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Integrated Pest Management

Strategies and Policies for Effective Implementation

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Tjaart W. Schillhorn van Veen, Douglas A. Forno, Steen Joffe, Dina L. Umali-Deininger, and Sanjiva Cooke

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Cover photograph by Dely P. Gapasin. Farmers examine potato plants for pests and natural enemies as part of the weekly *IPM* field school activity, Malang, Indonesia, 1994.

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Foreword

Since the 1940s pest management technology has relied increasingly on chemical pesticides. Although in many cases their use has significantly alleviated pest problems in the short term, it has also generated secondary pest problems and pesticide resistance, putting farmers in a vicious cycle of pests and pesticides and increasing the burden on the environment. Chemical pesticides are also associated with public health risks to farmers and others who apply them and to consumers of agricultural products. In the past decade, however, farmers and policymakers have become increasingly aware of the limitations of chemical pest control and the need to reevaluate pest management strategies.

As discussed in this volume, efforts to implement environmentally sound pest management strategies have often been impeded by government policies and regulations that inadvertently promote the use of chemical pest control over more sustainable practices. Such sustainable practices encompass a number of technologies and farmer-centered actions that are often referred to as integrated pest management (IPM). Although the concept of IPM is well-known and has been applied in a number of World Bank projects, broad acceptance has been slow.

The World Bank considers IPM to be the preferred approach in pest management and encourages staff and clients to enhance the application of IPM. Important steps are development of a sound policy framework and organizational structures conducive to adoption of IPM, provision of technical backup through research and extension, technical training of farmers, and encouragement of farmer participation in the design and administration of IPM initiatives.

This volume examines IPM as it applies to different levels of government, to farmers, and to the World Bank and other agencies that are involved in supporting agricultural development. I hope that the strategies described here will contribute to more wide-scale application of policies and practices that are conducive to sustainable pest management in agriculture.

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Vice President
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Abbreviations and Acronyms

CGIAR	Consultative Group on International Agricultural Research
FAO	Food and Agriculture Organization
GATT	General Agreement on Tariffs and Trade
IPM	integrated pest management
NAFTA	North American Free Trade Agreement
NGO	nongovernmental organization
OECD	Organisation for Economic Co-operation and Development
PIC	prior informed consent
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
WHO	World Health Organization

Executive Summary

The past half century has seen a worldwide trend toward more intensive agricultural systems and an associated shift toward monoculture and chemical-based approaches to pest management. Fueling this trend have been several factors more or less attributable to agricultural development strategies and associated macroeconomic and sector policies supported by governments and donors. Increasingly, however, questions are being raised about the long-term sustainability of production systems that depend on intensive use of agrochemicals. Negative externalities associated with such systems include direct public health risks, the destruction of natural enemies and emergence of secondary pests, the development of pesticide resistance, increasing soil and water contamination, the contribution to ozone depletion, and other environmental liabilities. Agricultural productivity gains, however, remain critical to secure food availability and livelihoods in the developing world. To achieve such productivity gains in the future will require approaches that are consistent with the conservation of the natural resource base and protection of human health. This effort will involve more judicious use of external inputs, greater dependence on management skills, location-specific knowledge of agroecosystems, and less reliance on chemicals.

During the past decade there has indeed been an increasing interest in, and support for, more sustainable approaches in agriculture and in agricultural pest management, especially in the use of integrated pest management (IPM). IPM uses sound agronomic practices based on an understanding of the ecology of animals, crops, and pests, thereby minimizing the use of synthetic chemicals. This approach is now widely analyzed, and in many cases it has proven to be more economical than pest control based solely on agrochemicals. But full adoption is slow, in part because of an established or lingering "pro-synthetic chemical" policy environment in many countries and in part because the IPM approach is information- or knowledge-intensive and requires education, training, and a technology-generating (research) backup.

Worldwide, changes are taking place in agriculture, especially a rising concern for agricultural and environmental sustainability, shrinking government fiscal resources, and increased harmonization of international trade regulations. These changes provide an opportunity to review and redirect this policy environment toward more sustainable farming practices including IPM.

Government Policies

Governments can have a tremendous influence on pest management practices, both through policies or incentive structures and regulations that affect the choice of pesticides or alternative approaches, and through public support for research, extension, education, and training initiatives. Examples of policies that encourage pesticide use include:

- Macroeconomic policies such as overvalued exchange rates that facilitate pesticide imports
- Minimum wage requirements that discriminate against labor-intensive pest control procedures
- Direct or indirect price subsidies of agrochemicals
- Support for research and extension with a strong pesticide focus, or excessive privatization of research and extension, which subsequently leads to a greater role of industry
- Regulations that are either weak or, through subsidies for research, promote pesticide use
- Government or development agency support for procurement and distribution of pesticides and application equipment such as sprayers.

