Chapter V

Obstacles to the Development and Adoption of Improved Pest Control Tactics and **Pest Management Strategies**

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Great advances have been made in crop protection in the United States over the past century, but there are many difficult problems and concerns about present and future capabilities to protect our agriculture from the ravages of pests. A clear need exists for new and improved crop protection tactics and new pest management strategies. There are also serious concerns about the negative impacts of tactics used in crop protection, especially as they affect human health, the environment, and agricultural productivity.

This chapter addresses the obstacles to the development and adoption of new and improved pest control strategies and tactics, and problems of the Federal, land-grant, and private enterprise systems that undergird agricultural pest management in the United States. The impression should not be drawn that all is wrong but rather that a reasonably good system has faults that should be modified to meet present and future needs.

The several constraints that are identified in this report form the basis of two dominant but related classes of obstacles to the implementation of integrated pest management (1PM): technological and administrative. Technological obstacles are: 1) inadequate knowledge base for full 1PM development in both basic and applied aspects of crop protection, z) narrow range of available control tactics, 3) inadequate delivery systems, 4) lack of environmental monitoring systems, 5) lack of adequate pest management training programs and trained manpower, and 6) grower skepticism. Administrative obstacles are: 1) lack of cooperation and coordination and 2) cosmetic (esthetic] standards. There is no general agreement among experts regarding the relative importance of each of these, but certainly the inadequate scientific knowledge base for full 1PM development is at the top of the list. Also, lack of cooperation and coordination within the Federal agencies and between them and the States is of prime importance.

TECHNOLOGICAL OBSTACLES

Inadequate Knowledge Base

An inadequate knowledge base is a major obstacle to future advances in crop protection. The rate at which new advances in pest management are made will depend largely on the rate of development of new knowledge in both basic and applied crop protection and related sciences. It is generally recognized that few sophisticated 1PM systems are oper-

ational. Of the programs in operation, most are already as sophisticated as they can be with existing information. Further information has not been developed on the basic biology of pests, biosystematics, interactions within pest complexes and between them and their host plants, economic thresholds, and the economics of pest management. Only research can provide this information.

A major gap impeding implementation of improved pest management is definitive knowledge of the interactions of pest complexes that attack the farm production unit. Growers are increasingly aware of the need to consider entire complexes of pests of all their crops in the total farm management system. They want information on the total impact of pest complexes rather than on individual pest species, and they need to know how actions taken against one pest or group of pests on one crop may affect other pest populations on that or other crops.

Data to support crop loss estimates due to most pests is lacking. Figures that are widely quoted on pest losses are little more than educated guesses. Accurate data on crop yield, quality, and the effect of pest populations on these factors are essential to establish economic thresholds, to make control recommendations, and to evaluate the success of pest management programs.

Adequate information in these crucial areas is not available. The broadly interdisciplinary research, which cuts across departmental, agency, and institutional lines and which is necessary to address these questions, has not been adequately supported. At present, a major portion of the public sector funds for crop protection is in basic and components research, but very little is spent putting the pieces together. Much of the fault for this lies in the necessity for a strong disciplinary base before interdisciplinary research can be effective. Funding and incentives simply have not been there to foster the kind of effort needed.

Pest management implementation programs also depend on the use of accurate economic thresholds to make decisions on when and how to act against a pest population. Thresholds are difficult to quantify; many are based on "rule-of-thumb" estimates of the tradeoff between costs of control and crop losses. If the number of implemented pest management programs is to increase, substantially greater effort must be expended on the development of economic thresholds and other short-term research needed primarily for implementation programs.

One other area, the economics of pest management programs, has not been adequately investigated. Economic benefits are the key to the rapid adoption of a pest management program by growers. Economic research is necessary to determine the costs and benefits of different control tactics, develop sophisticated economic threshold levels, and present growers with specific examples of the increases in economic return that can be obtained in a pest management program. Part of the problem is the lack of money available for such research. Much of the problem is due to the lack of awareness of the subfield of pest control by professional economists. Efforts to make more economists aware of the issues and opportunities in pest management should be encouraged.

Narrow Range of Control Tactics

A wide array of cultural, biological, and chemical control tactics is necessary to design and implement effective pest management programs. Unfortunately, a broad choice of tactics is not available for use on most crops. Some tactics are in their early stages of development; others are being slowly reemphasized and updated. For some conventional broad-spectrum pesticides, there are serious questions regarding their safety and applicability in pest management programs. Further, the effectiveness of some pesticides is being eroded as resistance to them becomes more and more widespread.

