AN EVALUATION OF THE SCOUTING ACTIVITIES OF PEST MANAGEMENT PROGRAMS

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EPA REVIEW NOTICE

This EPA Report has been reviewed by the Office of Pesticide Programs and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Environmental Protection Agency, or does mention of trade names or commercial products constitute endorsement or recommendation for use.

TABLE OF CONTENTS

SECTION		PAGE
	Interagency Agreement	iii
	Statement of Work	v
	Acknowledgement	x
I	Introduction	1
II	Past and Present	
	A. Scouting Objectives	4
	B. Pest Management Objectives	8
	C. Mechanics of Implementation	11
	D. Resource Implications	29
	E. Effectiveness	34
III	Future	
	A. Constraints	39
	B. Projected Costs	42
	C. Probable Effectiveness	49
IV	Recommendations	53
	References Cited	57

INTERAGENCY AGREEMENT BETWEEN THE
ENVIRONMENTAL PROTECTION AGENCY
AND THE
UNITED STATES DEPARTMENT OF AGRICULTURE

I. PURPOSE:

The purpose of this Interagency Agreement is to provide the Environmental Protection Agency, Office of Pesticide Programs, with a study which evaluates the results of Government sponsored and private pest scouting activities as part of organized pest management.

II. SERVICES TO BE PROVIDED:

The United States Department of Agriculture will develop a report following the attached statement of work.

The USDA representative will meet each month with the EPA Project Officer to discuss the study and submit a short resume of progress.

III. PUBLICATION:

The final report will consist of narrative and all tables and figures necessary for a clear understanding of the information provided. The report will contain as appendix material all necessary documentation to support and verify the statements made in the report. A draft of the final report will be submitted to EPA by June 30, 1974. Following a 30 day review period by EPA, USDA will have 30 days to submit twnety-five copies of a final report which reflects the EPA review. It is agreed that the USDA shall acknowledge EPA's support whenever research projects funded in whole or in part by this agreement are publicized in any news media. USDA shall include, in any publication resulting from the research performed under this agreement, an acknowledgment identifying EPA as the sponsoring agency and the associated agreement number.

IV. PERIOD OF AGREEMENT:

This agreement will cover a period of approximately six months. The information will be delivered in final form by June 30, 1974; it may be terminated by either agency upon 30 days advance written notice. The agreement may be modified by mutual consent of both parties.

V. PROJECT OFFICERS:

Mr. Charles D. Reese, Office of Pesticide Programs, EPA

Dr. James R. Brazzel, Plant Protection and Quaranting Programs, APHIS, USDA

VI. FUNDING ARRANGEMENTS:

EPA will reimburse USDA-APHIS for actual costs incurred in the performance of this work in an amount not to exceed $50,000. Request for reimbursement should be made by itemized SF 1080 submitted quarterly to the EPA Division of Financial Management, 401 M Street, S.W., Washington, D. C. 20460. Requests for reimbursement and related correspondence should cite the number of this agreement together with the following accounting information:

Appropriation Symbol	68X0108
Account No.	418332P991
Document Control Number	K00280
Object Class	25.70

VII. AUTHORITY:

This interagency agreement is entered into under the authority of the Economy Act of 1932 as amended (31-USC-686).

APPROVED AND ACCEPTED FOR THE UNITED STATES DEPARTMENT OF AGRICULTURE

John E. Carson

Date MAR 25 1974

APPROVED AND ACCEPTED FOR THE ENVIRONMENTAL PROTECTION AGENCY

Charles L. Elkins

Assistant Administrator for Hazardous Materials Control

Date 2/11/74

STATEMENT OF WORK
PEST MANAGEMENT

Background

The primary goal of any sound crop production system is to obtain maximum yields through the use of management practices which are ecologically, socially, and economically acceptable. Invariably, achievement of this goal is complicated by the presence of plant diseases, insect pests, and weeds. When the presence of these pests reach or exceed certain levels they become economically important and must be controlled. Traditionally, this situation has been taken care of on an individual grower basis and when a method of control was deemed necessary a pesticide was applied. If warranted and applied at the proper time these applications of pesticide were frequently effective in decreasing the population level of the pest. Often, however, a lack of sound knowledge of pest population levels and the full range of impacts of pesticide use has led to the widespread adoption of unnecessary prophylactic or insurance application of pesticides. In fact, such applications have in some cases inhibited the growth of crops and/or resulted in resurgence of major pests or eruption of secondary pests.

Since 1971, the Animal and Plant Health Inspection Service (APHIS) of the U. S. Department of Agriculture (USDA) has been involved in a cooperative Federal-State pest management program which is generating large amounts of biological data which may provide insights into many of the interactions and impacts of pesticides on several cropping systems. This data is being gathered as a result of the scouting or population assessment phase of the overall pest management program. Such data, after careful evaluation, has been used for making pesticide application recommendations. The net result of this scouting activity in some local pest management projects has been a reduction in the unnecessary application of pesticides.

Outline of Study

The contractor shall provide all personnel, materials, equipment, and facilities necessary to evaluate the results of government sponsored and private pest scouting activities. This analysis will consider program benefits and cost in addition to the level of public acceptance. The study will also address itself to the broader term of pest management and the concept of area-wide suppression of crop pests.

Three major aspects to this investigation of scouting activities are: (1) evaluation of past and present programs, both public and private; (2) implementation of scouting activities as a part of organized pest management; and, (3) the implementation of pest management programs in all crop production systems.

