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Report to the Chairman, Subcommittee on Research, Nutrition, and General Legislation, Committee on Agriculture, Nutrition, and Forestry, U.S. Senate

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AGRICULTURAL PESTICIDES

Management Improvements Needed to Further Promote Integrated Pest Management

GAO

Accountability * Integrity * Reliability

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Abbreviations

EPA	Environmental Protection Agency
IPM	Integrated Pest Management
OPMP	Office of Pest Management Policy
PAMS	Prevention, Avoidance, Monitoring, Suppression
USDA	United States Department of Agriculture

United States General Accounting Office
Washington, DC 20548

August 17, 2001

The Honorable Patrick J. Leahy
Chairman, Subcommittee on Research,
Nutrition, and General Legislation
Committee on Agriculture, Nutrition, and Forestry
United States Senate

Dear Mr. Chairman:

American agriculture produces a food supply that is abundant and inexpensive, and pesticides are an important tool in making such bounty possible. Pesticides help agricultural producers achieve higher yields, higher-quality harvests, and increased farm profits. The National Academy of Sciences has reported that, without pesticides, annual expenditures for food would increase by over $225 per consumer. On the other hand, pesticides are known or suspected to have unintended adverse effects on human health and the environment—such as increased risks for cancer, neurological disorders, and endocrine and immune system dysfunction; impaired surface and ground water; and harm to fish and wildlife.

Recognizing the need to maintain agricultural productivity while minimizing the potential adverse effects of pesticides, the U.S. Department of Agriculture (USDA) has for several decades supported a concept known as integrated pest management (IPM). IPM combines the use of chemical pesticides with a wide range of nonchemical pest management practices such as planting pest-resistant crop varieties and protecting beneficial organisms, thereby potentially reducing reliance on chemical pesticides. In 1993 USDA, in conjunction with the Environmental Protection Agency (EPA), established a goal that agricultural producers would implement IPM practices on 75 percent of the nation's crop acreage by the year 2000. USDA and EPA expected that the IPM initiative would reduce pesticide use and the associated risks while providing necessary crop protection.

In view of this goal, you asked us to examine the status of IPM adoption in U.S. agriculture. Specifically, this report addresses the following questions: (1) How widely has IPM been adopted in U.S. agriculture? (2) What are the environmental and economic results of IPM? (3) Are there impediments that limit IPM adoption and realization of its potential benefits?

Results in Brief

USDA estimates that some level of IPM had been implemented on about 70 percent of the nation's crop acreage as of the end of crop year 2000, only slightly short of USDA's 75-percent goal. Although the IPM goal has nearly been achieved, the implementation rate is a misleading indicator of the progress made toward an original purpose of IPM—reducing chemical pesticide use. In preparing its estimate of IPM implementation, USDA counts a wide variety of farming practices without distinguishing between those that tend to reduce chemical pesticide use from those that may not. Some individual IPM practices, such as monitoring for pests or cleaning farm equipment, may have little effect on chemical pesticide use. However, those practices are counted toward the goal in the same way as biologically-based IPM practices that significantly reduce chemical pesticide use—practices such as planting pest-resistant crop varieties or using beneficial organisms as natural predators. Our analysis of USDA data revealed that implementation of such biologically-based IPM practices is actually much more limited than the overall IPM rates would suggest. For example, while USDA estimates that IPM was implemented on 76 percent of corn acreage in 2000, biologically-based IPM practices were implemented on no more than 18 percent of corn acreage.

USDA research scientists, grower associations, and major food processors have demonstrated that IPM practices can produce significant environmental benefits in particular crops and locations, without sacrificing yield quality or quantity or incurring additional costs. For example, apple and pear growers in Washington, Oregon, and California used a biologically-based IPM strategy that resulted in an 80-percent reduction in the use of chemical pesticides. From an economic standpoint, the IPM strategy reduced their pest management costs and produced a higher-quality harvest. Furthermore, the National Academy of Sciences, the American Crop Protection Association, and the Global Crop Protection Federation report that IPM leads to more effective long-term pest management than chemical control alone. Nonetheless, IPM as implemented to this point has not yet yielded nationwide reductions in chemical pesticide use. In fact, total use of agricultural pesticides, measured in pounds of active ingredient, has actually increased since the beginning of USDA's IPM initiative. Use of a subset of chemical pesticides, identified by EPA as the riskiest, has declined somewhat since the IPM initiative began. However, this subset still comprises over 40 percent of pesticides used in U.S. agriculture.

Despite USDA's initial commitment to the IPM initiative, federal efforts to support IPM adoption suffer from shortcomings in leadership, coordination, and management. Specifically, USDA has not provided any departmental entity with the authority to lead the IPM initiative. While six USDA agencies, state and land-grant universities, and EPA all conduct activities intended to support IPM, USDA has abandoned its early efforts to coordinate those activities. Moreover, USDA has vacillated about the intended results of the IPM initiative, causing confusion among IPM stakeholders about the purpose of IPM. As a result of these deficiencies, federal funds are being spent on IPM without a clear sense of purpose and priorities, leaving a number of farm-level impediments to IPM adoption unaddressed. Such impediments include insufficient delivery of IPM information and services to growers, the perceived financial risks to growers of adopting IPM practices, and the higher cost of some alternative pest management products and practices. Although IPM stakeholders suggested that federal efforts might reduce farm-level impediments to IPM adoption, until USDA addresses the deficiencies in the leadership, coordination, and management of the IPM initiative, it is questionable whether federal efforts to address farm-level impediments would be effective.

The Government Performance and Results Act of 1993 links intended results of federal efforts to program approaches and resources, thus providing a framework to help address the shortcomings we identified. Specifically, we are making recommendations on the need to (1) establish effective leadership, coordination, and management for federally funded IPM efforts; (2) clearly articulate and prioritize the intended results of the IPM initiative, focus federal efforts and resources to achieve those results, and set measurable goals based on those results; (3) develop a method for measuring the progress of federally funded IPM activities toward those goals; and (4) foster collaboration between EPA and USDA to support the implementation of pest management practices that may reduce the risks of agricultural pesticide use.

In commenting on a draft of this report, USDA agreed with our assessment of the IPM program and stated that it planned to take several actions to implement our recommendations. EPA acknowledged that as efforts to promote IPM continue, cooperation with USDA will be vital.