Efforts should be made to improve the efficiency of pesticide use. A considerable potential for greater precision in the accuracy and uniformity of pesticide applications now exists. Improved equipment, such as electro-

statically charged dusts and sprays, variable-rate sprayers, recirculating sprayers, and microwave soil sterilizers, is now being evaluated. Such equipment may have potential for use in pest control if it can be developed for practical uses. The efficiency of certain pesticides can be improved by formulation changes that can provide extended periods of pesticide activity with lower rates of application. Also, certain broad-spectrum chemicals may be timed and properly applied to afford selective activity.

It is important that agricultural and chemical engineers be included in both the research and implementation phases of pest management. Their expertise can help to broaden the range of available tactics, add precision to current practices, and develop new control tactics. It is clear that a concerted effort has to be made to present the grower with a broad assortment of safe and effective control measures from which to design a practical pest managment program.

Control tactics regulated by the Federal Government include the pesticides as regulated by the Environmental Protection Agency (EPA), under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and to a much smaller degree the biological control programs of the U.S. Department of Agriculture (USDA) and the States, EPA responsibility for pesticide regulations affects both the development and use of pesticides in pest management programs. This includes not only conventional broad-spectrum pesticides but selective conventional pesticides—pheromones, hormones, viruses, and bacteria as well.

A new set of amendments to FIFRA has been passed by Congress to deal with the problems created by EPA's registration protocols. Developed after lengthy hearings and debate, they are designed to speed up the registration process without sacrificing environmental quality and safety. Because these issues are widely discussed elsewhere, they are not addressed here. One point that does deserve mention, however, is the lack of a uniform national policy for making regulatory decisions on potential carcinogens. There are concerns in two areas. One is a genuine disagreement over the accuracy of the various guidelines for determining carcinogenicity that are now used by regulatory agencies. The other is the effect that this lack of uniformity of standards has had on the predictability and stability of the regulatory process. EPA has developed one policy on interpreting data on the potential carcinogenicity of a chemical; the Occupational Safety and Health Administration, the Food and Drug Administration (FDA), and the Consumer Product Safety Commission have developed others. Industry is faced with a situation where the same chemical may be classed as a carcinogen by one agency and not by another simply on the basis of a different end use. This lack of uniformity and the resulting unpredictability of the regulatory process has affected the use of chemical pesticides as part of a pest control program. Current congressional and executive branch interest in developing a uniform policy for making regulatory decisions on carcinogenicity should be given strong support.

EPA's authority to regulate pesticides under FIFRA extends to their use in the field. Under FIFRA, legal use of a pesticide is governed by label restrictions and directions for use. The Agency took the stance that application of a pesticide to a crop named on the label but against an unnamed pest or at less than the recommended dosage was an illegal action. The inflexibility created by this situation made it difficult to design programs using less than label dosages or prescribed methods of application. The passage of the 1978 FIFRA Amendment should largely eliminate this problem by allowing pest management programs to be developed using pesticides against unnamed pests, at lower than labeled dosage rates, and applied by novel means unless prohibited by the label.

An unintended side effect of the amendment, however, increases the potential liability of pest management advisors. Under the present situation of strictly enforced label recommendations, liability lies primarily with

the manufacturer for harm due to foreseeable use. If a pest management advisor makes a recommendation to use a pesticide at less than label rate, against an unnamed pest, or using a novel method, and damage or poor control results, liability may shift from the pesticide manufacturer to the consultant. Liability problems may inhibit the formation of private pest management consulting firms and advisory organizations.

Some items falling under EPA's definition of pesticides have come under increasing public attention as potentially effective tools while presenting minimal health and environmental dangers. Included are narrowly selective conventional pesticides, the so called third-generation insecticides—pheromones, hormones, viruses, fungi, bacteria, and protozoa. The development and commercialization of these items have been exceedingly slow, much slower than the public interest in them would warrant.

Part of the difficulty is a question of quantity. One desirable feature shared by the above pesticides is their narrow spectrum of activity. By affecting only a particular pest genus or family, these pesticides, especially the insecticides and miticides, can allow beneficial predators and parasites to survive in a treated field. The narrow spectrum of their activity also means that in most cases relatively small quantities will be sold. This small market potential, coupled with the fact that the quantity of data required to register them is the same or more than that necessary for a broad-spectrum pesticide, has made their development an unattractive investment, and industry has opted for the more profitable broad-spectrum high-volume pesticides. Where profitable markets for certain narrow-spectrum pesticides do exist—for example, in situations where key pests are involved such as the boll weevil on cotton and the codling moth on apple—industry needs to redirect its development efforts and take advantage of these markets for narrow-spectrum pesticides. In addition, the Government could use all appropriate means to expand the research aimed at discovering new molecular models of selective pesticidal activity.

