Executive Summary

INTRODUCTION

In the United States, total losses from all pests are generally estimated to be one-third of total potential production before harvest, and nearly 10 percent after harvest. Losses are believed to be considerably greater in the tropics. Thus, at least one-third of the world's potential food harvest is lost to pests. The vulnerability of crops to pests makes pest control one of the major management components of the total crop production system. This vulnerability has become more prominent as the trend toward high productivity of only a few select crops has increased. This trend dominates U.S. agriculture. During the past century U.S. agriculture has changed from relatively small, labor-intensive, diversified units to large, highly specialized, and mechanized operations. Today, modern agriculture is a complex system in which a series of interlocking physical, biological, and management functions all interact to determine the yield and quality of a cultivated crop.

In the past three decades, U.S. agriculture has increasingly depended on chemical pesticides to control the pests that damage crops. Heightened concern over the environmental effects of pesticides, coupled with increased pest resistance and secondary pest outbreaks, severely limits the effective pesticides available to farmers. While these trends are most fully developed in the industrialized nations, especially in the United States, the problem is worldwide. If farmers are to meet the growing demand for food, new strategies for reducing pest damage must be found.

This pest management strategies assessment was requested by Senator Herman Talmadge, Chairman of the Senate Committee on Agriculture, Nutrition, and Forestry. Its primary focus is on agricultural crop protection. The study sought to:

1. assess crop protection problems, current and emerging control technologies, and projected future developments over the next 15 years for each of seven regional cropping systems in the United States,
2. evaluate Federal constraints to improved pest management in the United States, and
3. review the problems, potentials, and impacts of the transfer of North American crop protection technology to the developing world.

These objectives were addressed by nine study groups: one each for the seven cropping systems in 1 and one each for 2 and 3. The crops and regions selected were: wheat in the Great Plains States, corn in the Corn Belt, cotton and sorghum in Texas, deciduous tree-fruits (especially apple] in the northern half of the country, potatoes in the Northeastern States, soybean in the Southeastern sector, and selected vegetables in California. These crops are representative of more than 90 percent of U.S. agricultural production.

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DISCUSSION

Present Pest Control Tactics and Problems

Agricultural producers have coped with the changing nature of pest problems by using one or more of several control tactics. None of these practices is entirely satisfactory or universally applicable. Moreover, all practices used to control any one pest complex impact on nontarget organisms and can create other problems. Control tactics most commonly used on U.S. farms are:

- Chemical: herbicides, insecticides, fungicides, nematicides, etc.;
- Cultural: cultivation, crop rotation, strategic planting and harvesting dates, sanitation;
- Plant resistance: plant varieties genetically resistant or tolerant to pests; and
- Biological: predators, parasites, microbial.

Table 1 shows the principal control tactics used against major pests of the several crops in this report,

The major problems associated with present controls stem primarily from the extremely limited number of effective control tactics.

Table I.— Principal Control Tactics Used Against Major Pests of the Seven Regional Cropping Systems

	Major pests				
	Insects	Nematodes	Pathogens	Weeds	Vertebrates
Wheat (Great Plains)	2,1,3	2	3.2	1,2	2
Corn (Cornbelt)	1,2,3	–	3,2,1	1,2	–
Soybeans (Southeast)	1	1,3.2	1,2	1,2	–
Apples (North)	1	1 2	1,3,2	1,2	1,2
Potatoes (Northeast)	1,2	2,1,3	2,1	1.2	–
Cotton (Texas)	1,23	3	3,2,1	1,2	–
Melons (California) .	1	1	2,3	1,2	4
Cole (California)	1	1	2	1,2	4
Lettuce (California)	1,2	1,3	2,1,3	1,2	4
Tomatoes (California)	1,2	1,3	3,2	1.2	4
Strawberries (California)	1	–	2	1	4

Control tactics
1 Chemical (insecticides nematicides fungicides herbicides)
2 Cultural (cultivation crop rotation planting dates sanitation)
3 Plant resistance (plant varieties genetically resistant to pests)
4 Biological predators parasites ml crobials I

These problems are expected to increase as pests, through evolutionary adaptation, become resistant to existing controls. For example, disease-resistant wheat eventually loses its effectiveness as strains of disease pathogens evolve that are capable of overcoming such resistance, late planting of a crop to avoid an insect pest becomes futile as other pest strains are encountered that are adapted to late planting, and the continual exposure of pests to chemical pesticides promotes the evolution of pests resistant to these chemicals. Moreover, some pest control measures have secondary effects that are often as serious as the problems for which the controls originally were used. For example, some chemical pesticides eliminate beneficial predators and parasites and other nontarget organisms along with the targeted pests and produce secondary pest outbreaks, In other cases the removal of a primary weed pest may result in secondary pest outbreaks, and tillage for pest control increases soil erosion and water loss. Moreover, it often takes years to understand fully the secondary consequences. In addition. a de-emphasis in research programs in genetic plant resistance to pests is one factor that has led to a reduction in the acreage of certain pest-resistant crops. In Kansas and Nebraska alone, the acreage of Hessian-fly-resistant wheats has decreased from about 66 percent in 1973 to about 42 percent in 1977. Finally, the health and safety of agricultural workers and bystanders are of widespread concern as many of the chemicals in use today pose known and unknown risks to humans.

