of farmers (Kenmore, 1991), and because of the strengths and weaknesses of various institutional mechanisms, no single approach or institution is likely to be sufficient. Moreover, an understanding of the farmers' socioeconomic situation is imperative in bringing to bear whatever technology transfer entities already exist, or designing new technology transfer systems.

## 'Supply and Demand' in Technology Transfer

The adoption of new practices by farmers is the result of being provided new knowledge (technology push; supply) and having the new practices demanded of the farmer by others (technology pull; demand). Supply-side factors include the availability of new research information, the appearance of a new farm input, or the presence of an educational program. Demand-side factors include, among others, regulations requiring practice change, competitive advantage in the marketplace for farm products produced using certain practices, and pressure from the local community to change practices.

Any technology transfer plan should address both sides, and as many supply-and-demand elements in given farming systems as possible should be identified in the initial phases of the participatory process. Once identified, each element can be evaluated for its importance in the technology transfer process, and methods can be developed to address each of these elements in the process.

In the Philippines, farmers took annual loans from the Land Bank to establish their rice or vegetable crop. However, the loan from the Land Bank was only half in cash. The other half was provided as inputs such as fertilizer and pesticides. An IPM technology-transfer program that was ignorant of this fact might have tried to promote pesticide reduction, unaware that the farmer might already have obtained a full season's worth of pesticide from his 'loan,' making him reticent to not use the pesticide. On the other hand, this situation also provided an opportunity to change this demand-side factor by educating the Land Bank policy makers about the benefits of IPM so that they would substitute pesticides in the loan program with underwriting IPM practices.

## The Importance of Multiple Institutions

Publicly funded extension programs have played important roles in many countries in linking farmers with the latest research knowledge. Public systems can be especially important for reaching small farms and for extending socially beneficial research messages that the private sector may ignore due to lack of a profit incentive. However, some extension systems function better than others and most have become over-extended and less effective where they still exist. As developing countries become increasingly urban and public budgets tighten, public extension services become less valued and their budgets slashed. Therefore as IPM research produces additional knowledge, its broad diffusion is increasingly left to the private sector and to NGOs.

Involving the private sector (cooperatives, export firms, input suppliers, etc.) in IPM diffusion has the advantages that (1) where it is profitable, IPM will be strongly encouraged, (2) use of scarce public resources is minimized, and (3) the demands of the marketplace are brought back to producers. The disadvantages are that the private sector tends to focus on larger farms and on IPM practices that involve products (seeds, chemicals, seedlings, etc.), perhaps to the exclusion of small farms, management-intensive practices, and knowledge that improves the environment but not the bottom line.

Certain types of private-sector involvement can be very helpful in diffusing IPM. For example, cooperatives enable farmers to pool resources and take advantage of technology-transfer mechanisms that might otherwise be difficult to access. Again, in the Philippines, the National Onion Growers Cooperative Marketing Association (NOGROCOMA), whose members produce the majority of the onions grown in the country, support their own technology-transfer agents and test IPM practices, developed with the assistance of public national researchers, on their own demonstration plots and farms. NOGROCOMA is motivated to provide this support primarily because IPM can reduce costs and may offer an advantage when exporting onions to countries that place a value on safely produced food. In Guatemala, fruit and vegetable cooperatives help farmers achieve the quality control required for export markets by transferring IPM knowledge to their growers and developing pre-clearance protocols for export crops.

NGOs often make use of a combination of public and private funds to reach small farms and to address management practices ignored by the private sector. Their grassroots contacts tend to be strong. However, their programs may be targeted to small areas, be of short duration, and have few upstream connections to research knowledge. Because each of these three primary institutional mechanisms (public, private, and NGO) has its strengths and weaknesses, and the relative presence of each differs by country, it will often be the case that a combination of the three is optimal. A responsibility is placed on any participatory IPM research system to involve all three mechanisms for IPM diffusion.

## Approaches

Numerous approaches exist for transferring knowledge and engaging farmers in IPM. Within public extension systems, one common approach is to train agricultural extension agents and to station them in villages around the country. The agents are responsible for working with anywhere from a hundred to several thousand farmers. The agents may spend part of their time visiting individual farms in response to problems identified by farmers and part of it holding meetings, demonstrations, and field days with groups of farmers. The group meetings may focus on agendas set by farmers (or youth groups) or may focus on topics identified at higher levels in the extension system (such as occurred under the Training and Visit or T&V system designed by the World Bank). The agents are usually generalists but may be supported by specialists at the regional or national levels. The amount of training they receive and their interactions with research systems will differ by country, as will the supporting materials available such as publications, radio programs, videos, etc. Extension agents may be asked to extend supervised credit or undertake other activities in addition to extending research knowledge.