Background

Pests—weeds, insects, and pathogens—can cause significant crop losses. Since World War II, producers have relied primarily on chemical pesticides for pest management, contributing to tremendous gains in farm productivity. For example, average corn yields per acre have more than tripled over the last 50 years, partially because of chemical pesticides. As a result, our food supply is relatively inexpensive and abundant compared with that of other nations. Maintaining such productivity is important not only for meeting current needs, but also for meeting the future needs of a growing world population.

While the use of chemical pesticides has resulted in important benefits, their use also can have unintended adverse effects on human health and the environment. Exposure to pesticides can cause a range of ill effects in humans, from relatively mild effects such as headaches, fatigue, and nausea to more serious effects such as cancer and neurological disorders. In 1999, EPA estimated that nationwide there were at least 10,000 to 20,000 physician-diagnosed pesticide illnesses and injuries per year in farm work. Environmental effects are evident in the findings of the U.S. Geological Survey, which reported in 1999 that more than 90 percent of water and fish samples from streams and about 50 percent of all sampled wells contained one or more pesticides. The concern about pesticides in water is especially acute in agricultural areas, where most pesticides are used.

Furthermore, the use of chemical pesticides has caused or exacerbated some pest problems. Chemical pesticides become less effective as pests develop resistance to them, just as human pathogens develop resistance to antibiotics. As a result, growers increase pesticide applications and eventually switch to other pesticides that also may become ineffective. More than 500 insect pests, 270 weed species, and 150 plant diseases are now resistant to one or more pesticides, making these pests harder and more costly to control. In addition, many chemical pesticides kill not only the target pests but also eliminate beneficial organisms that would naturally help keep pest populations in check. Without the benefit of these natural controls, growers become more dependent on chemical pesticides, further exacerbating resistance problems. Because of this scenario, sometimes referred to as the "pesticide treadmill," the National Academy of Sciences concluded that there is an urgent need for an alternative approach to pest management that can complement and partially replace chemically-based pest management practices.

For several decades, the federal government also has recognized the need to combine a wide array of crop production practices to effectively control pests before they reach economically damaging levels—a strategy known as integrated pest management. The IPM strategy combines cultural, genetic, biological, and chemical pest-control methods, as well as careful monitoring of pests and their natural enemies. IPM practices and methods vary among crops and regions of the country. For example, in some regions, growers introduce insects that naturally prey on particular pests. In other areas of the country, growers use combinations of pest management practices, including rotating crops, altering planting dates, or planting pest-resistant crop varieties.

In December 1977 the Secretary of Agriculture announced that USDA's policy was to develop and encourage the use of IPM to adequately control pests while causing the least harm to human health and the environment. During the ensuing years, USDA undertook research, development, and demonstration activities to support IPM adoption. In 1993, the Deputy Secretary of Agriculture, with the support of the EPA Administrator, renewed the federal government's commitment to IPM by setting a goal that IPM would be implemented on 75 percent of total crop acreage by 2000 to reduce pesticide use and the associated risks. In 1994, USDA announced an initiative to help achieve the goal through research, outreach, and education.

Several USDA agencies are involved in the IPM initiative. USDA's Office of Pest Management Policy (OPMP) is the department's lead office on pest management policy, with responsibility for coordinating USDA's IPM activities. USDA's Agricultural Research Service conducts research on pests that have a major national impact on agriculture and tests biological IPM techniques over large land areas. USDA's Cooperative State Research, Education, and Extension Service provides research grants to state and land-grant universities to enhance understanding of IPM-related topics such as life cycles of pests and beneficial organisms, pest resistance to chemical control, and the development of pest-resistant crop varieties. The extension service also helps to provide IPM information to growers through education, outreach, and training programs. USDA's Natural Resources Conservation Service helps to support grower implementation of IPM practices through education, outreach, and limited financial incentives. USDA's Forest Service also conducts IPM-related research, such as studying IPM methods for controlling invasive weeds. In addition, USDA's National Agricultural Statistics Service and USDA's Economic Research Service gather and analyze information about IPM. USDA estimates that in fiscal year 2000, the department spent about $170 million on activities in support of IPM adoption. In addition, EPA awarded grants totaling about $500,000 in fiscal year 2000 for research and outreach to support IPM implementation.

USDA Estimates That IPM Has Been Implemented on About 70 Percent of Crop Acreage, but USDA Has Not Focused IPM on Meaningful Outcomes

Based on a sample of growers, USDA estimates that some level of IPM had been implemented on about 70 percent of the nation's crop acreage as of the end of crop year 2000, an implementation rate close to USDA's 75-percent goal. [1] However, this implementation rate is not a good indicator of progress toward an originally intended purpose of IPM—reducing chemical pesticide use. In estimating the IPM implementation rate, USDA counts a wide variety of farming practices without distinguishing between those practices that tend to reduce chemical pesticide use and those that may not. In fact, our analysis of USDA's data shows that the subset of IPM practices that tend to reduce reliance on chemical pesticides, often referred to as biologically-based practices, has been far more sparsely implemented than the overall IPM rates indicate. For example, while USDA estimated that IPM had been implemented on 76 percent of corn acreage in crop year 2000, the implementation rates of biologically-based IPM practices on corn cropland ranged from less than 1 percent for disrupting pest mating to about 18 percent for use of biological pesticides.

USDA Estimates That IPM Has Been Implemented on About 70 Percent of Crop Acreage

USDA established its goal of implementing IPM on 75 percent of U.S. crop acreage in 1993, but USDA did not develop its current IPM definition and method for measuring progress toward that goal until 1997. Beginning in that year, USDA's National Agricultural Statistics Service collected data annually on the implementation of various farming practices. The service, at the request of OPMP, grouped about 25 farming practices into four IPM categories—prevention, avoidance, monitoring, and suppression (PAMS).

- Prevention practices keep a pest population from infesting a crop or field. These practices include removing crop residue, cleaning implements after fieldwork, and tilling the soil to manage pests.
- Avoidance practices are used when pest populations exist in a field but crop damage can be avoided. These practices include adjusting planting dates, rotating crops, and planting crop varieties that are genetically modified to resist insects, pathogens, or nematodes.

[1] Estimates in this section and the next are based on the National Agricultural Statistics Service's survey of pest management practices. Because the survey covered only a sample of farmers, the estimates are subject to sampling error. See appendix II for information on the sampling error of estimates used in this report.

- Monitoring practices provide proper identification of pests and information about the extent and location of pest infestations. These practices include pest trapping, weather monitoring, and soil testing.