The third-generation pesticides and microbial face a qualitative as well as quantitative problem. They are qualitatively different from conventional pesticides; they act by to tally different mechanisms, and they raise different questions as to potential hazards to the environment. At present, EPA's registration requirements for these compounds are extremely unclear. Past decisions appear to have been based on the same tests required for chemical pesticides. The added delays due both to uncertainty over tests required and to conducting inappropriate tests have decreased their attractiveness to industry.

One explanation for this is that EPA has not made adequate use of the mechanisms available which would allow it to tailor reregistration requirements directly to the different classes of chemicals. Because broad-spectrum pesticides are the most important, the tests designed to answer questions about their potential dangers were developed first. EPA is applying the same tests to almost all compounds, and industry assumes they will continue to do so. While EPA intends to put together differential guidelines for the registration of pheromones, hormones, and microbes, guidelines for broad-spectrum chemicals have to be revised first. This will continue the confusion and delays in attempting to register third-generation pesticides.

Another obstacle facing the commercial development of pheromones and microbial is the uncertain status of patent and proprietary rights. Pheromones are naturally occurring chemicals and cannot be patented, but the process by which they are manufactured is patentable, as are any novel chemical analogues of them. Until recently, micro-organisms were also considered unpatentable. Two recent decisions[1] of the U.S. Court of Customs and Patent Appeals have opened the possibility that these organisms may be patentable.

With respect to "classical" biological control—i. e., the importation of natural

[1] Bergy, 197 USPQ, 78: Chakrabarty, 197 USPQ, 72.

enemies as opposed to the augmentation of existing forms or the use of autocidal methods—it is apparent that a major increase in support of Federal and State importation programs is long overdue. Classical biological control has proven potential, particularly for insect and mite pests, but programs to expand it have been understaffed and uncoordinated. Existing USDA and State programs for natural enemy exploration and importation have neither the funds nor the organizational network to adequately explore and take advantage of the possibilities for major breakthroughs. The need for more effective coordination of these efforts is now being recognized by the States and USDA.

Success in increasing the number of infield biological control organisms has been very slow. Much of the problem has been the low level of funding that biological control has received. Another part of the problem has been the lack of a formally designated action agency to ensure that once established, an introduced natural enemy is distributed within a large geographical area.

A related constraint is the inadequacy of international programs created to discover new germ plasm. Over 95 percent of crops grown in the United States have their origin, centers of genetic diversity, and pest centers outside the United States. Success of efforts to expand the use of host resistance as well as biological control requires work in parts of the world where these crops are indigenous. It is in these areas that, through thousands of years, balanced cropping systems, natural resistance, and biological control agents have evolved. Unfortunately, detailed information about the patterns of crop variability in centers of crop diversity is lacking for most crops. As a consequence, even less is known about ancient cropping systems, the basic biology of pests, and the distribution patterns of natural resistance and biological controls.

Seed and other breeding materials collected in centers of crop diversity are the best proven sources for developing natural resistance. Furthermore, these traditional materials will be needed even if the dreams of genetic engineers become a reality. For nearly a decade and a half, the United Nations' Food and Agriculture Organization has led in planning international efforts to collect and conserve crop variability. USDA's Agricultural Research (AR) has had a similar plan to minimize genetic vulnerability of the Nation's crops through germ plasm collection and conservation. If diverse genetic materials are not available to plant breeders, the long-term potentials of developing pest-resistant and tolerant varieties cannot be realized. The corollary task of understanding the basic mechanisms and genetics of resistance for each crop also depends on the availability of such germ plasm.

Lack of Adequate Delivery Systems

The lack of adequate pest management delivery systems also constrains improved crop protection. These systems must include the mechanisms and personnel required to Col lect and disseminate the information necessary to operate effective pest management programs. Delivery methods are in the early stages of development, and many different systems are being tried in various regions of the country. It is unlikely that any one single system will work successfully in all regions.

The organizations currently used to deliver pest management services to individual growers can be broadly categorized as follows: a) public service entities, b) private commercial entities, and c) grower-owned entities (commercial, cooperative, and nonprofit).