1. The evaluation of the effectiveness of past and existing scouting programs will include consideration of the following:

   A. Short and long-term objectives of past and existing scouting programs.

      - What was the rationale for selecting these objectives?

      - What was the strategy for achieving these programs?

   B. Short and long-term objectives of a total pest management program.

      - What was the rationale for selecting these objectives?

      - What was the strategy for achieving these programs?

   C. Mechanics of implementation.

      - For which crops and states were the programs selected? Why?

      - Are certain classes of chemicals more affected than others by scouting activities?

      - What managerial qualifications are needed?

      - Are people with this training available?

      - How are the scouts selected? What training do they receive? Have enough people been available? Is there any consideration given to personnel safety?

      - What data are collected? What is the frequency of collection? Why?

      - After the scouts collect the raw data what is the decision-making process used by managers to make recommendations? (Specific examples will be provided).

      - Do the scouting programs consider climate, genetic differences and/or adjacent crop interactions?

      - Are the environmental impacts assessed? How?

Resource implications (cost of programs).

- How many scouts were required in programs to date? Is the number of scouts determined on the basis of acreage, number of farms or some other factor?

- How and by whom are the scouts paid? Is the basis for pay an hourly rate, acreage, or some other factor?

- Is there a large turnover in scout personnel? What factors seem to cause turnover? What are the cost implications?

- What are the managerial costs of programs done to date? Who was paid for the programs?

- What are the costs of evaluating the environmental impact of these programs?

E. Effectiveness.

- Were the objectives of the programs achieved? Why or why not?

- What was the level of social acceptance to these programs?

- Was per acre pesticide use reduced? Why?

- What has been the effect on crop yields?

- Did the programs affect subsequent grower management practices? Why or why not?

- What was the environmental impact of these programs? Were the sampling programs adequate?

2. Implementation of scouting activities as part of an organized pest management program.

A. Constraints.

- Can existing pest management programs for particular crops be applied to all other areas of the U. S. where those crops are grown. How and why?

- What is the anticipated level of public acceptance? Why? What institutional modifications such as incentives and educational programs appear to be necessary to achieve public acceptance and program implementation?

- How many scouts will be needed and are they available?

- How many managerial personnel will be needed and are they available?

B. Projected costs.

- Cost of personnel required.

- Cost of training required.

- Other system costs to include administration, equipment, and incentives.

- Is the program cost effective?

C. Probable effectiveness.

- Will the objectives and strategies of present programs be achieved? Are new objectives needed and are they being developed?

- What will be the level of public acceptance of such programs?

- Will the total use of pesticides be reduced? What other benefits may result?

- Will the adverse environmental impact be reduced?

- Could past and existing programs yield management models?

3. Recommendations.

- Suggested changes in strategy and objectives.

- Improved training programs or techniques for scouts and managers.

- Improved data gathering and analysis procedures.
- Funding requirements.
- Incentives and public education for achieving public acceptance.
- Implementation plan for a national scouting program within the confines of a pest management program.

ACKNOWLEDGEMENT

We wish to acknowledge the assistance, through hours of discussion and answering questions, of a large number of people involved in the area of pest management. They shared their knowledge and experiences unselfishly. Groups or agencies represented were: the State cooperative extension services, the Extension Service, U. S. Department of Agriculture, the State agricultural experiment stations, growers, the State regulatory agencies, the chemical industry, private pest management consultants, and project scouts.

I

INTRODUCTION

INTRODUCTION

The origin of insect scouting in agricultural crops is lost in antiquity, to be sure. Insect scouting, as we know it today, seems to have appeared in the second decade of the 1900's. Its birth in Arkansas is well documented (Boyer et al., 1962). Scouting as the basis for cotton insect control in this State had its beginning in research conducted by Dwight Isley in the 1920's. The first commercial scout in Arkansas was hired in 1925 and worked under Isley's direction.

This initial scouting was done to determine pest population levels prior to the application of insecticides so that differences in efficacy among various materials could be determined. Isley's work in this area led to his insistence that insect infestations varied from field to field and from week to week, to the extent that scouting was needed on a weekly basis in all fields in order to use insecticides in a biologically and economically sound manner. With the need established, cotton scouting in Arkansas grew, and has since spread to other parts of the cotton growing region of the United States.

Until about the mid-1950's, cotton scouting usually resulted in the use of more insecticides as growers realized the limiting influence of insect pests on crop production. Over the years, however, boll weevils became resistant to an increasing number of insecticides. Entomologists also became aware that the insecticides used for boll weevil control were creating outbreaks of other pests by destroying their natural enemies. As a result, additional control strategies were developed against the boll weevil. The diapause control concept (Brazzel et al., 1961), which lessened the adverse impact of pesticides on natural populations of beneficial arthropods which suppressed other pests, is one such strategy.

In the last 15 years, the direction of cotton scouting has been toward its employment as a monitoring tool in a more complete management system. The development of alternate strategies, when successfully implemented, has resulted in optimizing insect control while often reducing the frequency and amount of insecticide usage.

The use of chemicals for control of insect pests has developed on other crops where the need for strategic timing is also essential. In addition, chemicals are now widely used to control weeds, nematodes, and diseases. Cultural and biological methods

aimed at management of pests have also continued to develop. Along with this evolution, scouting and consulting have developed into viable enterprises in certain areas of the country. These areas usually are regions where a combination of available technology, dedicated people, and economic feasibility coexists. For example, the number of consultants in California and the Mississippi River flood plain in the midsouth has rapidly increased in the last 8 to 10 years (now over 200 in these areas) and some have been in business for nearly 25 years.