- Suppression practices control infestations when pest levels become economically damaging. These practices include applying biological pesticides, preserving or releasing beneficial organisms that reduce pest populations, and using pheromones to disrupt mating.

For acreage to be counted toward the IPM goal, USDA's definition calls for growers to implement on their land at least one farming practice in three of the four PAMS categories. A detailed explanation of USDA's PAMS categories and IPM practices is given in appendix III.

Using the method discussed above, USDA estimated that IPM implementation gradually increased from 51 percent of crop acreage in 1997, to 57 percent in 1998, to 58 percent in 1999. In 2000, IPM implementation jumped to an estimated 71 percent. The National Agricultural Statistics Service and OPMP are uncertain of the reasons for this sudden increase, although they offered several possible explanations for the change. The service cited extremely low commodity prices, combined with escalating energy and input costs, among other conditions, as possible reasons for growers to use a broader range of pest management practices in an attempt to reduce their costs. In addition, both the service and OPMP noted that the methods for collecting pest management data changed from on-site interviews to telephone interviews, which may have affected the responses received. An OPMP official told us that the survey results suggest that certain survey questions may have been misinterpreted. For example, the survey results indicate a decrease in the use of genetically-modified crop varieties in cotton, and an increase in the use of biological pesticides in cotton—trends that are contrary to the OPMP official's expectations.

Notwithstanding the uncertainty about the reasons for the jump in IPM implementation between 1999 and 2000, the IPM estimate is not a good indicator of progress toward reducing chemical pesticide use. Crop acreage can be counted in the IPM estimate even if growers use a combination of practices that may result in little or no reduction in pesticide use. Economic Research Service economists found that some IPM practices, such as monitoring for pests or clearing fields of crop residue, either increased or had little effect on chemical pesticide use.[2] However, the economists found that biologically-based IPM practices—such as protecting beneficial organisms or disrupting pest mating—reduced pesticide use and toxicity substantially. Yet, USDA's definition of IPM does not distinguish biologically-based practices from other IPM practices, and USDA's estimate includes acreage that received none of the biologically-based practices that tend to reduce pesticide use.

Implementation of Biologically-Based IPM Practices Is Limited

USDA's 1994 strategic plan stated that the department's policy was to support implementation of "biologically-based" IPM practices. In 1998, USDA reported to Congress that some crops were managed under "rudimentary" IPM methods, and that the IPM initiative would be geared toward helping growers move toward more biologically-based practices. In addition, EPA representatives told us that their agency has tried to encourage the adoption of biologically-based pest management practices. In spite of these policy statements, USDA's IPM definition does not emphasize biologically-based pest management practices. As a result, while the USDA implementation rate indicates relatively broad adoption of IPM, the adoption of biologically-based practices is much more limited. As shown in table 1, the implementation rates of biologically-based practices are relatively low in all crops, particularly compared to USDA's estimate of overall IPM implementation for those crops.

[2] Economic Research Service economists analyzed the National Agricultural Statistics Service's multi-state survey of IPM practices in peach production.

Table 1: Percentage of Acres Under IPM Practices, Crop Year 2000

Crop	USDA IPM estimate	Biologically-based IPM practices: Crop varieties genetically modified to resist insects	Crop varieties genetically modified to be pathogen/ nematode-resistant	Biological pesticides	Beneficial organisms	Pheromones to disrupt mating
Cotton	86	15	[a]	47	32	14
Fruits and Nuts	62	[b]	[b]	30	16	18
Vegetables	86	[b]	[b]	27	15	4
Soybeans	78	[a]	[a]	7	3	[a]
Corn	76	18	[a]	18	3	[a]
Barley	71	[a]	[a]	4	8	[b]
Wheat	65	[a]	[a]	5	3	[a]
All Other Crops and Pasture	63	[a]	[a]	9	12	2
Alfalfa Hay	40	[a]	[a]	3	6	[a]

[a]Less than 1 percent.

[b]Insufficient data available.

Note: For information on sampling error of estimates, see app. II.

Source: USDA's National Agricultural Statistics Service, Pest Management Practices, 2000 Summary.

IPM Has Resulted in Some Environmental and Economic Benefits, but Use of the Riskiest Pesticides Remains Substantial

USDA-sponsored research projects, various grower associations, and major food processors have demonstrated that some IPM practices can reduce pesticide use as well as pest management costs, while still maintaining crop yield quality and quantity. Furthermore, the National Academy of Sciences and the American Crop Protection Association report that IPM leads to better long-term pest management because reliance on chemical controls alone reduces their effectiveness due to pest resistance. However, while IPM has yielded significant benefits in certain crops and locations, IPM does not yet appear to have quantifiably reduced nationwide chemical pesticide use. In fact, total use of agricultural pesticides, measured in pounds of active ingredient, has actually increased since the beginning of USDA's IPM initiative. Use of a subset of chemical pesticides, identified by EPA as the riskiest, has declined somewhat since the IPM initiative began. However, use of this subset still comprises over 40 percent of total agricultural pesticide use.

IPM Practices Have Produced Environmental and Economic Benefits in Specific Crops

USDA research scientists, crop growers, and food processors provided us information demonstrating that in several crops and locations, the use of IPM practices reduced pesticide use or toxicity, as well as pest management costs, without sacrificing crop quality or yield.

- Apple and pear growers in Washington, Oregon, and California, in conjunction with USDA's Agricultural Research Service, used a biologically-based IPM practice to control the codling moth, the key pest of these fruits in the western United States. Previously, toxic chemicals had been used to control codling moths. In 1995, the Agricultural Research Service organized apple and pear growers over a large area of the three states to employ an alternative pest-management strategy using pheromones to control the codling moth. Pheromones mimic the scent of female insects to attract male insects, reducing pest mating and thereby reducing pest populations. This project has reduced the need for chemical pesticides by at least 80 percent, reduced pest management costs, and produced a higher-quality harvest with at least a 60-percent reduction in codling moth damage.

- Potato growers in Wisconsin, in conjunction with the World Wildlife Fund, the University of Wisconsin, and EPA, used biologically-based IPM practices to control the weeds, insects, and diseases that damage potato production. Conventional pest management for potatoes involves heavy use of chemical pesticides. To reduce the use of high-risk pesticides, Wisconsin potato growers adopted IPM practices that enhance the potato plant's natural ability to resist pests, and switched to reduced-risk pesticides that do not adversely affect beneficial insects. As a result, the growers reduced their use of potentially toxic pesticides by nearly half a million pounds between 1997 and 2000. Many growers have found that profits increased because of the reduced costs for chemical pesticides.