Public service entities include Federal agencies and the land-grant universities with their research and cooperative extension services. The USDA/Extension Service-sponsored pest management pilot projects have been the major effort to implement pest management programs by the public sector. These programs have been extremely important in making people aware of pest management and creating a market for private pest management services. Care must be exercised in determining the most useful extent to which the publicly supported programs should be developed—i.e., the point at which

public programs stop creating a market for private firms and become competitive with services that could be provided by the private sector.

Private commercial entities will be a vital factor in the long-term success of pest management programs nationwide. Well-trained pest management consultants can offer farmers more individualized services than those in public programs, Private consultants are likely to have the most success in concentrated farming areas and where net farm income allows efficient manpower and equipment utilization.

A major problem facing private pest management consultants is the danger of unqualified persons identifying themselves as experts in the field of pest management. Most States do not have regulatory standards to determine the competence of a pest management consultant. Growers are faced with a situation in which enterprising individuals can sell themselves as pest management specialists on the basis of superficial field-checking skills while totally lacking the ability to translate field data into sound pest management recommendations. A few such individuals in a particular region could severely harm the emerging consultant industry in that area.

Another area of concern is the liability of pest management consultants for crop damage due to pests or control measures. If a grower changes his pest control practice on the basis of a consultant's advice and his crop suffers pest damage, the consultant can be sued for malpractice. Just as in many other professions, today's soaring malpractice insurance costs could present a severe financial obstacle to the formation of new consulting services.

Grower-owned entitites that are operated as business organizations that sell their services have to meet the same natural business constraints as private consultants and are faced by many of the same problems. Grower-owned pest management cooperatives also encounter the same governmental and natural constraints faced by regular commercial entities. The seasonal nature of pest management activities can create difficulties for ventures that are limited only to pest management services. This often can be overcome by providing pest management services in conjunction with other sales and service activities. For existing cooperatives, it may be possible to expand into pest management services. Both of these methods have been successfully employed by a small number of cooperatives around the country.

Organizing a cooperative specifically for the purpose of providing pest management services can often present an insurmountable financial barrier in areas where pest management is practiced only through an extension service pilot program. There are several constraints that apply here: 1) the number of farmers involved in the extension pilot program may be too small to assume the financial risk involved in capitalizing a full-service pest management co-op, 2) there is a natural reluctance to "sever the umbilical" to extension service pilot programs where they are in effect, and 3) the lack of qualified sales and service personnel to handle day-to-day operations makes formation of the cooperative difficult, even if otherwise possible.

Nonprofit grower-owned entities can be a means of avoiding these problems. They are functionally different from all other approaches to developing the pest management concept at the grower level. This is because: 1) they exist as a data-gathering base for joint land-grant university/Federal pest management programs; 2) they perform no sales or service functions such as consultation, pesticide sales, or pesticide application; and 3) the only direct benefit to member farmers is the receipt of a copy of pest identification and population data from the land-grant university. The farmer may use this information to make his own decision or furnish it to a consultant for recommendation. The direct benefit to the farmer is incidental to the overall benefit to farmers in general as a result of the data collected and analyzed.

These organizations can help growers move from extension pilot programs into self-supporting, grower-owned activities. They can be either registered as tax-exempt organizations or brought under the tax-exempt umbrella by becoming a county chapter of a university-sponsored State pest management association.

Obstacles to their widespread use include the unwillingness of growers to pay directly for pest management services and the complexities of registering with the Internal Revenue Service (IRS) for tax-exempt status. The paperwork surrounding the formation of these associations (even in an unincorporated form) may be a severe disincentive for farmers of low-to-moderate income and education. Farmers who need most to be involved in pest management programs are the ones most likely to be put off by endless correspondence and forms.

The role of pesticide company fieldmen and pesticide applicators in pest management programs has not been adequately defined. To date, these individuals have been the most readily available sources of information on pest control methods to farmers. Chemical company fieldmen are located in all areas of the country and are active in disseminating pest control information. Questions have arisen regarding the ability or willingness of these local company field representatives to embrace pest management at the farm level. Although a few are enthusiastic, their general approach to ongoing pest management projects has ranged from indifference to outright hostility. Industry spokesmen maintain that they recognize the benefits of the pest management approach and are willing to become involved. Some outside of industry express doubt that a person whose job is tied directly or indirectly to the sale or application of chemical pesticides can offer impartial advice on a program that uses multiple-control techniques. They view pesticides as comparable to human drugs and ask if physicians should be allowed to both prescribe and sell them to their patients.