Where good pest management strategies, including periodic monitoring of field conditions, have not been effectively employed, insecticides have been subject to overuse, poor timing, and other means of misuse. More recently, this has become prominent with other pesticides as well. In addition, the use of chemicals for one pest often counteract natural or other management methods for control of other pests, or adversely affect the yield potential of a crop through physiological damage. Further, practices employed in one field or on one crop often interfere with optimum pest management in another field or on other crops in the same area. What has clearly evolved is the need for planning and implementing overall management practices which not only optimize production in an individual field, but which, in the case of pest management, are in harmony throughout an area.

The widespread use of large quantities of pesticides, especially insecticides and herbicides, has also caused tremendous public concern over potential environmental destruction. As a result, the use of some chemicals has been banned, and many others may only be used under restrictive conditions, on certain crops, or in certain geographical areas. More stringent controls on pesticide use are destined for the future, and this will create an even greater need to sophisticate pest management strategies.

The United States farmer is faced with the need to solve the pest control dilemma for five principle reasons: (1) Unwise use of agricultural chemicals including pesticides which may adversely affect crop yields, (2) the increasing incidence of pest species becoming resistant to pesticides, (3) the adverse affects of pesticides on natural suppressive agents which result in the elevation of former secondary pests to the role of major pests, (4) pesticides contribute to environmental contamination, and must be regulated to reduce this occurrence, (5) costs of pesticides, as with other farming inputs, are constantly increasing disproportionately to the rise in farm income. These costs may accelerate even more due to the energy crises and stronger demand

for available petroleum products. The average grower may either not have the necessary information or capability to implement the type of pest management methods needed to cope with all these factors. He cannot be a specialist in all areas of farm management. As mentioned previously, he will also have to work with his neighbors for the most effective management of pests.

A number of States are currently taking steps toward solving the pest management dilemma. This report deals with some of their approaches, most of which rely heavily upon scouting activities.

II

PAST AND PRESENT

A. Scouting Objectives

Short-Term Objective of Past Scouting Program

A scouting program, as originally conceived, was designed to enable the grower to use insecticides more efficiently and to ensure that pest infestations did not develop and cause damage without the knowledge of the producer. Of course, this is based upon the fact that the growers and technical personnel recognize that an automatic or prophylactic approach to pest control with chemicals is uneconomical, and the knowledge that pest situations differ from field to field or in areas within a field. It was only logical that some systematic approach was needed to keep the farmer aware of his problems so that the necessary corrective action could be taken.

A basic philosophy in the early days of scouting was for the technical personnel to develop the techniques for scouting which were reliable, train the farmer, and then the farmer could do his own scouting. In fact, it was around this approach that the consulting entomologist profession, which is increasing rapidly in this country, came into being. The operator of a large farm, with more operations to supervise and with the greater complexity of operating farms in recent years, may not have the time to devote to population surveillance of pests in his crops. In this situation, if he recognizes the value of this service, the farmer usually goes to outside help to obtain such service.

Basically, the early strategy was designed primarily to determine when or when not to use a chemical pesticide. Also, during the early days of scouting, economic thresholds were very poorly defined, as they are for many crops at the present time. However, from experience and from the limited amount of research that had been done in this area, producers had general guidelines which they exercised in the initiation of chemical treatments when scouting was used as a part of their effort to control insect pests. To a great extent these guidelines were well on the safe side, and often resulted in use of pesticides in excess of amounts needed for acceptable control. Growers knew from experiences gained prior to the availability of the present highly effective pesticides the damage and severe losses that pests could inflict upon a crop. Therefore, scouting in the past, prior to the initiation of the concerted pest management effort which was begun in 1971, could be considered as a year by year pest surveillance program aimed directly at determining whether or not pesticides were necessary.

The strategy for achieving this objective in previous scouting programs started out primarily by recruiting entomology students and other interested persons for summer employment. The scouts were under the supervision of the extension service, or in many cases, under the supervision of the farmer himself. Most of the early consultants were trained in entomology and their services were almost entirely directed toward insects and insect control. However, in recent years with the advent of herbicides and fungicides as regular production tools in agriculture, it has expanded to the point that many of these consultants or part-time helpers are asked to obtain information which pertains to weed or disease control.

Gradually over the recent years, particularly since the 1950's with the advent of such a great variety of pesticides for use in agriculture, the use of scouts has become more organized and structured. To a great extent, the use of scouts in an area is tied directly to the interest of the local extension agent in furnishing or helping the farmers in the area to obtain such a service. This supplements the extension personnel in achieving their objective because it eliminates the personal service that the extension agent is expected, in many cases, to furnish. Some of the load of this work is shifted to the scouts with the agent using the scouting reports to advise the farmer in his information and education program. Also, in the early days of the development of this activity, some of the States recognized the need for promoting this service for the grower and assigned personnel, usually extension, to assist the farmers in organizing scouting areas and to assist in recruiting personnel to do the scouting.

As the demand or need for this service activity increased, some entomologists began to see the potential for meaningful employment as consultants in this area of furnishing pest control information to the farmer. As the program and need developed, information for herbicide and fungicide recommendations, soil types, need for lime, and various and sundry other decisions that had to do with agricultural chemicals, was necessary. This is what led to the development of the growing pest consultant businesses which have had their greatest success in California and in the midsouth. In California, this success has been in the very highly diversified and high unit value crop production, and in the south almost entirely in cotton, which is an intensively cultivated crop that requires constant attention during the growing season to protect it from pests.