These are major problems that are raising serious concerns about both the present and future availability of suitable control measures and alternative means of control.

Fifteen-Year Prelection for Crop Protection

No revolutionary new pest control tactics are expected to be implemented over the next

15 years. This projection assumes that such control technologies must already be in at least the early stages of development, Although the total use of pesticides is not expected to increase appreciably, the use of herbicides is expected to accelerate considerably. Several new tactics in crop protection, such as the use of hormones, antihormones, allelopathy, and molecular genetic manipulation will probably be of limited use during the next 15 years, although they have great potential for the future. One exception may be the use of pheromones (sex attractants) to control insects, a technique that could become widely adopted if technological problems can be solved.

However, there is a promising approach, integrated pest management (1PM), that is slowly evolving within U.S. agriculture, This approach offers promise of more stable crop protection and production with the least hazard to man and the environment. 1PM will be used more widely as efficient, economically sound systems become available. These should provide more stable management of many pests than now exists and should reduce pesticide use to the minimum effective level required to allow continued growth in agricultural production.

Integrated Pest Management

Because of the continually changing nature of pests, their environment, and the economic impact of pest combinations, coupled with a mounting public concern regarding human health and environmental problems associated with the use of chemical pesticides, a concerted effort is required to develop programs that contain pest damage while providing protection against hazards to humans, animals, plants, and the environment, 1PM views pest control within a whole-systems context of crop production and is defined as follows:

Integrated pest management (1PM) is the optimization of pest control in an economically and ecologically sound manner, accomplished by the coordinated use of multiple tactics to assure stable crop production and to maintain pest damage below the economic injury level while minimizing hazards to humans, animals, plants, and the environment.

In its broadest form, an 1PM program encompasses all significant components of the agroecosystem-soil, crops, water and air, insects, pathogens, weeds, nematodes, and other organisms—which interact among themselves and with other components of the system, Present 1PM programs, however, are most commonly limited to single-pest classes.

Present State of implementation of IPM

The full potential of IPM has not been realized in any of the seven cropping systems examined in this report. However, there are many situations in which multiple-control tactics are being used. Although these are relatively simple systems, they can be expanded in the future.

Where multiple tactics are used for any one crop, they are usually directed against specific pests or classes of pests rather than all pests. The tactics most commonly employed involve cultural controls and resistant plants combined with minimum effective rates of chemical pesticides. The combined use of herbicides and limited cultivation, to replace cultivation alone, for weed control has significantly reduced soil erosion, but has created other problems.

Short-term models developed from the data of some pest-monitoring programs are succeeding in predicting some pest outbreaks. These tools allow growers to apply pesticides only as needed or to substitute other appropriate tactics, Broad monitoring programs and predictive models are among the most promising components of 1PM, but are limited at present by a lack of organizational structure; a lack of adequate weather monitoring at the local, regional, and national levels; and insufficient bionomic data.

Transfer of IPM Technology to the Developing World

The concept of 1PM is widely accepted internationally and the transfer of its basic philosophy to the developing world through several national and international assistance programs has progressed. However, systems must be developed that are adapted to the agricultural conditions in the developing countries and are compatible with social customs, political structures, and economic systems as well,

Traditional subsistence agriculture of the developing tropical world must deal with an array of crops and associated pests generally not found in temperate countries. Pest management systems developed for the intensive high-energy agriculture of the temperate world are often inappropriate. Agromedical training, pest management workshops, adequate libraries, onsite demonstration projects, and crop protection research and extension under the title XII amendment to the Foreign Assistance Act and others will be required to develop the necessary knowledge bank and to implement vigorous, effective 1PM programs. It is estimated that 50 percent of the extremely high pest-caused losses in the developing world may be prevented through application of appropriate 1PM systems,

MAJOR FINDINGS AND CONCLUSIONS

1, The limited variety and effectiveness of present pest control tactics seriously limit farmers' ability to reduce current crop losses;

2. 1PM appears to be the most promising crop protection strategy for the next 15 years;

3, OTA estimates that 1PM programs for major U.S. crops can reduce pesticide use up to 75 percent, reduce preharvest pest-caused losses by 50 percent, and reduce total pest control costs by a significant amount;

4. International implementation of 1PM requires systems that are adapted to local agricultural conditions and are compatible with social customs, political structures, and economic systems;

5. Technological and administrative obstacles that-impede the development and implementation of 1PM must be removed to achieve a more effective crop protection system in the United States.