This problem is complicated by the fact that many fieldmen are upstanding members of the local community. Their advice is respected and their friendship valued. Some way of including them in the move to 1PM should be found. One key will be to involve them without limiting the choice of controI tactics available in a program.

Lack of an Environmental Monitoring System

In addition to information relating to an individual grower's field, areawide information on pest populations and weather is necessary. For most agricultural pests, information from individual fields does not provide the clues needed to predict long-term or areawide changes in pest populations. Since many pests move, either actively or passively, and all are affected by weather patterns, data on weather, crop mix and growth, and pest populations are necessary for the development of predictive techniques and the use of these techniques in pest management programs.

A national environmental monitoring system does not exist, and useful information in existing research or implementation programs is slowly communicated to others. This results in duplication and information gaps that are both costly and unnecessary.

A national agroecosystem monitoring program using existing computer and electronic-sensing technology is necessary to provide the predictive capabilities essential to pest management systems. Such a program would provide benefits in two major areas: 1) extension specialists, agricultural agents, and private pest management consultants would have access to accurate and timely crop, weather, and pest population forecasts for use in existing pest management programs; and 2) researchers who cannot now afford to gather the areawide weather and crop information necessary to understand their relationship to pest populations would have available the information necessary to predict potential pest outbreaks.

Two major impediments to attempting to design such a system on a project-by-project or State-by-State system are: 1) the costs of data acquisition are too great to be borne by individual projects or farmers, and 2) many projects do not have the expertise to choose, install, operate, and service the specialized instruments required.

An interlocking network of State, regional, and national systems should provide the best possible service.

Lack of Pest Management Training Programs and Trained Manpower

The lack of trained manpower and programs in many institutions to train personnel limits the research, education, and implementation efforts in pest management and results in part from the incomplete acceptance of the concept within the university community. To date, most administrators, professional researchers, teachers, extension specialists, and paraprofessionals have been educated along strict disciplinary lines. This incomplete acceptance, coupled with decreasing Federal financial support for teaching, research, and extension in the food and agricultural sciences, has inhibited the development of multidisciplinary training programs in pest management. In a 1977 survey, only 34 of the 49 responding land-grant universities reported having undergraduate programs in pest management. These were aimed mainly at technical positions. At the graduate level, the number of M. S., Ph. D., and professional re-education programs is much smaller. These are the programs that will supply the individuals for teaching, research, and extension efforts so critical to the future of pest management.

A major constraint in establishing pest management training programs as well as academic teaching, research, and implementation programs has been the lack of adequate financial and facility support. The limited financial support for pest management that has been provided has come from the Federal Government through special grant or pilot program funds. This "soft money" does not attract highly trained faculty or provide motivation to develop programs that require an expansion of classroom or laboratory space at a university. There is little incentive to attach a high priority to programs that would, in effect, increase mission responsibility with an inadequate provision for increased staff and facility needs. Further, a "soft money" approach does not provide sufficient security incentives to attract the best practitioners available. In many universities there is a budgetary inability to pick up and continue programs at the expiration of grant or pilot program funds.

Along with a sound scientific foundation, pest management personnel must have training with a strong applied component. People with experience in field diagnosis and in making control recommendations are essential to the successful design of future pest management research and education programs, as well as the implementation of pest management programs. Field experience through internships must be a central component of any pest management training curriculum.

There are some unique difficulties in the training of private pest management advisors. A major one is the need for broad specialization in several areas. Scouts, scout supervisors, and pest management advisors such as county extension agents and private consultants are all needed to ensure effective coverage of a farmer's pest management needs.

Recruitment and training of scouts face some unique problems because of the seasonal nature of the work. Scouts must be trained to identify accurately at least the major pests in a grower's field and to assess pest damage to crops. The type and duration of their employment make it difficult to establish a permanent pool of trained scouts from which to hire each year. Efforts to locate individuals willing to work in the fields are concentrated on vacationing college students, farmers' spouses, and undergraduate students in pest management. Effective short-term training programs are needed to ensure the competence of the scouts.

Pest management practitioners are responsible for reviewing the data collected by the scouts and making control recommendations to the farmer. They should have a solid background in fundamental science as well as experience in field problems and farm management. They must be able to recognize and deal with all aspects of a farmer's pest problems, including weeds, diseases, nematodes, and insects. Specifically trained pest management practitioners are rare. Lack of personnel to provide the total production management schedule on a farm is a major limiting factor in pest management implementation. Traditional university departmental lines and the difficulty with which adequate applied components are introduced into a training program have made their establishment difficult. The lack of support for practical internships is a large obstacle.