However, prior to the cooperative effort initiated in 1971, the emphasis on scouting or consultant activity was built basically

around the decision of whether or not to use agricultural chemicals. Further, in all cases, the final decision as to the use the farmer made of this consultant information was left to the farmer himself. This is as it should be, since he is the person who has the investment in and the experience in producing his crop on his land. This is even more important when one realizes that economic thresholds, as they are presently developed, cannot be accepted as absolute infallible values, and the level of tolerance of pest populations in a crop will depend upon many factors including production practices, production conditions, the market standards for the crop, and many others.

Short-Term Objective of Existing Scouting Program

The short-term objective of the existing scouting program, other than that sponsored by the cooperative effort which was initiated in 1971, is as mentioned before. This is to furnish the farmer the necessary information on which to base a decision on whether or not to apply a pesticide on his crop as an economical production practice. The short-term objective of the sponsored pest management program is to demonstrate to the farmer the value of a supervised control program upon which he can depend for economic control of his crop pests. It is recognized that this control program is basically one in which the decisions involve whether or not to use pesticides. Our major objective in this area, on a short-term basis, is to convince the farmer that he needs to know what is in his field in order to make rational decisions on the use of pesticides. At the same time, we have begun to bring to the consciousness of the farmer, in these sponsored programs, the fact that there are other strategies which can be used under certain situations which do not necessarily involve pesticides. It is recognized that it is going to be extremely difficult to break the present pesticide use patterns which have developed during the last 25 years. This is primarily because these techniques are very easy to use, they are successful, they are highly effective, and from a practical standpoint, they are the best way for the farmer to control his crop pests with the least amount of effort and time. The investment for pest control, while it is continuing to grow, is still a relatively small percentage of the cost of production of the crops in those situations where you have an intensively produced, high value crop. In situations where a crop with a lower per acre value is produced you will find less pesticide use. However, we firmly believe that there are more pesticides used than is necessary at the present time; and, that we do have some economically feasible alternative control techniques, which are not based upon chemicals,

that will fit into most control programs very well. It is absolutely necessary that we have a pest surveillance activity going on in the field in order to use these new techniques.

With this in mind, the short-term objective, restated, is to educate the farmer as to the value of a population surveillance or a supervised control program as a needed and economically efficient part of his operations. We hope to show them their need for this service so that they begin to use it to the extent that they will offer employment, in the private sector, for people to do this type of consulting work. By this program we hope to reduce the wasteful overuse of pesticides, and build a sound basis for the development of a consultant program or consultant industry which is viable and which will continue to attract qualified people to it.

Long-Term Objective of Past Scouting Programs

With a few exceptions, there was no long-range strategy involved in pest scouting programs of the past prior to initiation of the cooperative effort in 1971. Scouting was primarily a season by season activity which certain growers had learned was of economic value to them. This service allowed them to efficiently control their pest populations so that they could count on making a crop insofar as pest problems were concerned.

Long-Term Objectives of Existing Scouting Programs

The long-term objective, as referred to previously, is to develop a solid, viable, pest consultant enterprise which will attract good sound agricultural pest control specialists to furnish this important service to farmers where it is needed. It is recognized by those involved in pest management that the base upon which any pest management program is built must be a knowledge of the current and potential pest situations in the crop. The only way that we have at present to obtain this information is through scouting or surveillance of the fields in some fashion to get a reading on population levels. These levels may in turn be related to economic threshold levels. Economic thresholds take into consideration production practices, cropping systems, and other factors in crop production. Knowledge of pest population potential and economic thresholds allow a farmer to make a rational decision as to whether or not there is need for some control strategy other than natural control which is always at work in these fields.

However, we do not consider scouting as the ultimate or end activity in pest management. Scouting is considered essential in achieving a true pest management approach in pest control which involves the use of a series of alternate strategies. The scouting information is necessary in order to intelligently use certain chemical and nonchemical controls.

Pest Management Objectives

Short-Term Objective of Total Pest Management Program

The short-term objective of the pest management program is to very broadly demonstrate the feasibility of the concept. This involves a number of requirements and is inclusive of some of the scouting objectives, but goes beyond them in scope. A pest management system is highly technical and requires a much more knowledgeable consultant or scout than the present prophylactic or inseason control type activities with agricultural chemicals. Therefore, demonstration of the need for a sound consulting industry with qualified persons is one of these requirements.

Another requirement is that of demonstration of the worth of the various alternate control strategies. An educational program to inform the farmers of the benefits to be obtained from approaching his pest problems in this manner is essential. This is because, as mentioned, before, so many of our present chemical control strategies are so highly effective and so relatively inexpensive that there is reluctance on the part of the farmer to change his methods when the present system is working. Therefore, it is necessary to develop, through demonstrations, a sound program which will show the farmer in his field that there are alternative controls that will work which also have tremendous value associated with them. In addition to controlling his pests, these control measures protect the environment and extend the longevity of the chemical control agents which must be available for use when required.

Another requirement, that of structuring and developing a multidisciplinary organizational unit for an organized cooperative approach to the various pest control problems, is essential to the implementation of a functional pest management system. This is necessary to prevent the recommendation by one discipline of a pest control measure which will aggravate or intensify pest control problems associated with another discipline.