One common feature of a well-functioning public extension system is that it responds to the demands of farmers, regardless of the commodity or problem. Therefore as new problems arise, they can be addressed relatively quickly or the agents can bring the problem back to researchers for assistance. Because many problems identified by farmers will be pest-oriented, the opportunity for extending IPM solutions is significant, albeit highly dependent on the dedication and training of the agent. The best agents often come from the local areas where they serve and have some knowledge both of the social and cultural environment, and of the farming systems. They reside locally and may be available for consultation on weekends and in informal settings in addition to their structured interactions. Because they reside locally, they also can be held accountable to farmers for the quality of their advice, and the group interactions they have can provide a forum for farmers to share their indigenous knowledge (Figure 8-1).

Because IPM involves attempts to bring all available knowledge to bear on a pest-management problem, and is facilitated by farmer knowledge of

*Figure 8-1. Discussing potato IPM with farmers in Ecuador.*

beneficial insects, and by farmers experimenting themselves and sharing their knowledge within groups, some public research and extension services, and many NGOs, have taken an intensive IPM farmer-research and knowledge-diffusion approach called the Farmer Field School (FFS) approach. Described in more detail in Chapter 9, the FFS has stressed the importance of farmers growing a healthy crop, observing their fields weekly, conserving natural enemies, experimenting themselves, and using relevant, science-based knowledge. A farmer-training program is held with groups of 12 to 25 farmers. The "field schools" last for an entire growing season in order to take the farmers through all stages of crop development. Little lecturing is done, with farmers' observations and analyses in the field a key component. Farmers and trainers discuss IPM philosophy and agro-ecology, and farmers share and generate their own knowledge (Kenmore, 1991; van de Fliert, 1993; Yudelman et al., 1998). The Global IPM facility at the Food and Agriculture Organization (FAO) of the United Nations has been a driving force in the spread of the FFS approach around the world.

The IPM diffusion mechanisms described above have their individual strengths and weaknesses. Village-level extension agents, if properly funded, have the advantage of providing farmers with the opportunity to place IPM in the context of the total agricultural system. IPM instruction is not tied to just one commodity, and farmer groups with whom the agent works can meet together, perhaps every two weeks, over many years. This system worked extraordinarily well for the Colombian Coffee Federation for many years. Its extension agents addressed all commodities, not just coffee, and were in small part responsible for Colombia's success in establishing itself as a high-quality producer in the world market, with fewer pest problems than many neighboring countries. It was able to reach virtually all farmers in the coffee zone of Colombia.

A weakness of the village-agent approach is that is requires substantial and sustained funding over many years. The example of the Colombian Coffee Federation can be difficult to duplicate in areas without a major export crop. The research and extension activities of the coffee federation were funded in part via a small check-off or tax on exports. In other regions of Colombia served by another government extension agency, agents were not supported as well and were not as successful.

Within the village-agent approach are also other variants of extension methods. Demonstration plots strategically placed around the region/country, with field days held at appropriate times during the growing season (see Figure 8-2, page xxi); radio programs, posters, dramas, and campaigns to spread simple messages can be relatively low cost and yet reach large numbers of farmers for specific messages (Heong et al., 1998). Certain components of IPM programs can be diffused through such methods, and where they are appropriate the methods can be very cost-effective in speeding up technology adoption. Sticky traps, bio-control agents, and grafted seedlings for disease control are examples of IPM practices that may lend themselves to this approach. The Colombian Coffee Federation delayed the spread of coffee rust for several years after Brazil and other neighboring countries experienced it due to active use of posters and radio messages. In Vietnam, pesticide use was reduced over 50% in rice in large areas where the simple message: "no spray for the first 40 days on rice" was widely broadcast. A critical question, however, is how to spread more complex messages rapidly and cost effectively.

Not all IPM extension education must be focused on adults. IPM in school programs can be an effective means of reaching future farmers (and consumers) with information that may change their attitudes and behavior at a young age. Mobil IPM teaching laboratories can be used to reach large numbers of school-age children in areas where widespread training of teachers is difficult.