Some have suggested that an entirely new program is needed leading to a professional degree in pest management, such as a doctor of plant health. Such a program would be similar to present programs in veterinary medicine and would involve a broad practical interdisciplinary education with an intensive clinical experience component. It would more adequately prepare an individual to address the special problems encountered when implementing a practical pest management program.

Grower Skepticism

Grower skepticism is often cited as an obstacle to the adoption of pest management systems. Reluctance by growers can be ascribed to such factors as confidence in their present pest control practices, hesitancy to spend money for the uncertain services offered in a pest management program, lack of serious threat from pests with currently used systems, and lack of demonstrated economic benefits from employing a pest management program.

These are less a reflection of growers' attitudes than of the present state of the art of pest management. Many growers have enthusiastically adopted a pest management program when a program was well-developed and presented. In some instances, the pest management approach has been the only solution to growers' pest problems and has saved their operations from financial disaster. The lack of availability of demonstrated economically sound pest management systems is the overriding obstacle to farmer adoption of 1PM.

Being businessmen, growers are the first to adopt new ways to solve their problems and cut their costs. People working in pest management must design programs that can be understood by growers, are practical in terms of growers' total farm management, and that offer them real economic benefits.

ADMINISTRATIVE OBSTACLES

Lack of Cooperation and Coordination

The preceding obstacles to improved crop protection and to the pest management approach refer to specific control tactics or strategies. Lack of cooperation and coordination are general constraints that are pervasive throughout crop protection and particularly for 1PM.

In 1971, concern over the environmental and health problems of pesticides resulted in the passage of the Federal Environmental Pesticide Control Act of 1972 (FEPCA) and an intensified search for more effective and desirable methods of pest control. The immediate product of the latter was the 1972 report of the Council on Environmental Quality (CEQ) entitled "Integrated Pest Managemerit. " Pest management was hailed as a way to couple environmental protection with the practical concerns of agricultural production. Unfortunately, this combination has become the center of a policy struggle.

The main agencies involved in the issue at the Federal level are CEQ, USDA, EPA, the National Science Foundation, and, to a lesser extent, FDA, and the Departments of State, Defense, and the Interior.

Before detailing this obstacle a brief introduction to the roles and responsibilities of these agencies is presented.

Council on Environmental Quality: CEQ's role is that of a catalyst. By performing broad policy oversight, participating in the budgetary process, and making recommendations to the President, it plans to "help the agencies develop a comprehensive approach to 1PM. " While CEQ recognizes the importance of production economies to the future of pest management, the main focus of its approach is to protect the quality of the environment. Its goal, as recently stated by Charles Warren, former chairman of the Council, is to "reduce the excessive use of such chemical pesticides and to use natural biological and environmental measures to achieve pest control whenever practical. "

U.S. Department of Agriculture: While CEQ has been given broad policy responsibility, the lead Agency for pest management research, education, and demonstration is USDA. Working with the associated system of land-grant universities, State agricultural experiment stations, and cooperative extension services, USDA aims to promote efficient, productive agriculture. These cooperating public institutions are the biggest factor in the development and introduction of new technologies for U.S. agriculture.

As the lead Agency for agriculture in the Federal Government, USDA is concerned with the ability of farmers to produce adequate supplies of food and fiber at a reasonable cost. Its many programs are designed to make U.S. agriculture more efficient, more productive, and economically sound. While vitally concerned with the environment, USDA's top priority in pest management is to ensure that the programs offer farmers adequate protection against pest damage at a reasonable expense.

Six major agencies of USDA are directly involved in efforts on pest management: Agricultural Research (AR); Cooperative Research (CR); Extension Service (ES); Economics, Statistics, and Cooperatives Service (ESCS); Animal and Plant Health Inspection Service (APHIS); and the Forest Service (FS). To coordinate the efforts of these different agencies, the Department created an interagency work group on pest management chaired by the Deputy Assistant Secretary for Conservation, Research, and Education. Its role is one of making suggestions and recommendations; it has no program direction or managerial responsibilities. In addition, the newly organized Science and Education Administration (SEA), home of AR, CR, and ES, recently formed an SEA-wide coordinating team for pest management. Composed of technical experts from the three agencies listed above and chaired by a pest management specialist, it makes recommendations on methods to integrate the programs of the involved agencies.