All of these requirements are being addressed directly by the individual pest management-projects that have been established across the country. These projects were initiated through cooperative agreements among the various Federal and State agencies involved. The agencies and their roles are presented in the following table.

Agency	Role
Animal and Plant Health Inspection Service (APHIS)	With the Extension Service, to jointly provide leadership at the national level. Assist in collection of pest population data, collection and analysis of samples to monitor personal safety, evaluate program efficiency and environmental impact. Compilation and retrieval of all data collected in the projects.
Extension Service (ES)	With APHIS, to jointly provide leadership at the national level. To provide educational informational support to the Cooperative Extension Service.
Cooperative Extension Service (CES)	Provide leadership at the local level. Develop an information and education program aimed at program needs. Make pest control recommendations.
State Agricultural Experiment Stations (In cooperation with the Agricultural Research Service and the Cooperative States Research Service)	Conducts research in support of local projects. Develops alternate control technology.
State Regulatory Agencies	Where appropriate, regulate the proper use of pesticides; promulgate and enforce regulations on cultural practices areawide pest suppression techniques, movement of plant materials, and licensing of pesticide applicators and consultants.

Long-Term Objectives of a Total Pest Management Program

The long-term objective, as stated in the Pest Management Committee Report of April 1971 (see appendix), is, "to achieve pest control based on sound ecological principles which integrate chemical, biological, and other methods into a feasible control program." This was modified in a 1975 APHIS budget justification to read as follows: . . . "the development of areawide pest suppression techniques in which one or more control methods are selected for use in an integrated program using a series of alternatives including parasites and predators, cultural practices, sanitation, resistant varieties, pathogens, and chemicals." This will be accomplished as pest management projects in similar cropping systems receive acceptance and are implemented on an areawide basis. This is of extreme importance because frequently pest problems go beyond the political boundaries of a county or a State and require an areawide approach to their solution.

Another area of importance involves the development and use of predictive and action models. In the development of pest models it is necessary to collect, in a systematic fashion, data on pest populations, weather conditions, production practices, and so forth, which can be used in developing the models for use in predicting the likelihood of pest outbreaks. Scouting information, collected with the proper degree of standardization, can be used for this purpose. In addition, standardization of scouting procedures is needed so that data on pest conditions can be used by the information and education agencies from one State to another in educating farmers as to the likelihood of the problems that they may face.

The scouting activity is absolutely essential to the intelligent use of selective pest control strategies when a pest situation is such that the best approach for control is an areawide population suppression program. In this context, not only is information and education necessary, but the necessary regulatory measures to require and achieve the proper level of participation by all producers in an area is absolutely essential. The scouting activity, hopefully handled by consulting entomologists in cooperation with the information and education agency and the regulatory agencies, could result in an organized and highly efficient approach to our pest control problems. This approach would utilize a variety of pest control strategies to achieve the most economic pest control, insure economic production of the crop, and insure maximum protection of the environment.

While many of the projects are concerned with only one discipline, entomology, a number are becoming multidisciplinary and there is evidence of recognition of the need for this type of an approach in all projects. A coordinated approach involving consulting entomologists, information and education agencies, and regulatory agencies can best be achieved through an organized cooperative effort by these groups at the local level. Inputs from grower organizations will be necessary to insure that procedures proposed for use in such an approach are in effect supported and desired by the growers. This is particularly true where regulatory measures would be used to achieve the level of participation by the growers to make the selective strategy employed effective to reach the objective. In effect, this is the organizational approach recommended in initiating the present pest management projects. However, in the course of most of these projects there has been little input from either the consulting entomologist or the regulatory agency in the area. In addition, it is believed that a given public agency should have the prime responsibility in developing and assisting in development of farmer organizations and in the development of control strategies to be used with the grower group, the information-education group, research group, and regulatory group.

C. Mechanics of Implementation

For which crops and States were the programs selected? Why?

As stated in the Pest Management Committee Report of April 1971, (see appendix) . . . "pilot projects should be located on crops in which intensive chemical pest control is presently practiced." The crop that fits this criterion best is cotton. Of the first 22 projects to be initiated, 14 were on cotton.

After selection of the cotton projects, additional projects were selected on the basis of the merits of solicited project proposals. Guidelines for these proposals dated August 28, 1972, are included in the appendix.

The following criteria were used in selecting projects for funding:

1. Severity of pest problem

2. Extent of cooperation with other agencies

3. Pesticide use problem present

4. Pest threshold levels established

5. Research backup for program

6. Nonfederal funding for program

7. Prospects for long-term benefits

8. Prospects for short-term benefits

9. Present use of scouts

10. Size project to be meaningful

Crops, other than cotton, that were considered to be high pesticide users were tobacco, apples, peanuts, sweet corn, citrus, and potatoes. As additional money became available, projects on these commodities were funded.

Research progress in a particular crop is a very important criterion for initiation of a project. The objective in pest management is to implement alternate strategies in the best scheme for achieving economic pest control while preserving the environment. This makes it almost essential that we have alternate methods, which have shown promise on a limited scale in research, to substitute for some of the chemical control that is presently being used. In many cases, this research may not be perfected to a high level. Therefore, it was decided that the best way to demonstrate to ourselves and to the growers that these alternate methods will work was to approach them on a large-scale demonstration basis. This is basically what the cooperative pest management projects do. The idea is that the growers will see the methods in action, see that they are the most efficient methods of pest control, and will adopt them in their production practices. Growers in the vicinity will observe the program and begin to adopt the practices in a gradual spread of the new technology. We recognize that the spread of these practices will be slow because of the difficulty of changing pest control patterns which are presently working and in which the grower has confidence. Also, the necessity of regulatory measures in some cases will be abhorrent to certain people and growers. In many cases, we may not have adequate alternate strategies for control of certain pests and it will still be necessary, until these are developed, to continue, as we have for the last 25 years, the unilateral use of pesticides. The number of failures through use of this approach are increasing. Research to develop new strategies as production practices and cropping systems change will be necessary in order to have a viable up-to-date program.

