Resources & Environment

Toward a Broader Assessment of Integrated Pest Management

The USDA National Initiative on Integrated Pest Management calls for a broader assessment of IPM practices than has occurred in the past. Past efforts to evaluate IPM program impacts had generally focused on the cost and efficacy of IPM practices, and assessment of environmental impacts has often been limited to measuring changes in pesticide use. Broadening the assessment to document the economic, environmental, and public-health impacts adds further complexity.

The IPM Initiative, in operation since December 1994, aims at implementing the Administration's goal of applying IPM methods and technologies on 75 percent of the nation's cropland by the year 2000. This goal involves identifying, developing, and encouraging adoption of ecologically based pest management approaches that reduce dependence on synthetic pesticides and are more environmentally sustainable, but which are also economically viable for farmers and are compatible with producing an economical, safe, and plentiful food supply.

USDA's IPM Initiative is aimed at developing and implementing a strategic plan to achieve a two-pronged goal: IPM adoption and ecological risk reduction. A major focus of the IPM Initiative has been to redirect new and existing resources toward IPM research and implementation priorities that are identified through stakeholder involvement. Incorporating the input of IPM food and fiber producers, landscape managers, consumers, agribusiness, and environmental groups—to name a few stakeholders—helps ensure that IPM programs are consistent with the values and concerns of farmers, farm-related businesses, and the public.

Forging a Consensus On Assessment Methods

The goal of implementing IPM practices on 75 percent of crop acres has thrown the spotlight on defining and measuring the extent of IPM adoption in the U.S. The concomitant goal of reducing reliance on high-risk pesticides to garner environmental and public-health benefits demands new methods of measuring pesticide impacts. Ensuring that IPM practices and technologies are profitable for producers, and that they contribute to keeping American agriculture competitive in world markets, requires careful evaluation of economic impacts at both the farm and national level.

Developing the methods for measuring progress towards the IPM adoption and risk reduction goals is the challenge facing agricultural interest groups that include, among others, IPM practitioners; social, physical, and biological scientists; and environmentalists. While there is agreement on the need to better document the economic, environmental, and public health impacts of IPM adoption, a consensus has not yet been forged on the appropriate assessment method(s).

The sheer diversity of IPM systems used in the U.S. precludes adoption of a single approach to defining and assessing economic, environmental, and public-health impacts. However, several key elements must be addressed in any approach in order to measure progress toward achieving IPM adoption and risk reduction goals: developing site- and crop-specific definitions of IPM; selecting appropriate environmental and public-health indicators; and integrating the different indicators into a common framework for comparing tradeoffs among IPM program objectives.

While IPM is defined in a number of ways, there is general agreement that it is a *systems* approach to pest management that combines a wide array of crop production practices with careful monitoring of pests and their natural enemies. IPM practices include use of resistant varieties, timing of planting, techniques of cultivation, biological controls, and judicious use of pesticides. IPM systems are designed to anticipate pests and prevent them from reaching economically damaging levels.

Developing a commodity- and location-specific definition of IPM is the first step in measuring the extent and degree of IPM adoption. The diversity of IPM systems is difficult to capture in a single

This article highlights some of the major issues discussed during the Third National Integrated Pest Management (IPM) Symposium/Workshop held in Washington, D. C. from February 27 to March 1, 1996. Attending the workshop were more than 600 participants from around the country, reflecting a wide array of disciplines and professional backgrounds. The Symposium/Workshop was co-sponsored by USDA's Cooperative State Research, Education, and Extension Service and Economic Research Service, along with the Extension and Experiment Station Committees on Organization and Policy and their IPM subcommittees.