Apart from the nonsustainable increase in pesticide use, these policies discourage other management practices that are more in line with the principles of IPM. Support for monocropping of high-yielding crops or for high-density livestock production can lead to conditions that are ideal for the rapid growth of pest populations and disease. The risk that such populations or diseases will reach epidemic proportions is great. The common response of formal agricultural research and extension systems has been to emphasize the development of technology packages that are pesticide- or drug-based.

These technology packages exacerbated the pest-control problem in the long term by reducing natural pest predators ("good bugs," or *beneficials)* that traditionally help keep populations of "bad bugs" in check. Less emphasis has been placed on maintaining genetic diversity or breeding disease- and pest-resistant plants and animals. The introduction and continuing development of cheap and quick-acting pesticides and veterinary pharmaceuticals have led to products that are effective and bring high economic returns in the short term. But long-term sustainability and health concerns are raising questions about these practices in many countries.

A variety of tools can be used to assist in the creation of a policy environment that is conducive to IPM, thereby promoting safe and effective pest-management methods. These tools include:

- Development of a regulatory framework governing production, distribution, and use of pesticides and reorientation of economic incentives through appropriate agricultural and environmental policies, including taxes and special levies on pesticide use to account for negative externalities, and short-term subsidies to account for the positive externalities in the use of IPM
- Reorientation of research and technology policies to generate a socially optimal supply of pest management information and technologies
- Creation of a system that informs policymakers, consumers, and producers of the hazards of unlimited pesticide use.

An important factor in ascertaining safety and quality is the evaluation and registration of pesticides and the regulation of their use, as implemented worldwide by many governments. Regulation is increasingly influenced by international organizations such as the Food and Agriculture Organization (FAO), the World Health Organization (WHO), the General Agreement on Tariffs and Trade (GATT), the North American Free Trade Agreement (NAFTA), and international standards such as the Codex Alimentarius and the Montreal Protocol (see chapter 3).

World Bank Portfolio and Strategy

A review of World Bank investments during 1988–95 points to the need for increased attention to more environmentally safe pest management through World Bank development assistance. The review showed that pesticides for agricultural use were procured in 44 percent of the ninety-five pest management projects or project components. Only 23 percent of these projects provided for the implementation of IPM-related programs. While $361 million was allocated to finance pesticides, just $81 million was provided to finance on-farm implementation of IPM-related activities (a sum that excludes the often significant contribution of farmers and training institutes). Among projects supporting pesticide procurement, 43 percent had a Category B environmental assessment classification, requiring environmental review; 32 percent were rated Category C, not requiring

any environmental assessment; and 24 percent of projects, most of them begun before 1989, were not assigned an environmental assessment category.[1]

Against this background the analysis and discussion in this volume provide guidance on policies and best practices that are drawn from the collective experiences of a wide range of pest management programs. Accordingly, it is recommended that the World Bank reasserts its operational policy on pest management in favor of a more proactive role for the Bank in promoting and supporting environmentally safe and sustainable pest management practices. To achieve this goal, use of the following instruments and best practices are recommended:

- Assessment of needs and priorities in relation to IPM and other sustainable production technologies should move upstream in country programming and be an integral component of sustainable growth strategies.
- More use should be made of economic and sector work to analyze and define relevant sector policies and associated regulatory and institutional frameworks.
- Project screening tools such as the environmental assessment process should be used more to analyze the sustainability aspects of proposed strategies, including prospects for IPM.

The main objective of using these instruments is to encourage an early dialogue among World Bank task managers (and member country officials), the regional environmental divisions, and the agricultural, technical, and policy staff in the region, as well as in the Agriculture and Natural Resources Department, regarding best practices relative to sustainable production technologies. Specific IPM assessments may be warranted in some circumstances.

The World Bank does have limited relevant expertise to assist its task managers in determining whether appropriate and sustainability promoting policies and techniques are pursued in Bank-financed projects. There is a need to increase exposure of Bank staff to the concept, economics, and implementation of IPM; to enhance their awareness; and to improve in-house IPM project (component) identification and review processes. As such IPM is included in the core training programs being developed for Bank staff who work in the Agriculture and Natural Resources and Environment Departments.