We have also put many of our projects in areas where scouting is already reasonably well to a highly established activity. The reason for doing this was to proceed beyond the short-term objective of the scouting, which has been mentioned already, and proceed to the next step which is the integration of alternate control strategies into the present control system. Of course, scouting is a necessary part of achieving this objective.

Are certain classes of chemicals more affected than others by scouting activities?

In general, scouting activities have no effect on the class of pesticide used on certain crops. However, data collected by scouts does, in certain rather advanced pest management systems, influence the selection of specific materials within a given class. A case in point would be the selective use of various miticides on apples. Depending on the time of the year and the presence and level of predacious mites, various materials at differing rates may be recommended to lessen the effect on these beneficial species.

However, in most pest control situations the necessary alternate chemicals and expertise for using them in a selective manner has not been developed to the point that the grower has the confidence in approaching his pest control problem in such a highly selective manner. In most cases it will be the cost of the available effective pesticides that will be the determining factor.

The following table illustrates how various materials can be used in a selective manner based on the time of year and the predacious mite situation.

Timing uses of Pesticides for Michigan
Pest Management Project 1972-75 - B.A. Croft

Chemical Formulation	Rate/Acre	Usable prior to June 1	Usable prior to June 10	Usable between June 10 to end of season	Usable after predator prey interaction has occurred
Lime Sulfur	± 8 gal.	x			
Cyprex 65W	∓ 2 lbs.	x	x	x	x
Phygon 50W	∓ 1 lb.	x			
Captan 50W	∓ 8 lbs.	x	x	x	x
Dikar 80W	8 lbs.	x	x		x
Dikar 80W	6 lbs.	x	x	x	x
Wettable Sulfur	∓ 24 lbs.	x			
Parathion 15W	± 8 lbs.	x	x	x	x
Phosphamidon 8 EC	2 pts.	x			x
	1 pt.	x	x		x
Systox 6 EC	1-1/3 pts.	x	x		x
	2/3 pt.	x	x		x
Cygon 2.7 EC	6 pts.	x	x		x
	4 pts.	x	x	x	x
Guthion 50W	∓ 2 lbs.	x	x	x	x
Imidan 50W	∓ 4 lbs.	x	x	x	x
Norestan 25W	2 lbs.	x			
	1 lb.	x	x		x
Acaralate 2 EC	± 6 pts.	x			
Calacron or Fundal SP	∓ 2 lbs.	x			
Gardona 75W	∓ 2-3/4 lbs.	x			
Thiodan 50W	4 lbs.	x	x		x
Thiodan 50W	2 lbs.	x	x	x	x
Sevin 50W	± 4 lbs.				
Diazinon	± 4 lbs.	x	x		x

(2)

Chemical Formulation	Rate/Acre	Usable prior to June 1	Usable prior to June 10	Usable between June 10 to end of season	Usable after predator prey interaction has occurred
Zolone 3 EC	± 4 pts.	x			
Omite 30W	± 5 lbs.	x	x	x	
Kelthane 35W	± 5 lbs.	x			
LeadArsenate	± 8 lbs.	x	x	x	x
Katathane 25W	2 lbs.	x	x		x
25W	1 lb.	x	x	x	x
Plictran 50W	1-1/3 lbs.	x			
Plictran 50W	1/2 lb.	x	x	x	
Superior Oil - Phosphate		x			
Dieldrin		x			
Polyram		x	x	x	x
Difolitan		x			
Tedion 1 EC	4 qts.	x	x		
Lists preferable materials to use after June 10 for pest control		(a) [Guthion Imidan Parathion Lead-Arsenate] (b) [Diazion] (c) [Gardona Zolone Sevin]	(a) [Captan Cyprex Polyram] (b) [Dikar Karathane] (c) [Sulfur]	(a) [Cygon] (b) [Thiodan Phosphami-don Systox]	(a) [Omite Plictran] (b) [TEPP Morestan] (c) [Kelthane Acaralate Fundal Galacron]

a = best if necessary

b = will cause intermediate mortality

c = will almost eliminate predators

What managerial qualifications are needed?

Because of the complex nature of the pest management programs, managerial personnel need the training and perspective which will enable them to put all the required inputs together into a totally unified program. This necessarily includes inputs from a combination of or all of the following disciplines: entomology, agronomy, plant pathology, nematology, meterology, economics, weed science, soil science, biometrics, systems analysis, agricultural engineering, sociology and agricultural business.

It is obvious that few, if any, individuals possess the high level of competence which would be ideally needed in all these fields of work. For this reason, the sponsored pest management program employs the strategy of using multidisciplinary teams of specialists to develop and implement the pilot pest management projects. It is true that many of these projects presently are not multidisciplinary in nature. However, project personnel are continually urged to expand these programs to include the other relevant disciplines as rapidly as possible. A remarkable amount of progress is being made in this area of a multidisciplinary approach as project personnel in the field see the need for this kind of cooperation.