Environmental Protection **Agency:** EPA's involvement in pest management stems from its overall responsibility to protect the quality of the environment by regulating environmental and public health hazards. This duty is very different from the USDA's responsibility to promote agricultural production. These different roles are reflected very clearly in their approaches to pest management.

EPA's approach to 1PM represents a commitment to the production of food and fiber in the most environmentally protective way that is also economically sound. The responsibility is clearly to protect the environment by minimizing the application of pesticides to cropland. This affects pest management in two different ways. One involves the general effect of its registration procedures on the availability of pesticides for use in pest management programs. The second area includes plans by EPA to directly employ pest management in its regulatory programs. In a decision on registering a pesticide, ways to minimize the risks from the use of that pesticide are a central consideration. EPA views

pest management as one method for reducing these risks.

EPA is also moving into the area of gathering and disseminating information about and encouraging the implementation of pest management programs. EPA has also funded research in pest management, including the Huffaker Project (see NSF).

National Science Foundation (NSF): NSF has been involved in pest management research and education. As part of its responsibility for supporting basic research, NSF was the lead Agency on the Huffaker Pest Management Project. This was the most ambitious pest management research project ever undertaken. It pioneered the use of systems analysis in looking at plant/pest interactions within a crop ecosystem and helped to bring pest management to the attention of all the land-grant universities. Together with EPA, NSF funneled $12.5 million into the project over a 7-year period.

NSF has also sponsored several undergraduate pest management training programs. As part of its science education effort, NSF helps develop programs to prepare scientists to work on important national problems. Demonstration pest management education programs have been started at Michigan State University, Cornell University, Kansas State University, University of California at Fresno, and Alabama A&M. The objective of these programs is to develop practical pest management curricula that can be used across the country.

In addition to these four agencies, several others have program responsibilities that affect pest management.

Food and Drug Administration: FDA is responsible for monitoring contaminants in food and feed under amendments to the Federal Food, Drug, and Cosmetic Act of 1938. The Act requires that EPA set maximum pesticide residue tolerances in food and feed. FDA is responsible for monitoring residue levels and enforcing the tolerance levels. Also under this Act, FDA has responsibility for monitoring processed foods for the presence of filth or foreign objects. This latter responsibility has involved FDA in the debate over the effect of cosmetic standards on pest management programs.

State Department: The State Department's Agency for International Development (AID) supports several activities that relate directly to pest control in developing countries. These programs are in the broad categories of training and education, country development projects, and direct emergency assistance. AID provides funds for the training of foreign nationals in many fields, including pest management. The Agency also supports pest management projects in developing countries through loans for equipment, supplies, and training. In addition, AID furnishes technical consultants and pesticides to countries where pest outbreaks have created disastrous crop-loss emergencies.

Since 1972, AID has supported the "University of California/AID Pest Management and Related Environmental Problems" project. The project has involved extensive surveys of pest problems in developing countries and workshops on pest and pesticide management. Project members have served as short-term consultants on pest problems and advised AID on matters relating to pests and pesticides.

Interior Department: Interior has responsibility for managing vast tracts of public lands. At present, the Department relies mainly on pesticides to protect these lands, while conducting some research into alternative methods of pest control. Wildlife and Fishery Divisions also conduct experiments on the impact of pest control techniques on nontarget species.

Defense Department: The Defense Department carries on a limited pest control research program that focuses on organisms that interfere with the Nation's military capability.

In the public sector, three areas in which the lack of cooperation is especially critical are identified within the Federal Government, between the Federal Government and

the States, and within the land-grant university complexes. Lack of cooperation and coordination are frequently cited obstacles to the development of any program but the degree to which they affect pest management is unusually high.

Within the Federal Government

Although there has been considerable interest in pest management by Congress and the President, the lack of a well-defined set of objectives, with clearly outlined goals and responsibilities, has severely hampered efforts in this area. One result has been that agencies are competing for jurisdiction over pest management.

Each of the four main agencies involved in pest management (CEQ, USDA, EPA, and NSF) has its own particular organizational structure and set of priorities. The absence of a comprehensive set of goals leaves each of these agencies to pursue its own ends in pest management. CEQ's efforts to promote pest management have little impact without active Presidential support. USDA's leadership in pest management has been cautious. EPA took the initiative in 1972 with the new pesticides legislation to become an active promoter of pest management. NSF, following its basic mission, became involved in pest management by funding basic research and new educational programs. The result of this uneven Federal effort is a patchwork design of conflicting goals and overlapping efforts.