Finally, it is recommended that the World Bank use clear directives and good practices to specifically adopt an IPM approach to pest management and to accommodate quality assurance, handling, storage, and disposal issues that are chemical-specific. These directives should be followed by additional best practice papers to further assist task managers in implementing IPM and procurement procedures that enhance the judicious and safe use of pesticides.

The World Bank, the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and FAO recently established a joint program to facilitate the development and pilot testing of IPM. This program is expected to lead to an increasing number of high-quality lending operations that contribute to sustainable agriculture.

Note

1. The World Bank assigns projects an environmental assessment category (A, B, or C) according to the degree of oversight necessary to ensure prevention or mitigation of potential environmental or health risks.

Introduction

Generating the agricultural productivity gains necessary to secure food availability and livelihoods in the developing world over the coming decades requires an approach in which the intensification of agricultural systems is consistent with conservation of the natural resource base. This approach requires less reliance on the intensive use of external inputs and greater dependence on management skills and location-specific knowledge of agroecosystems. Integrated pest management (IPM) constitutes one such approach (box 1).

The IPM concept is far from new. Farmers used integrated pest control long before scientists coined the term. In traditional farming systems, pest management is inseparable from sound farm management. It involves farm practices that promote good plant and animal health and keep pest losses in check without the use of manufactured chemicals. Changes in farming systems during the past half century lost sight of this approach, and chemical control methods increasingly became the pillar in the control of pest and diseases in modern agriculture. During the past decade, however, growing concerns about the risk and negative effects of chemical methods have spurred agriculturists, environmentalists, and economists to explore pest management strategies that have fewer side effects on public health and the environment. The most well-known among these strategies is IPM.

IPM can best be described as a farmer's knowledge and use of an optimal mix of pest control tools and tactics, taking into account a variety of factors, including yield, profits, risk, sustainability, and safety (box 2). IPM is a key component of integrated farming practices (that is, good agronomy) that are based on an understanding of ecology and the interaction between crops or animals and their pests, as well as an understanding of the environments in which pests operate. The concept is nearly as old as agriculture itself, but modern research has greatly enhanced the understanding of population dynamics and broadened the scope and scale of pest control strategies.

Although IPM is used mainly in the context of cropping, the principle also applies to forestry and animal and public health.

IPM is the preferred strategy for pest management under Agenda 21 of the United Nations Conference on Environment and Development (UNCED 1992, 7). Agenda 21 states:

> Chemical control of agricultural pests has dominated the scene, but its overuse has

Box 1. What is integrated pest management?

IPM is a knowledge-intensive and farmer-based management approach that encourages natural control of pest populations by anticipating pest problems and preventing pests from reaching economically damaging levels. Appropriate techniques are used, such as enhancing natural enemies, planting pest-resistant crops, adapting cultural management, and, as a last resort, using pesticides judiciously.

Source: Adapted from USDA/ARS 1993.

adverse effects on farm budgets, human health, and the environment, as well as on international trade. New pest problems continue to develop. Integrated pest management, which combines biological control, host plant resistance, and appropriate farming practices and minimizes the use of pesticides, is the best option for the future, as it guarantees yields, reduces costs, is environmentally friendly and contributes to the sustainability of agriculture.

Box 2. Integrated pest management technical toolbox

The main features of IPM involve the use of nonchemical methods of pest control:

- *Biological controls.* The use of natural enemies, often called *beneficials*, which include parasites, predators, and insect pathogens.
- *Cultural and crop or livestock management controls.* Tissue culture, disease-free seed, trap crops, cross protection, cultivation, refuse management, mulching, field sanitation, crop rotations, grazing rotation, and intercropping.
- *Strategic controls.* Planting location, timing of planting, and timing of harvest.
- *Genetically based controls.* This includes insect- and disease-resistant varieties and root stock. Environment-friendly chemical interventions are sometimes included in biological controls, such as the use of semiochemicals, including pheromones and feeding attractants, and biopesticides (for example, specific and beneficial friendly insecticides).

In practice IPM often combines natural forms of control, taking advantage of (and providing training in) ecological relationships in the agricultural system, with economically derived rules for the application of pesticides. However, the pesticide use in IPM differs from the approach used in conventional pest control. When possible, IPM relies on pesticides that target specific pests, can be applied at lower rates, and are less toxic to beneficial organisms. New application methods are being developed that employ biological materials such as pheromones and feeding attractants to lure the target pest to the pesticide. Application rates, timing, and frequency are chosen to minimize effects on beneficials. Pesticides that can be substituted for each other are interchanged to slow the development of pest resistance to pesticides.

Source: Adapted from Vandeman and others 1994.