- Several major food processors encourage their growers to use IPM practices as a means to significantly reduce the amount of chemical pesticides applied to crops. For example, one food processor assists its vegetable growers in using IPM practices, including release of beneficial insects, disruption of pest mating, and application of biological pesticides. According to the food processor, the number of synthetic pesticide applications on crops grown for the company has been reduced by 50 percent or more, production costs have been reduced, and crop yield and quality have been maintained. For example, a group of growers in the processor's IPM program eliminated their use of synthetic pesticides, reduced their insect management costs, and experienced 85 percent less insect damage on tomatoes than non-IPM growers. These results were achieved through using pheromones to disrupt pest mating and through applying biological pesticides.

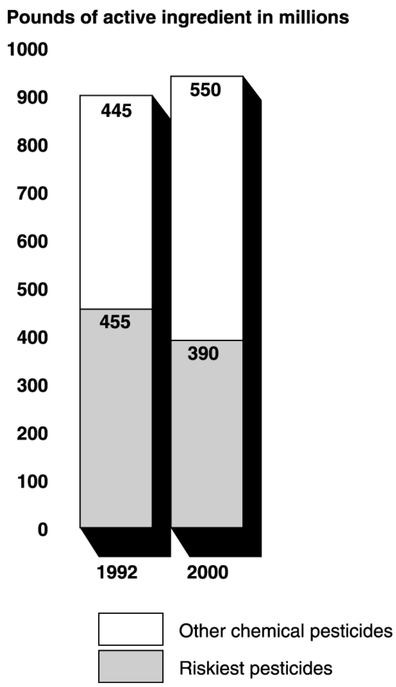
In addition to these results, the National Academy of Sciences reports that IPM also helps to provide better long-term pest control than chemical control alone. According to the academy, U.S. cotton production provides a compelling example of the limitations of relying on chemical pesticides alone. Years of widespread use of chemical pesticides in cotton eventually resulted in elimination of the natural organisms that controlled cotton pests. Populations of cotton pests increased despite increased pesticide applications, and the pests became resistant to chemical control. As a result, acreage planted to cotton decreased dramatically in the southeastern states, and cotton production was threatened in Texas and California. Finally, the development of an IPM program, which combined reduced pesticide applications with mating disruption and other IPM practices, brought the cotton pests under control and helped restore cotton production. The IPM program resulted in reduced pest-control costs, and it increased yields, land values, and acreage planted in cotton.

The American Crop Protection Association, a group representing manufacturers, formulators, and distributors of pesticides and other crop protection products, concurs that IPM provides better crop protection than chemical control alone. The association recognizes that combining the use of chemical pesticides with other IPM strategies prolongs the effectiveness of chemical pesticides by minimizing the development of pest resistance. Similarly, the Global Crop Protection Federation, a worldwide association representing the crop protection industry, views IPM as "the way forward for the crop protection industry." Specifically, the federation states that IPM provides stable and reliable yields and production, reduces the severity of pest infestations, reduces the potential for problems of pest resistance, and secures the agricultural environment for future generations.

The Riskiest Subset of Pesticides Still Comprises a Substantial Portion of Agricultural Pesticide Use

Although some IPM practices have resulted in significant reductions in pesticide use, nationwide use of chemical pesticides in agriculture has not declined since the beginning of the IPM Initiative. Chemical pesticide use in agriculture—which accounts for about three-fourths of all pesticides used in the United States—has increased from about 900 million pounds in 1992 to about 940 million pounds in 2000, according to EPA, even as total cropland has decreased. However, data on total pesticide use aggregates relatively benign pesticides, such as sulfur and mineral oil, with more risky chemical pesticides, including organophosphates, carbamates, and probable or possible carcinogens. This subset of pesticides—which has been identified by EPA as posing the greatest risk to human health—is suspected of causing neurological damage, cancer, and other adverse human health effects. As shown in figure 1, use of the riskiest subset of pesticides decreased from 455 million pounds of active ingredient in 1992 to about 390 million pounds in 2000. However, use of the riskiest pesticides still accounts for over 40 percent of the pesticides used in U.S. agriculture.

Figure 1: Use of Chemical Pesticides in Agriculture, 1992 and 2000



Source: GAO's analysis of EPA data and National Center for Food and Agricultural Policy data.

The reasons for the decreased use of the riskiest pesticides are unclear. However, EPA officials suggested that the decrease may have occurred because some pesticides (1) were discontinued because of EPA regulatory action; (2) were discontinued because of business decisions by the chemical pesticide industry; (3) became noncompetitive compared to newer, cheaper pesticides; (4) became less effective as the target pests developed resistance; or (5) were used less with the introduction of crop varieties genetically modified to resist insects. USDA officials added that use of the riskiest pesticides may have declined because some growers have made progress in implementing nonchemical pest management practices for some crops.

Several Impediments Limit Realization of IPM's Potential Benefits

USDA's initial commitment to the IPM initiative has not been buttressed with the management infrastructure necessary to maximize the benefits of IPM in American agriculture. Specifically, USDA has not provided any departmental entity with the authority necessary to lead the IPM initiative. Furthermore, six USDA agencies, state and land-grant universities, and EPA are all conducting IPM-related activities with little or no coordination of these efforts. Moreover, USDA has vacillated about the intended results of the IPM initiative, causing confusion among IPM stakeholders about what IPM is supposed to achieve. As a result of these shortcomings, considerable federal resources are being spent on IPM without a clear sense of purpose and priorities, and thus a number of farm-level impediments remain unaddressed. Such impediments include insufficient delivery of IPM information to growers, the growers' perceived financial risks of adopting IPM practices, and the higher cost of some alternative pest management products and practices. Although IPM stakeholders suggested that federal efforts and/or financial subsidies might alleviate farm-level impediments to IPM, it is questionable whether such efforts would be effective unless the management deficiencies of the IPM initiative are corrected first. The Government Performance and Results Act calls for linking intended results of federal efforts to program approaches and resources, and thus provides a framework for USDA to address the management deficiencies of its IPM efforts.