## Transferring IPM across Regions

Farmers fail to adopt an IPM (or any) technology for three reasons: (1) it is unavailable, (2) they are unaware of the it, or unaware that it will help them, or (3) it is unsuitable for their farm due to profit, risk, or other reasons. While the second reason is the primary basis for public support of technology-transfer programs, all three reasons can influence the appropriate design of the technology-transfer system and the ease with which IPM technologies spread from one geographical area to another.

### Technology Availability

The major reason farmers fail to adopt IPM is that IPM solutions are not available for their specific pest/crop/location even if it is available elsewhere. Because resources are scarce, research priorities are needed that are based on assessments of projected returns to society (economic, environmental, health, or social returns) locally and across wide geographic areas. Potential aggregate benefits as well as benefits to specific groups must be assessed. Farmers are influenced by numerous considerations within the farm household; therefore participatory approaches such as those discussed in this book are required once the broad geographic focus is determined.

Because regional and global spread of IPM strategies is desired on projects such as the IPM CRSP, information on the importance of the crops and pests beyond the local research domains must be factored into the priority setting process.

Availability of IPM information can be a problem if it is developed with little attention to how it will be commercialized. While input markets respond to profitable opportunities, multiplication and sale of a technology require investments and, in many cases, overcoming a series of regulatory hurdles. Bio-control techniques may require mass rearing of beneficial insects, import and distribution of pheromones, or regulatory approval of a virus that controls an insect. Availability of potentially useful biotechnologies is constrained in countries where bio-safety rules are not in place. The implication is that attention to market and regulatory issues must proceed hand-in-hand with development of the IPM technology if it is to be spread.

Many extension services throughout the world currently have extension agents who are constrained by lack of available technologies. While the fault for lack of spread of IPM is often placed at the feet of extension, in many cases there are extension agents out in the villages who would be willing to extend additional IPM knowledge, if it existed. There are NGOs as well who could do more to extend IPM programs if a greater knowledge base of potential solutions existed.

## Awareness of Available Technology

Because farmers are numerous and diverse, are broadly dispersed, and become aware of and understand the need for some technologies more readily than others, multiple technology-transfer methods may be required to cost-effectively reach desired audiences with the depth of knowledge required. Issues of (1) appropriate participation (who, how, when), (2) the need for information on benefits and costs of the technology (implying a need for impact assessment), and (3) the relative effectiveness of various technology-transfer methods must be addressed.

No technology transfer method is a silver bullet. Intense training programs, such as the Farmer Field Schools mentioned above, can be very effective with small groups, but costly to multiply to broader audiences (Feder et al., 2003, 2004). On the IPM CRSP, farmer participation is included at three levels: during research prioritization, during the research process, and during the diffusion process. However, as described in earlier chapters, other groups besides farmers and scientists participate. During research prioritization, policy makers, regulatory officials, marketing agents, technology-transfer agents, and others are included in participatory appraisals. Cooperating farmers from several villages are key players in the subsequent research process, which includes most, but not all, research in farmers' fields. Numerous farmers are also surveyed quantitatively and/or qualitatively early in the research process, to assist with research priority setting, and to permit analyses of factors influencing adoption, both near the center of the research and across potential adoption regions within the country.

A key issue is how to combine the technologies and strategies being developed, with the appropriate amount of participation for maximum diffusion, given public-resource (especially financial) constraints for technology transfer. The IPM CRSP has used Farmer Field Schools extensively in most of its sites and found them excellent for: (1) testing integrated sets of technologies (in our case IPM strategies) that have been developed cooperatively among scientists and farmers, (2) training technology-transfer agents such as extension agents and representatives from nongovernmental organizations (NGOs), and (3) imparting an in-depth understanding of the IPM philosophy to defined groups. A well-functioning field school can achieve its purposes for about $40-50 per participant. Unfortunately, the spread of information from farmer participants to neighbors tends to be weak. Therefore the most effective use of field schools may be to train technology-transfer agents rather than farmers. Some of these agents may then be facilitators in field schools where financial support exists or may utilize other diffusion mechanisms. In all cases, use of mass media should be exploited where possible, and demonstrations and field days be used to spread technology to as broad an audience as possible.