   The technological obstacles lie primarily in the areas of basic knowledge, delivery systems, and personnel. An inadequate base of knowledge in the basic biology, bionomics, and interactions of crop pests seriously limits the range of control tactics available for integrating pest management into a total crop production system.

   At the same time, the lack of an adequate delivery system impedes the dissemination of data necessary to support effective pest-management decisions. Along with this is a shortage of properly trained personnel to conduct needed research, to develop 1PM programs, and to provide information delivery systems. The extension pilot 1PM programs were initiated with Federal funding but did not provide adequate means to increase the knowledge and trained manpower base with which to support 1PM. A lack of practical, demonstrated interdisciplinary programs has resulted in grower skepticism and uncertainty regarding the economic benefits of 1PM.

   The administrative obstacles stem from the lack of cooperation and coordination between Federal and State agencies which impede programs of basic and applied research in 1PM. A clear focus of intent concerning future 1PM activities must be conveyed by the various agencies involved in the funding of research and extension activities, the regulation of pesticide use, and in the marketing of farm products.

6. Congressional action or inaction will affect the future form of U.S. crop protection strategy.

CONGRESSIONAL OPTI0NS

The basic option that Congress faces is whether to make a policy judgment to commit the additional resources required to accelerate the present slow evolutionary trend toward the adoption of 1PM crop protection systems, Thus, Congress faces a choice between: 1) the status quo for U.S. pest control methods, which, although including 1PM, continues to rely heavily on chemicals or 2) developing a strategy to accelerate the present slow evolutionary shift to 1PM as a whole-systems approach to U.S. crop protection.

Option 1: Status Quo

Pros: The control tactics presently available for crop protection are relatively simple, readily available, and economically attractive. They are used primarily in response to single-pest outbreaks. Their principal advantage is that their effects are known, they work, and they have gained the confidence of growers.

Cons: Chemical pesticides are the most frequently used tactic at present. Effects of some chemical control measures include the induction of secondary pest outbreaks, adverse effects on beneficial species and on nontarget organisms, development of pesticide-resistant pests, and environmental and health hazards. There is serious concern about the future availability of suitable control tactics, since the already-limited range of tactics will be reduced even further as more pests develop resistance to some chemical pesticides and as Government regulations remove other pesticides essential to pest control. Alternative control tactics are limited and often are not feasible to use or are not adequately effective. The evolutionary shift to 1PM is too slow to have a significant impact except in a few situations.

Option 2: Accelerate the Shift to Integrated Pest Management

Pros: Under IPM, pest management is accomplished through a whole-systems approach that considers all components of the agroecosystem that interact among themselves and with other components of the system. Problems posed by resistant pests, destruction of beneficial organisms, and secondary pest outbreaks would decline; greater management flexibility and ecosystem stability would be provided while greater precision in taking control action may reduce the need for pesticides which, in turn, could reduce the onset of pesticide resistance and health and environmental hazards.

Cons: A substantially greater investment of money, personnel, and time in research, education, and implementation will be needed to increase the speed of adoption of 1PM. Included is the high cost of educating growers, agents, consultants, and others as well as that of maintaining monitoring and delivery systems. Congress could provide either moderate or major support toward accelerating the adoption of 1PM.

A moderate increase in commitment would augment the present teaching, research, and extension programs. With this increased support, 1PM could eventually replace most unilateral pest control programs over the next 20 to 30 years.

A major effort over the next few years to remove the obstacles to the implementation of 1PM would enable much of the potential of 1PM to be realized within 15 years. Under 1PM U.S. agriculture could achieve an increased production while at the same time providing maximum protection to man, his crops, and the environment.

To remove the obstacles to 1PM, the following actions are all required:

- provide increased funds and longer time support for disciplinary and interdisciplinary research in the basic biology, bionomics, and interactions of crop pests:
- provide increased support for biological control and host-plant resistance efforts, along with increased flexibility in pesticide use and incentives for the development of low-sales-volume, selective pesticides;
- create a federally coordinated pest and weather-monitoring program, support public information delivery systems, offer incentives for the formation of private information delivery systems, and increase support for State plant health clinics;
- provide direct Federal support for pest management training programs and establish regional pest management study centers;
- provide the means to make available increased education, extension, and practical 1PM demonstration programs:
- review the relationship between existing food quality standards and pesticide use; and
- establish a clear focus of Federal intent and assign to the U.S. Department of Agriculture, the lead Agency, the responsibility, authority, and necessary funding to coordinate 1PM research programs and to implement an adequately staffed and coordinated information delivery system,