The IPM Initiative Is Hampered by Serious Leadership, Coordination, and Management Deficiencies

When USDA launched its IPM initiative in 1994, the department announced that the initiative would combine the IPM-related activities of USDA agencies into a single department-wide effort. However, the department did not endow any entity with the authority necessary to lead such an effort. Instead, authority over IPM resources remains fragmented among the multiple USDA agencies involved in the IPM initiative. At the outset of the initiative, USDA established the IPM Coordinating Committee, consisting of representatives from the agencies with responsibilities for IPM research and implementation. The committee's role was to provide interagency guidance on policies, programs, and budgets—albeit without actual decision-making authority. In 1998, the functions of the committee were transferred to the newly created Office of Pest Management Policy (OPMP). However, OPMP, like its predecessor, was not given authority to direct the department's IPM activities and spending. OPMP's Director acknowledged that the office does not have sufficient authority to lead the IPM initiative.

Lack of effective coordination is another major shortcoming of the IPM initiative. We recently reported that crosscutting programs—such as IPM—that are not effectively coordinated waste scarce funds, confuse and frustrate program stakeholders, and undercut the overall effectiveness of the federal effort.[3] When the IPM initiative began, USDA acknowledged that strong coordination among the department's agencies and between the department and other public and private-sector organizations would be required to effectively support IPM implementation. Early in the initiative, USDA attempted such coordination through its IPM Coordinating Committee. In 1998, USDA transferred the coordination responsibility to OPMP and stated in a report to the Congress that it was "committed to maximizing the impact of existing resources by improving the coordination of IPM and related pest management programs." However, OPMP has done little to coordinate IPM activities, according to officials from several USDA agencies, EPA, and the crop protection industry. As a result, six USDA agencies, state and land-grant universities, and EPA are conducting IPM activities with no assurance that federal resources are being used on the highest priorities, or that duplication and gaps in efforts are being avoided. For example, EPA, the Agricultural Research Service, the Cooperative State Research, Education, and Extension Service, and the Forest Service all conduct or provide grants for IPM research without a coordination mechanism in place. Moreover, the crop protection industry conducts substantial research related to IPM, but USDA does not coordinate federal research with private-sector research. Representatives from the American Crop Protection Association told us that there is little interaction between government and industry on IPM-related research, although the association has approached USDA about coordinating research efforts.

The IPM initiative also lacks clear objectives that articulate the results to be achieved from federal expenditures, a key prerequisite to effective management, as emphasized in the Government Performance and Results Act of 1993. Although USDA set a goal of having 75 percent of the nation's crop acreage under IPM practices by 2000, the department has vacillated on the intended results of achieving this goal. Initially, the Deputy Secretary of Agriculture clearly stated that the IPM initiative was intended to reduce pesticide use. Subsequently, USDA's strategic plan for IPM stated that IPM was intended to "meet the needs of agriculture and the

[3] *Managing for Results: Using GPRA to Assist Oversight and Decisionmaking* (GAO-01-872T, June 19, 2001).

American public" but made no mention of reduced pesticide use as an intended result. During the course of our review, USDA and EPA suggested that an appropriate objective for IPM could be reduction in pesticide risk to human health and the environment, but neither agency adopted that objective. The federal IPM initiative's lack of clarity on intended results has caused confusion among IPM stakeholders across the nation. For example, a survey of 50 state IPM coordinators indicated that, of the 45 respondents, 20 believed that the IPM initiative is primarily intended to reduce pesticide use, 23 did not, and 2 were undecided. During the course of our review, we met with members of a national IPM committee representing state land-grant university scientists involved with IPM. Most of the members of this committee evidenced confusion about the environmental results the IPM initiative is intended to accomplish, and stated that the federal government, particularly EPA, needs to provide clearer guidance on this matter. Several other IPM stakeholders we interviewed during the course of our work echoed the need for clearer guidance to focus the IPM initiative on tangible environmental results.

A related management shortcoming of the federal IPM initiative is that USDA has not devised a method for measuring the environmental or economic results of IPM implementation. In USDA's 1994 strategic plan for implementation of IPM, the department stated that it would assess the economic and environmental impacts of IPM. However, very limited progress has been made in this area. Researchers have conducted some studies of IPM's results, but only for certain crops and locations. Although economists from USDA's Economic Research Service have summarized these studies, service officials acknowledge that no method exists to comprehensively or systematically measure the national environmental and economic results of IPM. Service officials told us that they have been trying to develop a method for measuring IPM's results, but have not done so—7 years after recognizing the need to assess the environmental and economic results of IPM. Moreover, as the officials stated, it is difficult to assess the initiative's results when the department has not clearly articulated the initiative's intended outcomes.

Farm-Level Impediments Limit IPM Implementation

As a result of deficiencies in the leadership, coordination, and management of the IPM initiative, a number of farm-level impediments to IPM implementation remain largely unaddressed, including the following:

- IPM implementation requires that growers have current information on the latest technologies and how to use them. Crop consultants, both in the public sector and the private sector, can provide such information and assistance to growers. In 1994, USDA's Economic Research Service stated that inadequate knowledge of IPM alternatives and too few crop consultants to deliver IPM services were impediments to IPM adoption. In 2000, representatives of the land-grant universities involved in IPM acknowledged that in many areas of the country there are not enough crop consultants to assist growers in implementing IPM, particularly for lower-value crops such as corn and soybeans.

- Some growers are reluctant to adopt IPM because of a concern that alternative pest management practices could increase the risk of crop losses. Crop insurance is one way to reduce that perceived or actual risk, and in 1994 USDA committed to using its crop insurance programs to encourage grower adoption of IPM practices. However, our discussions with IPM stakeholders indicated that little progress has been made in this regard. The IPM Institute of North America recently received a USDA Small Business Innovation Research grant to study the potential for providing crop insurance for growers who implement IPM in corn and cotton, but the federal crop insurance program does not yet cover losses related to IPM implementation.

- Some of the pesticides that pose reduced risks to human health and the environment are more expensive than conventional chemical pesticides. In addition, because reduced-risk pesticides generally are pest-specific, more than one of them may be necessary to replace any one conventional broad-spectrum pesticide. Many IPM stakeholders we interviewed from USDA, EPA, the land-grant universities, and the private sector told us that the higher cost of reduced-risk pesticides is a major impediment to IPM adoption.