In addition to the assessment of IPM impacts, the topics addressed included: involving IPM customers (farmers, agribusiness, consumers) in the design, implementation, and evaluation of IPM programs; analytical and data needs for pest management programs; working with customers to identify research and implementation priorities; and policies for promoting biological and reduced-risk alternatives.

standardized definition or list of practices. Regional variation in geophysical characteristics, ecosystem function, and climate results in many unique agricultural areas. The variation in cropping systems (crop mix and practices) and institutions supporting agricultural production (e.g., research and extension, finance, agribusiness, transportation) adds to the complexity. Annual variation in weather and pest infestation levels can also influence the set of recommended IPM practices.

Ecosystem-specific IPM programs could contain recommended practices that differ significantly by crop, region, and pest problem. For example, IPM systems recommended for apple production in the Yakima Valley in Washington State are different from those in New York's Hudson Valley. IPM practices for insect control in vegetable crop production in Florida differ from the practices for weed control in Iowa corn.

There may be some overlap in recommended IPM practices—for instance, the use of scouting (systematic monitoring of pest infestation levels) and economic thresholds (levels of pest infestation above which economic damage takes place). But the core similarity across all IPM systems is a decision-making process that relies on the use of sound biological, physical, and economic data to make pest management decisions.

The adoption of IPM is not a discrete yes-no choice. Producers incorporate into their production practices, to varying degrees, some number of the potential IPM practices available. Thus, measuring IPM adoption is a matter of locating a producer's position along a continuum from none or basic, to advanced or intensive use of IPM practices specific to a particular ecosystem.

An IPM Tool Box

Biological pest management includes the use of pheromones, plant regulators, and microbial organisms—such as *Bacillus thuringensis* (*Bt*)—beneficial organisms, and genetic resistance to insects, disease, and other pests.

Cultural pest management includes crop rotations, tillage, alternations in planting and harvesting dates, trap crops, sanitation procedures, irrigation techniques, fertilization, physical barriers, border sprays, cold air treatments, and habitat provision for natural enemies of crop pests.

Areawide pest management systems combine primarily biological and cultural methods of pest management to contain or suppress insect pest populations over large definable areas. This is in contrast to traditional IPM systems which are implemented on individual farms and ranches. Areawide pest management is implemented through partnerships with growers, commodity groups, and government agencies.

Pesticide efficiency tools include scouting and economic thresholds, expert systems, precision farming, and bioengineered herbicide tolerance.

Creating an Integrated Assessment

Traditional crop production using agricultural chemicals has many economic, environmental, and public-health consequences—direct and indirect, harmful and beneficial. Potential beneficial consequences of the use of agricultural chemicals in crop production include higher yields, reduced production risks, and increased crop options. Potentially harmful consequences include water quality impairment, loss of biodiversity, reduced populations of beneficial organisms, and health risks to farm workers. Assessing the economic, environmental, and public-health impacts of alternative pest management practices requires examining tradeoffs across a range of potential effects.

Economists use a set of well-established methods to assess the impacts of IPM adoption on producer profitability. The primary method of estimating farm-level profitability is through calculating partial or enterprise budgets, which capture changes in prices and quantities of inputs and output resulting from the adoption of IPM methods. Farm budgets also are important inputs in more aggregate assessments of IPM impacts. For example, if the sample of farm budgets is large enough, estimates of changes in aggregate crop production levels and input demand can be calculated for a given region or for the country as a whole. This information in turn is used to analyze the distribution of benefits and costs of IPM adoption among producers and consumers, regions, and socioeconomic groups.

More difficult is the assessment of actual or potential environmental and public-health impacts associated with different levels of IPM adoption. Many impacts of pesticide use occur off-farm and over time, making it difficult to link specific farm practices directly with environmental impacts. Thus, directly assessing the physical or biological impacts of changes in pesticide use is complex.

In developing comparative risk estimation and ranking methods for the environmental and public-health impacts of pesticide use and alternative pest management approaches, analysts face two challenges. First, gaps exist in the data needed to evaluate pesticide impacts in areas of potential concern to society. For example, much of the ecological effects data on pesticides come from single-species toxicity tests, but species or groups of species vary in their sensitivity to different pesticides. In addition, information on other important factors—persistence, pesticide formulation, weather, application methods, and use of safety precautions—all of which can be site- and time-specific, is often not available.