An essential aspect of IPM is its integration of technical and social knowledge. This integration requires a sound understanding of key pest constraints and biological and farm management systems. These are often highly location-specific, and farmer participation and networking are essential in the design of modern science-based IPM schemes. The major limiting factor, however, is insufficient backup of farmers with adequate and applicable IPM-related technologies. Another problem is a lack of appropriate farm-focused research.

Development agencies, notably bilateral programs sponsored by Germany, the Netherlands, and the United States, as well as those sponsored by FAO, have been advocating and supporting efforts to implement IPM for more than twenty years. The World Bank is now a significant IPM supporter and has invested some $80 million in implementation projects since 1988. However, despite these efforts and notable successes in some countries, widespread implementation of IPM remains an elusive goal in most parts of the world. The conventional paradigm of agrochemical control continues to be attractive to farmers and governments alike because it is simple and can lead to high immediate economic returns. In many cases it is the standard approach extended to farmers by both government and private commercial interests, and the traditional farming system and pest management tools are neglected.

If IPM is to become widespread, farmers must have the appropriate incentives, relevant knowledge, and practical techniques to make use of nonchemical-based approaches. To apply IPM, farmers need to accept a practice that is usually more management- and labor-intensive than the use of chemical agents. Hence farmers will need to see a demonstrable economic payoff. Ultimately, the choice of pest management technology will be influenced by the costs, benefits, and availability of competing alternatives, as well as by any rules or other social norms governing its use.

Governments influence the prospects for widespread implementation of IPM through the incentive structures and regulations affecting the choice of pesticides or alternative approaches. Governments' influence is also strong through

support for research, extension, education, and training initiatives. This dimension of IPM implementation, including the influence that donor organizations can have on government polices, is one of the most important but least-documented aspects of the challenge facing the international community in implementing UNCED recommendations on IPM.

Consequently, this volume reviews how governments can support and encourage IPM implementation and how the World Bank and other development agencies can assist this process. The first chapter considers the factors that affect farmers' choice of pest management technology. The second chapter reviews issues related to development strategies and government policies and shows how many countries have created a policy environment that favors the use of chemical pesticides. The third chapter assesses the policy instruments that governments can use to create a more level playing field for alternative pest management practices and to promote IPM where appropriate. The fourth chapter discusses national IPM policy and the need for more farmer-centered research, extension, and training. Finally, the fifth chapter analyzes the World Bank's current portfolio of relevant projects and looks at the instruments and options available to pursue pro-IPM policies and to promote wide-scale adoption of IPM.

1. Farmers and Pest Management

Pests, diseases, and the losses that they cause are an inescapable part of agricultural production. In principle, farmers have available a range of pest management techniques, from natural controls based primarily on cultural, physical, and mechanical techniques, to the use of biological control agents or chemical pesticides. This chapter examines the factors that influence farmers' choices and techniques (box 1.1). In simple terms the choice of pest management techniques is a function of the *costs* (purchased inputs, other variable costs such as labor, and fixed costs such as sprayers or information costs) and *returns* (labor saving prevention of crop loss in monetary or subsistence terms).[1] In practice, however, whether farmers act to limit losses due to pests and what measures farmers take are determined by a number of factors largely specific to particular production systems. Poor farmers, however, are limited in their choices, and may especially benefit from cost-effective integrated pest management (IPM) approaches.

The perceived economic importance of the losses caused by a particular pest and the availability of the relevant information and skills to deal with them are important factors influencing the choice of pest management practice. Farmers combat the pests that they know about, are concerned about, and can successfully afford to do something about. The breadth of information and technologies available is a function of the number and quality of supply channels, including formal research and extension systems, farmer training, farmer networking, chemical suppliers, and indigenous technical knowledge (box 1.2).

Box 1.1 Factors affecting the economic feasibility of pest control measures

- Yield and quality effects
- Severity of damage
- Pest spectrum
- Frequency of pest problem
- Technical effectiveness of the (bio-) control agent
- Output price
- Risk
- Timely availability
- Price of control agent
- Cost of implementation
- Benefits and cost of alternative programs
- Community and regional organization

Box 1.2 Indigenous technical knowledge

Indigenous technical knowledge has been shown to be a rich source of innovation in pest management, but it tends to break down in the face of rapidly changing farming systems. In general, farmers' knowledge about specific pests tends to be influenced by the visibility of the causal relationship between pest and losses (Bentley 1989). This knowledge is not always complete or accurate—for example, farmers may not be aware of the yield losses caused by viruses or of details of a pest's life cycle that indicate key points for intervention. A partnership between farmers and scientists will often yield practical information based on a mutual exchange of information.