IPM stakeholders suggested the need for federal involvement to address these impediments. For example, some suggested that the federal government could foster crop consulting by subsidizing grower costs for these services. IPM stakeholders also suggested that the federal government could subsidize the cost of special insurance to reduce the financial risk of adopting IPM, just as the government subsidizes the cost of traditional crop insurance. Further, IPM stakeholders suggested that the federal government could subsidize grower costs for reduced-risk pesticides. While these measures might help advance IPM implementation, they would involve substantial federal expenditures. Without first improving USDA's management infrastructure, the department's ability to solve farm-level impediments will continue to be hampered.

Conclusions

Chemical pesticides play an important role in allowing Americans to enjoy an abundant and inexpensive food supply. However, these chemicals can have adverse effects on human health and the environment, and their long-term effectiveness will be increasingly limited as pests continue developing resistance to them. Consequently, it has become clear that sustainable and effective agricultural pest management will require continued development and increased use of alternative pest management strategies such as IPM. Some IPM practices yield significant environmental and economic benefits in certain crops, and IPM can lead to better long-term pest management than chemical control alone. However, the federal commitment to IPM has waned over the years. The IPM initiative is missing several management elements identified in the Government Performance and Results Act that are essential for successful implementation of any federal effort. Specifically, no one is effectively in charge of federal IPM efforts; coordination of IPM efforts is lacking among federal agencies and with the private sector; the intended results of these efforts have not been clearly articulated or prioritized; and methods for measuring IPM's environmental and economic results have not been developed. Until these shortcomings are effectively addressed, the full range of potential benefits that IPM can yield for producers, the public, and the environment is unlikely to be realized.

Recommendations

We recommend that the Secretary of Agriculture

- establish effective department-wide leadership, coordination, and management for federally funded IPM efforts;
- clearly articulate and prioritize the results the department wants to achieve from its IPM efforts, focus IPM efforts and resources on those results, and set measurable goals for achieving those results;
- develop a method for measuring the progress of federally funded IPM activities toward the stated goals of the IPM initiative.

If the Secretary of Agriculture determines that reducing the risks of pesticides to human health and the environment is an intended result of the IPM initiative, we also recommend that the Secretary collaborate with EPA to focus IPM research, outreach, and implementation on the pest management strategies that offer the greatest potential to reduce the risks associated with agricultural pesticides.

Agency Comments

We provided USDA and EPA with drafts of this report for their review and comment. In response, the Secretary of Agriculture agreed with our assessment of the IPM program and stated that, based on our recommendations, USDA plans to make the management of the program a high priority. In addition, she stated that USDA will (1) develop a comprehensive, authoritative, and focused roadmap for IPM; (2) prioritize the results that USDA wants to achieve; and (3) set measurable goals for the IPM initiative and devise methods for measurement of progress toward the goals. (See app. IV.)

The Director of EPA's Office of Pesticide Programs said that EPA appreciated our efforts to highlight this issue, and that promoting IPM is an important component of EPA's approach toward reducing risks posed by pesticides. The Director also acknowledged that as efforts to promote IPM continue, EPA/USDA cooperation will become even more vital. (See app. V.)

We conducted our review from September 2000 through June 2001 in accordance with generally accepted government auditing standards. See appendix I for our scope and methodology.

As agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution of it until 30 days from the date of this letter. We will then send copies to other congressional committees with jurisdiction over agriculture programs; the Secretary of Agriculture; and the Administrator, EPA. Copies will also be made available to others upon request.

If you or your staff have any questions about this report, please call me on (202) 512-3841. Key contributors to this report are listed in appendix VI.

Sincerely yours,

John B. Stephenson
Director, Natural Resources and Environment

Appendix I: Scope and Methodology

To assess the level of adoption of integrated pest management (IPM) in U.S. agriculture, we analyzed the U.S. Department of Agriculture's (USDA) data on pest management practices from the National Agricultural Statistics Service's annual Fall Agricultural Survey for crop years 1997 through 2000. The service had published the results of its survey as individual pest management practices, but it had not yet analyzed the data to assess progress toward the 75-percent goal. Therefore, we requested that the service analyze the data using USDA's definition of IPM in order to assess the overall rate of implementation. We spoke with officials at USDA to determine which pest management practices are considered biologically-based. We then examined the adoption rates of the biologically-based subset of pest management practices.

To assess the environmental and economic results of IPM, we (1) interviewed IPM stakeholders in the government, academic, agriculture, nonprofit, trade/commodity association, and corporate sectors; (2) examined related government and nongovernment reports and documentation about IPM; and (3) analyzed use of the subset of agricultural pesticides riskiest to human health. Stakeholders interviewed included USDA officials from the Agricultural Research Service; Economic Research Service; Cooperative State Research, Education, and Extension Service; National Agricultural Statistics Service; Natural Resources Conservation Service; and Office of Pest Management Policy. We also interviewed officials from the Environmental Protection Agency (EPA) and the U.S. Geological Survey. In addition, we spoke with scientists from major land-grant universities about their research on the environmental and economic effects of IPM. We also interviewed individual farmers, commodity groups representing farmers, private crop consultants, and the crop protection industry. We examined supporting documentation from these groups to assess what is known about the overall environmental and economic impact of IPM adoption. To assess whether IPM adoption has resulted in a measurable decline in the use of agricultural chemicals, we reviewed available data on pesticide use from EPA and the National Center for Food and Agricultural Policy. We also analyzed changes in the use of a subset of pesticides identified by EPA as the riskiest to human health and the environment.

To determine whether there are impediments that limit IPM adoption and realization of its potential benefits, we checked for USDA management-level impediments to effectively promoting IPM, as well as for farm-level impediments to adopting IPM practices. In assessing any management-level impediments, we compared early documentation from USDA and EPA about the IPM initiative's objectives and management strategies with progress toward implementing those objectives and strategies. We discussed the causes of any shortcomings with representatives from the various agencies involved in the IPM initiative, as well as with other IPM stakeholders. To assess any farm-level impediments, we interviewed and obtained supporting documentation from individual growers, commodity group representatives, private crop consultants, the Cooperative State Research, Education, and Extension Service's state IPM coordinators, and the Agricultural Research Service's Office of Technology Transfer, in addition to the government officials listed above.

We conducted our review from September 2000 through June 2001 in accordance with generally accepted government auditing standards.