This is particularly true between USDA and EPA. USDA is faced with the difficulties associated with reorienting a complex Federal/State system, which has operated mainly under the philosophy of unilateral approaches to pest control, to a philosophy that actively seeks to include a large variety of control techniques. There is uncertainty within USDA over how the Department's existing programs can fit into the new research and education thrusts.

EPA stepped into what it sees as a void left by USDA and has become the main proponent of pest management at the Federal level. While it does not have a major responsibility for research and education or possess research and extension networks, EPA is becoming more and more active in these areas. The Agency provided a major part of the funding for the Huffaker Project and obtained authorization for $2.5 million to aid in the funding of the Adkisson project. It is also devoting some effort to developing information systems and incentives to promote the adoption of pest management. EPA's involvement in these areas of traditional USDA responsibility has increased the jurisdictional problem between the agencies.

As EPA expands the use of pest management in its regulatory programs, philosophical conflicts between the agencies arise as well. USDA feels that the best way to promote pest management is through education, not regulation. EPA's responsibility is to reduce the environmental hazards posed by pesticides. If they can employ pest management in a regulatory scheme to accomplish this goal, they will attempt to do so.

Without a firm commitment to bring agency programs together and to develop mutual goals and objectives, these jurisdictional and philosophical conflicts can only increase. The recent interagency agreement between EPA and USDA should eliminate much of the past confusion and conflict.

Between the Federal Government and the States

The federally funded extension pest management pilot projects have become a successful program of coordinated State and Federal action. On the other hand, the communication and cooperation in planning programs between the two arms of the public agricultural research effort—USDA's Agricultural Research and the State Agricultural Experiment Stations—have been much less successful.

This lack of cooperation in joint planning has been recognized as a serious problem by both USDA and the State Agricultural Experiment Stations, but progress has been very

slow in the past. The Department's creation of SEA was aimed at increasing the cooperation among AR, the State research institutions associated with CR, USDA/ES, and the Cooperative Extension Service. The SEA-wide coordination team on pest management is currently examining ways to improve the coordination of Federal and State research efforts.

Within the Land-Grant Universities

Cooperation and coordination in teaching, research, and extension efforts have been slowed because of the universities' disciplinary and professional departmentalization. This departmentalization, which evolved over the past 100 years to meet the needs of students and to best conduct research and extension programs, serves the disciplinary needs of the universities but causes some obstacles for interdisciplinary approaches. These obstacles include lack of promotion and financial rewards for academic staff and inadequate funding for interdisciplinary programs, In addition, the pest management concept has not been accepted universally by researchers and extension specialists in the plant protection disciplines.

Cosmetic (Esthetic) Standards

The term "cosmetic standards" presents a problem itself. It has come to include a wide variety of different quality guidelines all relating to pest damage or contamination of foods. These guidelines include the "defect action levels" (DALs) for pest parts in food enforced by FDA, the State-set quality standards for produce, as well as the local co-op and processor standards for surface blemishes and appearance, All of these guidelines set acceptable levels for produce. Some aim at pest contamination; others aim at pest damage and produce appearance. Responsibility for setting them ranges from FDA to local marketing co-ops. Produce that does not meet these standards is kept off the market or sold at a lower grade and price.

Cosmetic standards in pest management mainly have impacts on fruits and vegetables grown for human consumption. Under strict standards, the economic threshold for pest damage on these crops is almost zero. This means that the farmer can tolerate almost no surface blemishes on the produce or pests or pest parts in the harvested crop. It means that pests in the field, especially insects, must be eliminated as completely as possible. This severely limits the use of biological control and other management techniques which depend on the presence of some pests in the field.

While widely discussed in articles on the future of pest management, "cosmetic standards" (some prefer the term "esthetic") do not appear to be a major obstacle to the adoption of pest management programs. What really is at issue is the tradeoff between the hazards associated with the use of pesticides and the hazards and willingness of the public to accept pest-damaged and contaminated food. With existing technology, achieving near-zero pest damage is possible only in a system based mainly on the use of chemical pesticides. If the cosmetic standards were relaxed, with a resulting increase in the economic threshold, the type of applicable pest management program could change considerably. Greater use could be made of natural control factors and other tactics that allow higher levels of some pests in the field. In either case, a pest management approach can be taken, but unless consumers become willing to trade less pesticide use for more pest-damaged food, programs on these crops will remain limited in the scope of control tactics employed.