Insofar as the private consultant approach to pest management is concerned, the type of managerial personnel required are generally those who have developed the necessary skills while working in the field or in on-the-job training. The acquisition of these skills has come over a period of many years of experience and the development of mutual respect and confidence between these private consultants and the growers they advise. It can be found that all these consultants have excellent training in one or more of the disciplines involved. From this basic background they have been able, through frequent contacts with research and extension personnel in the related disciplines, to develop the necessary expertise to advise growers on their many pest problems. The need for practical, on-the-job training for any manager, consultant, or otherwise, of a supervised pest control program cannot be overemphasized.

A basic qualification for a managerial position is a Ph. D. or equivalent experience and education in the lead discipline involved in the project. This is not to imply that the obtainment of a Ph. D. degree in any of these disciplines is a necessity. Those who have obtained this level of training are expected to have the necessary basic background which will enable them to rapidly adapt the necessary information in the other disciplines

into a management system. More than an information transfer system is necessary for the management of these programs. In the cases of the managers of the sponsored projects or the consultants, these people are the ones who advise the grower on the basis of the pest population levels detected by the scouting activity. As emphasized earlier, pest management is of sufficient complexity that many growers will not trust themselves to make the necessary control decisions alone, but will request the assistance of specialists in their problem area. This need is presently being filled primarily by research and extension personnel. This need could be (is being to a limited extent) very effectively filled by pest management consultants as this activity and service function grows and the necessary number of personnel are developed.

In addition to the qualifications mentioned above, an academic background or experience in one or more of the supportive disciplines is also helpful. Possibly more important, than even this, is a realization of the complex manner in which factors within the various disciplines interact in a given cropping system. This qualification of broad thinking and interdisciplinary understanding is mastered more through experience on the job rather than in the classroom. To reemphasize this point, living with the problems of pest management on a day to day basis is developing pest management specialists or advisers out of entomologists, plant pathologists, agronomists, etc.

In addition, people involved in this activity must have a feel for production practices of the crops involved and they must develop rapport with the farmer. The farmer is quick to detect indecision on the part of an adviser. When this happens, he loses confidence and the adviser becomes ineffective. It is absolutely necessary that there be a close and intimate exchange of information, discussions, and thoughts with the farmer if the adviser is to be effective. Therefore, he must be able to talk the farmer's language and to present to him, in a lucid and very candid fashion, what his alternatives are, describing the advantages and disadvantages of each to assist the grower in making his decision. In this context, consultants or advisers should be familiar with models, when developed, and how to effectively utilize them as a part of the decision making process.

The support system for the pest management consultant or adviser will consist of the research and extension personnel in the land grant colleges as well as in industry and others with expertise in plant pest control. In many cases the consultants will go directly to the researcher to get the answer to his problems. In

other situations they will go to the extension specialist or the local county agent for this assistance. Most States presently provide yearly training programs designed to update private consultants and growers on new developments in pest control so that they have available the latest information. As the pest management projects progress, more universities are offering training in this area in recognition of the need for on-the-ground, on-the-job training. In many cases universities are giving cotton scouts and other project personnel academic credit for their work experience.

Are people with this training available?

Very few people with the necessary training are available to enter into the pest consultant business and satisfy the needs of the farmer in this area. Those that are available started with the basic principles from their college training and then further developed their training at the practical field level. We are convinced that there is no way to turn out seasoned agricultural consultants from a university. What people get in the universities are the basic principles. An additional intern program under the possible sponsorship of the university could involve on-the-job or infield training so that interns could develop a feel for the requirements out in the field. Concern over this problem of training prompted a workshop for "the development of the educational concepts for a integrated approach to economically and ecologically sound pest management and plant protection." This workshop addressed itself very well to this problem area. A report of this meeting is enclosed in the appendix. In an attempt to provide the proper mix of academic training and work experience, a number of universities have initiated advanced degree programs in pest management. Virginia Polytechnic Institute, North Carolina State University, and the University of California, are a few of the universities with such a program.

It must be emphasized that consulting will never be cut and dried, where you compare a column of figures of pest populations against a column of figures for economic thresholds. There is need for a certain amount of judgment and a certain amount of rationalization involving production practices, grower preferences, weather conditions, and many other factors. Making pest control decisions is more of an art than a science. No two crop fields will be the same. Each field will require individual consideration and a decision as to its requirements. There is no way that the necessary training, such as an internship, for doing this properly can be obtained without a close and intimate knowledge of farming practices in the area as they relate to the pest populations.

How are scouts selected?

Scout selections are usually made in one of the following ways:

1. By pest management project personnel
2. By members of a grower organization
3. By local county agents
4. By combinations of 1, 2, and 3 above
5. By private consultants.

The criteria for selection of scouts varies considerably from project to project depending on the crop or crops involved, the intensity of the pest problem, and the availability of labor in a given location. Scouts are usually of high school or college age and are selected because of their interest, background, or education in entomology, or some other ag-related field. Others are selected who do not meet these criteria, but who are interested in this type of work and exhibit a responsible attitude towards it.

What training do they receive?

The type and amount of training varies from program to program depending on the background of the scouts and the kind of scouting program being conducted. A formal 3-day school is common among the cotton projects while others provide as little as 1/2 day. The scouts are briefed in some or all of the following areas:

1. Pest identification
2. Insect behavior and life history
3. Sampling techniques
4. Recordkeeping
5. Economic thresholds
6. Pesticide safety
7. Public relations.