Appendix II: Sampling Error of Estimates From the National Agricultural Statistics Service's Integrated Pest Management Survey

The estimated percentage of acres under IPM practices for crop year 2000 that we provided in table 1 was developed by the National Agricultural Statistics Service from a survey of farmers. Because the survey covered a sample of farmers rather than all farmers, the estimates are subject to sampling error. We obtained from the National Agricultural Statistics Service the information needed to estimate the sampling error, at a 95-percent confidence level, for USDA's IPM estimates by crop. For the estimates of combinations of crops and pest management practices in table 1, the service provided general information about the reliability of the estimates but did not provide the information needed to compute the sampling error for each estimate.

The sampling errors for USDA's year 2000 IPM estimates by crop ranged from 3 to 17 percent. The smallest sampling error was for soybeans; the estimated percentage of acres under IPM was 78 percent plus or minus 3 percent. The largest sampling error was for fruits and nuts; the estimated percentage of acres under IPM was 62 percent plus or minus 17 percent. Based on information provided by the National Agricultural Statistics Service, the sampling errors for the biologically-based IPM practices in table 1 vary by crop and can be large relative to the estimate. For practices that are not commonly used, the sampling error could be twice as large as the estimate. The National Agricultural Statistics Service indicates that these practices generally have insufficient data for publication. For more commonly used pest management practices, the sampling error for the national-level estimates ranges from about 2 to 40 percent of the estimate. For example, if the estimate that 15 percent of the cotton acres were planted in crop varieties genetically modified to resist insects had a sampling error that was 40 percent of the estimate, the sampling error of the estimate would be 40 percent of 15 (6 percentage points). Given an estimate of 15 percent with a sampling error of 6 percentage points, we could feel confident that between 9 and 21 percent (15 percent plus or minus 6 percent) of all cotton acreage was planted in varieties genetically modified to resist insects.

Appendix III: USDA's IPM Categories and Survey Questions

This appendix contains information from USDA's National Agricultural Statistics Service's *Pest Management Practices 2000 Summary*.

Prevention practices keep a pest population from infesting a crop or field. Prevention includes such tactics as using pest-free seeds and transplants, preventing weeds from reproducing, choosing cultivars with genetic resistance to insects or disease, scheduling irrigation to avoid situations conducive to disease development, cleaning tillage and harvest equipment between fields or operations, sanitizing fields, and eliminating alternate hosts or sites for insect pests and disease organisms. The following survey questions measured prevention practices:

- Did you clean tillage or harvesting implements after completing fieldwork for the purpose of reducing the spread of weeds, diseases or other pests?
- Did you remove or plow down crop residues to control pests?
- Did you use practices such as tilling, mowing, burning, or chopping of field edges, lanes, ditches, roadways or fence lines to manage pests?
- Did you use water management practices, such as controlled drainage or irrigation scheduling, excluding chemigation, to control pests?

Avoidance practices are used when pest populations exist in a field or site but the impact of the pest on the crop can be avoided through some cultural practice. Examples of avoidance tactics include rotating crops so that the crop of choice is not a host for the pest, choosing cultivars with genetic resistance to pests, using trap crops, choosing cultivars with maturity dates that may allow harvest before pest populations develop, promoting rapid crop development through fertilization programs, and simply not planting certain areas of fields where pest populations are likely to cause crop failure. Prevention and avoidance strategies may overlap. The following survey questions measured avoidance practices:

- Did you use any crop varieties that were genetically modified to be resistant to insects (Bt, etc.)?
- Did you adjust planting or harvesting dates to control pests?
- Did you rotate crops for the purpose of controlling pests?

- Did you use any crop varieties that were genetically modified to be resistant to plant pathogens or nematodes causing plant diseases?
- Did you choose planting locations to avoid cross infestation of insects or disease?
- Did you grow a trap crop to help control insects?

Monitoring practices include proper identification of pests through surveys or scouting programs, including trapping and soil testing where appropriate. The following survey questions measured monitoring practices:

- Was this crop scouted for pests (weeds, insects or disease) using a systematic method?
- Did you use field mapping of previous weed problems to assist you in making weed management decisions?
- Did you use soil analysis to detect the presence of soil-borne pests or pathogens?
- Did you use pheromones to monitor the presence of pests by trapping?
- Did you use weather monitoring to predict the need for pesticide applications?

Suppression practices include cultural practices such as narrow row spacings, optimized in-row plant populations, no-till or strip-till systems, and cover crops or mulches. Physical suppression tactics may include mowing for weed control, baited traps for certain insects, and temperature management or exclusion devices for insect and disease management. Chemical pesticides are an important suppression tool, and some use will remain necessary. However, pesticides should be applied as a last resort in suppression systems. Biological controls, such as pheromones to disrupt mating, could be considered as alternatives to conventional pesticides, especially where long-term control of an especially troublesome pest species can be obtained. The following survey questions measured suppression practices:

- Did you use any crop varieties that were genetically modified to be resistant to specific herbicides (Roundup Ready, Liberty Link, Poast-Protected corn, STS soybean, IT corn)?
- Did you use scouting data and compare it to university or extension guidelines for infestation thresholds to determine when to take measures to control pests?
- Did you use beneficial organisms (insects, nematodes or fungi) to control pests?
- Did you use topically applied biological pesticides such as Bt (Bacillus thuringiensis), insect growth regulators, neem, or other natural products to control pests?
- Did you maintain ground covers, mulches or physical barriers to reduce pest problems?
- Did you adjust row spacing, plant density or row direction to control pests?
- Did you alternate pesticides to keep pests from becoming resistant to pesticides (use pesticides with different mechanisms of action)?
- Did you use pheromones to control pests by disrupting mating?

Appendix IV: Comments From the Department of Agriculture

USDA

United States Department of Agriculture

Office of the Secretary
Washington, D.C. 20250

AUG 3 2001

The Honorable John B. Stephenson
Director
Natural Resources and Environment
U.S. General Accounting Office
Room 2966 (Mail 2T23)
441 G Street, NW
Washington, D.C. 20548

Dear Mr. Stephenson:

Thank you for the opportunity to comment on the draft report "Agricultural Pesticides: Management Improvements Needed to Further Promote Integrated Pest Management." We appreciate the thoroughness of your review and the amount of time and effort you and your staff committed to the task. While we in the U.S. Department of Agriculture (USDA) are very proud of the accomplishments in the Integrated Pest Management (IPM) program, such as achieving over 70 percent of cropland acres under IPM, we continually seek improvements that could potentially contribute to enhance success in IPM.