Farmers may be aware of a technology but not adopt it because they are unsure of its net benefits. One reason that the field-school approach is attractive is that it helps farmers themselves explore some of the benefits and costs of various technologies. Information on farm-level economic benefits, generated through credible impact assessments, can also help. Many times the IPM strategy most effective in reducing pest incidence in farm-level trials is not the most profitable option for the farmer due to labor costs or other factors.

Packaging of IPM information can take many forms. Booklets, fact sheets, videos, and radio programs can be relatively low-cost options for information transfer at a superficial level, and can be very useful tools in short- or long-term outreach programs or courses. Computer-aided decision tools, while common in more developed countries, are less utilized in developing countries except for transferring information among scientists or extension personnel.

### Technology Suitability

Regardless of how strongly it is recommended, adoption of an IPM technology will not occur if it is unsuitable for a specific environment. Profitability or risk may be related to expected level and variability of yield, or input costs, but many agro-ecological, institutional, and personal factors can determine suitability. And, even if a technology is suitable from a farmer's perspective, external costs and benefits may make it less suitable from society's standpoint. Therefore priority-setting exercises, adoption studies, and impact assessments that focus on only one or a few of these factors will be incomplete.

Technology suitability is often not black and white. Farmers may adopt only part of an IPM package, not because they want to jump in slowly, but because only part of it is suitable to their situation. Adoption and impact-assessment studies in IPM have had to focus on defining IPM adoption first, as adoption is frequently a matter of degree.

## Assessing Adoption

Several empirical studies of IPM adoption have been conducted to assess which specific factors or characteristics correlate with adoption decisions by farmers (Napit et al., 1988; Harper et al., 1990; McNamara et al., 1991; Fernandez-Cornejo et al., 1994). The purpose of the studies has been to generate knowledge that will improve technology-transfer approaches and to help predict adoption of new technologies for *ex ante* impact assessment. Most adoption studies use cross-sectional data from farm-households, including them in logit or probit models. Because IPM adoption is often a matter of degree rather than either/or, a simple binary (adopt or not adopt) decision model may not suffice, and the multinomial logit or probit is used with multiple, but discrete, choices to adopt various sets of IPM practices.

A typical IPM adoption analysis uses a logit model in which the dependent variable takes a value of 1 if there is adoption and 0 otherwise. In the binary model, the probability of adoption by the ith farmer is given by $P_i = F(\mathbf{B}'X) = 1/(1+ \exp(-\mathbf{B}'X))$, where F is the cumulative distribution function (Maddala, 1988). The log-likelihood function of the general multinomial logit model is $\log L = \Sigma i\ \Sigma j\ Y_{ij} \log P_{ij}$, where $Y_{ij}$ is a dummy variable equal to 1 if the individual i falls into the jth adoption category and

0 otherwise. It is assumed that each producer's objective function contains a non-stochastic portion which equals **B'X**, where **B** is a row vector of parameters and **X** is a column vector of exogenous variables. The model can be estimated using maximum likelihood. The marginal effect of a change in a variable on the probability of selecting a specific level of adoption can be computed using the following equation: $\delta P/\delta x_{ij} = \beta_j P_i(1-P_i)$, where $\beta_j$ is the initial parameter estimate for independent variable j. Goodness of fit of the model can be measured using the McFadden $R^2$, which is defined as McFadden $R^2 = 1 - (\text{Log } L(\beta_{ML})/\text{Log } L_o)$, where Log L $(\beta_{ML})$ and Log $L_o$ are the log-likelihood values of the restricted and unrestricted models respectively. The predictive ability of the model can be judged by the number of correct predictions divided by the number of observations.

Examples of applying this type of model on the IPM CRSP are found in Tjornhom et al. (1997), Cuyno (1999), and Bonabona-Wabbi et al. (2002). Cuyno, for example, estimated a logit model to assess factors affecting willingness to adopt IPM practices on onions in the Central Luzon, Philippines. The purpose in her case was to predict future adoption of three specific IPM technologies in different regions. The following categories of variables were included that potentially might affect suitability or farmer awareness of the technologies: (1) farmer characteristics such as age, education, experience, tenure status, (2) managerial factors such as time spent in off-farm employment and the ratio of pesticide costs to total costs, (3) farm structure factors such as farm size, and the share of onion profits in total farm income, (4) physical location, (5) informational factors such as source of pest-management advice and participation in IPM training, and (6) experiences with health or environmental problems associated with pesticides and use of protective measures against pesticide poisoning. The IPM technologies considered in her analysis were burning of rice hulls to reduce nematode problems, trap cropping with castor, and using Bt and nuclear polyhedrosis virus to reduce armyworms. She conducted a survey of 176 farmers, and while in her analysis many of the above factors were found to significantly influence adoption of the IPM technologies, information variables were particularly so, and previous use of protective measures against pesticide exposure.