Second, analysts must determine which environmental and public-health impacts to assess, how to quantify or measure changes in impacts, and the weights to be assigned to different impacts (depending, for example, on their perceived relative importance). Potential areas to examine

Comparing Pesticide Risks

To facilitate comparing pesticide risks, several different research teams have developed multiple-attribute classification tools to help growers in making pesticide choices. Approaches range from relatively uncomplicated pesticide classification lists to more sophisticated software-based whole-farm planning systems. Following are three examples of such tools, presented at the recent IPM symposium/workshop.

Red/Yellow/Green pesticide classification schemes divide all pesticides registered for a particular crop into three categories. The use of pesticides coded "red" is prohibited for management systems designated as IPM, with some exceptions; pesticides coded as "yellow" can be used with caution and in association with other preventive measures; and pesticides labeled "green" can be used without restrictions.

National Agricultural Pesticide Risk Analysis (NAPRA), developed by USDA's Natural Resources Conservation Service, is a field-level planning tool that allows growers to compare water quality risks resulting from various pesticides in different crop and tillage scenarios. Based on an environmental fate model, NAPRA quantifies relative environmental risks associated with pesticides in percolation, solution runoff, and erosion by generating climate-specific probabilities of off-site pesticide loadings and concentrations. This information, when coupled with pesticide toxicity data, provides a quantitative evaluation of the relative risks associated with different management options.

PLANETOR 2, developed by the Center for Farm Financial Management at the University of Minnesota, is a comprehensive environmental and economic farm-planning software program. Different modules evaluate impacts of reducing or changing pesticide, nitrogen, phosphorus, and manure applications; tillage systems; and crop rotations. Different management options are compared for impacts on soil erosion, nitrate leaching, phosphorus runoff, pesticide movement, as well as economic profitability.

include impacts on water quality, worker safety, and the welfare of aquatic, avian, and other beneficial organisms. Indicators of the effects of IPM efforts might be reduced pesticide runoff, decreased pesticide-related illness, increase in populations of beneficial organisms, and/or a shift to biological pesticides. The appropriate combination of impacts and weights may depend on the nature of the IPM system under evaluation and the priorities and interests of the stakeholders.

A unifying framework is needed to assess tradeoffs among economic, environmental, and public-health impacts of alternative pest management technologies. No one technology will be superior in all areas of assessment. A particular technology or practice may reduce damage potential in one assessment category (e.g., water quality) but increase damage potential in another category (e.g., worker health). An additional concern is how benefits and costs of IPM adoption are distributed between producers and consumers, as well as among regions and socioeconomic groups.

Translating all impacts into a common unit makes comparison of tradeoffs between objectives easier. Using monetary values is convenient because the economic impacts of alternative production technologies on producers and consumers can be measured using market prices and well-established economic techniques.

Meaningful monetary values do not exist, however, for such environmental and public-health impacts as decreased biodiversity, impaired water quality, or diminished human reproductive capability. But resource economists have developed a set of techniques for estimating monetary values of nonmarket impacts which have been used to estimate a value for environmental and public-health impacts. If appropriate values can be determined for the nonmarket impacts, a benefit-cost framework can be used to assess tradeoffs between different objectives.

Achieving the Administration's goals of implementing IPM on 75 percent of U.S. cropland by the year 2000 and reducing environmental and public-health risks from pesticides will require a concerted effort by all IPM stakeholders. The returns on that effort have the potential to produce widely shared benefits for all sectors of society.

Given the diversity of agroecosystems, stakeholder priorities, and IPM systems in the U.S., finding an appropriate method to assess those shared benefits will be a challenge. But careful documentation of IPM's economic and environmental goals, including continued profitability for farmers and reduced risks to human health and the environment associated with pesticide use, is an essential step in enlisting producer and public support for IPM.

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