While reducing pesticide use in agriculture was one goal articulated in the 1993 initiative, it is widely recognized that IPM offers many positive economic, human health, and environmental benefits in addition to those that might accrue from simply reducing pounds of pesticides used. As you point out in your report, although total pounds of pesticides used increased by around 4 percent from 1992 to 2000, use of those pesticides identified as the riskiest by the U.S. Environmental Protection Agency (EPA) declined by over 14 percent. USDA is working cooperatively with EPA to help reduce the risk from agricultural pesticide use, and we believe we are making good progress in that direction. You pointed out three excellent examples of well funded, highly specific programs, each with dedicated leadership, in which pesticide use has been altered and risky practices have been reduced. We can list many other programs in which pesticide use has been dramatically changed. For example, according to National Agricultural Statistics Service (NASS) survey data, from 1992 until 2000 the use of herbicides in corn classified as probable or possible human carcinogens was reduced from 164.2 million pounds to 91.2 million pounds, a 45 percent reduction. Similarly, in soybean, herbicides classified as probable or possible human carcinogens declined by over 78 percent from 19.2 million pounds to 4.2 million pounds. Other positive impacts have resulted from the development of over 400 crop profiles, which document production and pest management practices for individual crops, a critical starting point for development of pest management strategic plans that identify high priority pest management needs.

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The Honorable John B. Stephenson
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We agree with your assessment that the USDA definition of IPM does not distinguish between those practices that tend to reduce pesticide use and those which may not. In formulating the definition, we included as many IPM practices as possible in recognition that IPM is a continuum of production practices. Furthermore, the broad definition acknowledges those growers who are making concerted efforts to implement IPM programs, even if at an elementary level. It is important to recognize that IPM adoption by farmers is voluntary. In many instances it is not possible to reduce pesticide use because no alternatives for control exist. However, the IPM definition makes it very clear that pesticide use should be the last resort, after prevention and avoidance practices have been exhausted and monitoring has shown that a pest problem of economic significance still exists. The following quote from the USDA IPM definition illustrates this point.

> "Chemical pesticides are important in IPM programs, and some use will remain necessary. However, pesticides should be applied as a last resort in suppression systems using the following sound management approach: (1) The cost:benefit should be confirmed prior to use (using economic thresholds where available); (2) Pesticides should be selected based on least negative effects on environment and human health in addition to efficacy and economics; (3) Where economically and technically feasible, precision agriculture or other appropriate new technology should be utilized to limit pesticide use to areas where pests actually exist or are reasonably expected; (4) Sprayers or other application devices should be calibrated prior to use and occasionally during the use season; (5) Chemicals with the same mode of action should not be used continuously on the same field in order to avoid resistance development; and (6) Vegetative buffers should be used to minimize chemical movement to surface water."

Like all multi-agency programs, the IPM program will continue to be managed through my office working with all involved agencies and stakeholders. As we initiate planning based on your recommendations, attention to the management of the program will be of high priority. Based on those recommendations, USDA will:

- Work with all relevant and involved entities in the Department (Office of Pest Management Policy; Agricultural Research Service; Cooperative State Research, Education, and Extension Service; Economic Research Service; NASS, Natural Resources Conservation Service; and the Forest Service) to develop a comprehensive, authoritative, and focused roadmap for IPM;

- Prioritize the results the USDA wants to achieve. We have already begun this effort by formulating a draft strategic plan for pest management for the next decade. This draft plan will be submitted for comment to a wide range of IPM experts across the country and a workshop to finalize the plan is being organized for as soon as practical, hopefully early 2002; and

The Honorable John B. Stephenson
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- Work with all Agencies involved to set measurable goals for the IPM initiative, and devise methods for measurement of progress toward the goals.

Thank you again for your comprehensive review of this program. We look forward to greater success because of your efforts.

Sincerely,

Ann M. Veneman
Secretary

Appendix V: Comments From the Environmental Protection Agency

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JUL 25 2001

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

John B. Stephenson
Director, Natural Resources and Environment Division
United States General Accounting Office
441 G Street, NW
Washington, D.C. 20548

Dear Mr. Stephenson:

Thank you for the opportunity to comment on the draft report describing the results of the General Accounting Office's (GAO) review of the use of integrated pest management (IPM) in agriculture. GAO's report entitled "Agricultural Pesticides: Management Improvements Needed to Further Promote Integrated Pest Management" examines the status of IPM adoption in U.S. agriculture. EPA appreciates the efforts of GAO in preparing this document to highlight this important issue.

As the report notes, IPM is an effective and environmentally sensitive approach to pest management that relies on a combination of common-sense practices. IPM programs use current, comprehensive information on the life cycles of pests and their interaction with the environment. Ideally, this information, in combination with available pest control methods, is used to manage pest damage by the most economical means, and with the least possible hazard to people, property and the environment.

EPA has a number of efforts to promote the use of IPM in agriculture, many sponsored through its Pesticide Environmental Stewardship (PESP) program. The PESP is a voluntary program that forms partnerships with pesticide users to reduce pesticide risks in both agricultural and non-agricultural settings. Information about the PESP program, and examples of success stories under the PESP program, can be viewed at **www.epa.gov/oppbppd1/PESP/publications/successes.htm.** Another example is EPA's agreement with the American Farmland Trust, with funding from the Pew Charitable Trusts, to help establish private public partnership projects to implement IPM programs across the country.

Promoting IPM is an important component of EPA's approach towards reducing risks posed by pesticides. Under the Food Quality Protection Act (FQPA), pesticides are subject to rigorous scientific standards, including a requirement that EPA reevaulate the risks posed by existing pesticides. This review has focused first on pesticides which potentially pose the greatest risk to human health. While EPA has the primary responsibility for implementing FQPA, USDA has been and continues to be a key player in this process, in assisting with

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obtaining data for risk assessments, helping pesticide users adjust to changes to pesticide uses, and ensuring the availability of appropriate alternative pest management strategies. As efforts to implement FQPA, and to promote IPM continue, EPA/USDA cooperation will become even more vital.

Again, thank you for the opportunity to comment on this report. Please feel free to contact me if you would like additional information on any of our programs.

Sincerely,

Marcia E. Mulkey
Director, Office of Pesticide Programs

Appendix VI: GAO Contact and Staff Acknowledgments

GAO Contact

John B. Stephenson, (202) 512-3841

Acknowledgments

In addition to the individual above, Chuck Barchok, Patricia J. Manthe, Terrance N. Horner, Jr., Donald J. Sangirardi, Karen Bracey, and Cynthia Norris made key contributions to this report.

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