Tjornhom et al. used a logit model to assess factors influencing pesticide misuse on onions in the Philippines at the start of the IPM CRSP program in that country. They surveyed more than 300 farmers; their analysis of the data found that educational activities and interpersonal contact are the most important factors influencing pesticide misuse. The need for farmer training and awareness was evident in the reduced instances of pesticide misuse by farmers who attended Farmer Field Schools and by farmers who viewed pesticides as harmful to water quality and natural enemy populations.

Bonabona-Wabbi et al. conducted a logit analysis of adoption of eight IPM technologies on cowpea, sorghum, and groundnuts in Uganda. Low levels of adoption (<25%) were found for five of the technologies; three technologies had high adoption (>75%). Results indicated that farmers' participation in on-farm trial demonstrations, accessing agricultural knowledge through researchers, and prior participation in pest-management training were associated with increased adoption of most IPM practices. Farm size did not affect IPM adoption, suggesting that IPM technologies may be scale neutral. Unlike in the Philippines, farmers' perception of harmful effects of chemicals did not influence farmers' decisions with regard to IPM technology adoption.

In addition to these quantitative technology-adoption analyses, focus group and other qualitative techniques as well as simple surveys can be used to identify critical issues that may influence adoption. Identifying issues associated with gender and labor use in the farm-household are especially important. Focus analyses have been conducted on the IPM CRSP in almost every site and have proven useful both for identifying potential constraints to adoption that might have been missed with a survey, and in facilitating follow-up discussions as to why certain factors are constraints. Small surveys of 50 to 600 farmers have also been used to summarize factors that may influence future adoption or to estimate adoption that has already occurred. In Ecuador, for example, 600 farmers were interviewed to assess their knowledge of plantain pests and use of pest-management practices.

## Scientist Training

Diffusion of IPM knowledge requires a critical mass of IPM expertise within the research and extension systems of the country. Due to its multidisciplinary nature, education is needed in a range of disciplines including entomology, plant pathology, weed science, nematology, economics, and other social sciences. Graduate education is expensive; hence development of local capacity is essential to minimize the costs. Agricultural graduate programs in developing countries have grown over the past few years in Africa, Asia, and Latin America, especially for masters-level training. On the IPM CRSP, costs have been kept down for Ph.D. education by supporting "sandwich" type programs in which a semester or two of critical course work is completed in a U.S. university and the remainder of courses and research are completed in the host country, sometimes in conjunction with short-term research at an international agricultural research center (IARC) such as the Asian Vegetable Research and Development Center (AVRDC). This type of program also increases the chances of keeping the scientist in the program after the degree. U.S. universities and IARCs also play a critical role in non-degree short-term training.

## Future Challenges

Each IPM program must assess its capabilities for sustaining the development of IPM knowledge and diffusing it in a cost-effective manner. Because the capacity of the extension system to deliver IPM messages varies widely by country, the importance of private groups and NGOs has increased over time. However, where extension services still exist, there may be agents who are eager to spread new useful technologies; thus public extension opportunities should not be discounted too quickly.

Social, economic, institutional, and agro-ecological factors all influence adoption decisions. Geographic information systems (GIS) can be used to help identify common geographic areas where IPM technologies are likely to be appropriate, once the importance of specific constraints to adoption are identified. A broad view of IPM adoption constraints is needed because factors such as gender roles, off-farm employment opportunities, and other indirect factors can have a significant influence on adoption decisions. Adoption of grafted eggplant seedlings to control bacterial wilt is spreading faster in Bangladesh than in the Philippines. It is important to know if the reason is the quality and quantity of the technology-transfer mechanisms (awareness), the cost of labor (suitability), or the effectiveness (availability) of the technology.

## Conclusions

The key issue in IPM technology transfer is how to cost effectively spread IPM to millions of farmers around the world in enough depth that they will adopt IPM in an appropriate manner. Farmer Field Schools, which are discussed in the next chapter, are useful for transferring in-depth knowledge of crop ecosystems to farmers, maximizing their ability to make appropriate IPM decisions. However, they are expensive and therefore reach a relatively small proportion of farmers. The programs tend to end when the donor funding ends, much as occurred with the earlier T&V system. One option is to focus the FFS programs on training of trainers so that there is a cadre of facilitators with the more in-depth knowledge. Then these trainers can be supported by various mechanisms while they conduct more abbreviated training programs that include meetings, establishment of demonstration plots, distribution of printed material and videos, and field days. If the trainers are public extension personnel, they must integrate IPM training into the other aspects of their program or the public sector will usually be unable to adequately support them.

Too little effort has gone into the rapidly growing possibilities for mass-media instruction, especially through television and radio. Shows such as radio and TV soap operas are popular in many developing countries. IPM messages can be included in these shows.

Too little attention has been devoted to IPM training in schools. While the latest technologies can be imparted through mass media, demonstrations, field days, and in some cases through FFS, the optimal place to achieve an appreciation of agro-ecology is in primary- and secondary-school classrooms. School science curricula are likely to be the most cost-effective mechanisms for helping a broad spectrum of the population gain an appreciation for differences among pests, beneficial insects, and other insects. Once they have this appreciation, their ability to take advantage of short-term IPM messages about the latest technologies and their ability to innovate on their own should be enhanced.

## References

Anderson, J., and G. Feder. 2004. Agricultural Extension: Good Intentions and Hard Realities. *The World Bank Research Observer* 19: 41-60.

Bonabona-Wabbi, J. 2002. Assessing factors affecting adoption of agricultural technologies: The case of Integrated Pest Management (IPM) in Kumi District, Eastern Uganda. M.S. thesis, Virginia Tech.

Cuyno, L.C.M. 1999. An economic evaluation of the health and environmental benefits of the IPM program (IPM CRSP) in the Philippines. Ph.D. thesis, Virginia Tech.

Feder, G., R. Murgai, and J. Quizon. 2004. Sending farmers back to school. *Review of Agricultural Economics* 26 (February): 45-62.

Feder, G., R. Murgai, and J.B. Quizon. 2004. The acquisition and diffusion of knowledge: The case of pest management training in Farmer Field Schools, Indonesia. *Journal of Agricultural Economics* 26(July): in press.

Fernandez-Cornejo, J., E.D. Beach, and W.Y. Huang. 1994. Adoption of Integrated Pest Management technologies by vegetable growers in Florida, Michigan, and Texas. *Journal of Agricultural and Applied Economics* 26(July): 158-172.

Harper, J.K., M.E. Rister, James W. Mjelde, Bastiaan M. Drees, and Michael O.Way. 1990. Factors influencing the adoption of insect management technology. *American Journal of Agricultural Economics* 72(November): 997-1005.

Heong, K.L., M.M. Escalada, N.H. Huan, and V. Mai. 1998. Use of commmunication media in changing rice farmers' pest management in the Mekong Delta, Vietnam. *Crop Protection* 17: 413-425.

Kenmore, P. 1991. Indonesia's Integrated Pest Management: A model for Asia. Manila, Philippines: FAO Intercountry IPC Rice Program.

Maddala, G.S. 1988. *Introduction to Econometrics*. New York: Macmillan Publishing Company.

McNamara, K.T., M.E. Wetzstein, and G. K. Douce. 1991. Factors affecting peanut producer adoption of Integrated Pest Management. *Review of Agricultural Economics*. 13(January): 129-139.

Napit, K.B., G.W. Norton, R.F. Kazmierczak, and E.G. Rajotte. 1988. Economic impacts of extension Integrated Pest Management programs in several states. *Journal of Economic Entomology* 81(February): 251-256.

Tjornhom, J.D., G.W. Norton, K.L. Heong, N.S. Talekar, and V.P. Gapud. 1997. Determinants of pesticide misuse in Philippine onion production. *Philippine Entomologist* 11(October): 139-149.

Van de Fliert, E. 1993. Integrated Pest Management: Farmer Field Schools generate sustainable practices, a case study in Central Java evaluating IPM training. Wageningen, The Netherlands: Agricultural University of Wageningen, Thesis 93-3.

Yudelman, M., A. Ratta, and D. Nygaard. 1998. Pest management and food production: Looking to the future. Food, Agriculture, and the Environment Discussion Paper 25, International Food Policy Research Institute, Washington, D.C.