Actually, formal training for a scout to do the job of collecting information in the field can be rather limited. It does not require a long training period to acquaint the scout with the major pests and the damage that they do and to teach him to record the necessary data on a prepared form. However, the best way to train a scout is to give him some basic information on the points just mentioned and then make training a continuing on-the-job activity between the scout supervisor and the scout. This continual practice of season long, on-the-job training is an important part of most sponsored projects.

It is also important that scout supervisors have frequent contact with the scout and do some scouting behind him to verify that he is collecting the data properly. The supervisor should also explain to him all of the many variables that occur in the course of evaluating a pest population. If the scout is not receptive to this information and shows little interest, the odds are that a bad selection was made and another person should be selected. If he has interest, he will pick up the scouting rapidly and can within a very short period of time be very reliable.

Under actual conditions of the sponsored projects it is evident that a great number of the growers themselves do some spot checking behind the scouts. This is apparently done to satisfy themselves that the data obtained are accurate. This is considered to be an excellent practice on the part of the grower and shows he is truly interested in this service rather than just relying on the scout supervisor or project leader to give him a control recommendation without verifying it for himself.

As mentioned earlier, in the history of scouting activities, scouting originally started as a practice which the grower could be instructed in and use. However, while many growers are capable of doing this scouting, other management practices are so pressing that they do not have the time. In cases where time is available, counsel from pest control specialists is usually requested by the grower.

Examples of some of the material covered in the formal training sessions from the pepper and lettuce project in Delaware and the cotton project in Arizona are included in the appendix.

Have enough people been available?

Generally, an adequate number of people have been available to fill scouting positions. If there has been any problem, it has been during the first year of a project. In the second year of

the cotton project in Mississippi (1973), twice as many people applied for scouting positions as there were positions available (32 applicants for 16 positions). In Arkansas (cotton) where 150 or more scouts may be hired each year, scout recruitment has become a year-around job and no cotton has gone unscouted due to a lack of scouts.

The most difficult problem in obtaining scouts, since most scouts are students, has been for those crops where surveillance activity is needed before summer vacation or after school starts in the fall. This has required that some of the areas rely heavily on their scout supervisors during this period. Others have been able to hire scouts on a part-time basis, such as after school lets out in the afternoon or on weekends. In a few cases scouts are permanent people who work the year-round. Naturally, the best approach to this would be to let a well-developed consultant industry be responsible for finding the labor to do the scouting. However, it is realized that this will not be possible at all times and some provisions must be made for attracting the necessary labor. Consultants presently use the same source of labor for scouting as the sponsored pest management projects.

The ideal situation would be to develop the consulting industry to the point that it becomes a year-round service. One of the most common deterrents to qualified scientists entering the field is that it is now basically a 3 to 4 month operation during the summer. However, the most successful consultants have worked variations into their activity such as soil sampling, farm mapping, structural pest control, and other activities and have made it a highly successful year-round operation. From the long-range standpoint we should think in terms of ultimately having technical people make this a year-round enterprise.

Is there any consideration given to personal safety?

Personal safety has been of prime importance since the beginning of the cooperative pest management programs. A set of guidelines was developed for use in setting up projects and training personnel in pesticide safety. In addition to pesticide safety, these guidelines also cover monitoring of cholinesterase activity (included in appendix).

The following is excerpted from the 1973 Mississippi Annual Report and illustrates our concern in this area:

> "Several precautionary measures were taken against insecticide poisoning of scouts. Blood samples were taken four times during the 1973 season (two preexposure samples and

> two postexposure samples) to monitor acetylcholinesterase levels of each scout . . . Each hospital in the pest management area and surrounding counties were notified of the scouting program and requested to maintain sufficient levels of antidote in the event of accidental poisoning. Each scout was encouraged to wear protective clothing and to carry a card containing emergency instructions and information on poison control centers in the States. Scouts were warned not to enter a field within 24 hours of an insecticide application."

An additional safety precaution has been the use of scouts in pairs.

What data are collected?

The data collected in the pest management programs fit into four general categories. They are:

1. Insect, disease, weed, and nematode information (beneficial as well as pest species).

2. Chemical usage (insecticide, defoliant, fungicide, nematicide, herbicides, or other growth regulators).

3. Cultural and phenological information (including nonpest related crop damage).

4. Identification and background information.

What is the frequency of collection? Why?

Category 1 information is collected for the very obvious reason that to make rational pest control decisions, a grower must know the population level of pest species present in his crops. The frequency of collection of this data depends on the crop, and how quickly or under what conditions the pest species reproduce.. Annual or semiannual sampling for nematodes is considered adequate whereas sampling twice a week to pinpoint critical greenbug situations in sorghum is necessary. Most situations involving insects and diseases require at least weekly collection of data while sampling of weeds and nematodes is sufficient if done twice a year.

With respect to the grower making his immediate pest control decisions, the above information is basically all he needs. However, if long-range management of his pest problems is what a grower is after, then the following information is also important.

Chemical use data, category 2, is collected on a regular basis as it occurs, usually once every week or two. This has proven to be the most difficult data to collect. Experience has shown that many growers in our pest management projects keep very poor pesticide use records, or for one reason or another will not reveal this information. In some areas, commercial concerns handle most pesticide applications, and in these cases, good records are available and are used. Along with documentation of the type of chemical used, the application date is important since its comparison with pest population levels gives information on efficacy.

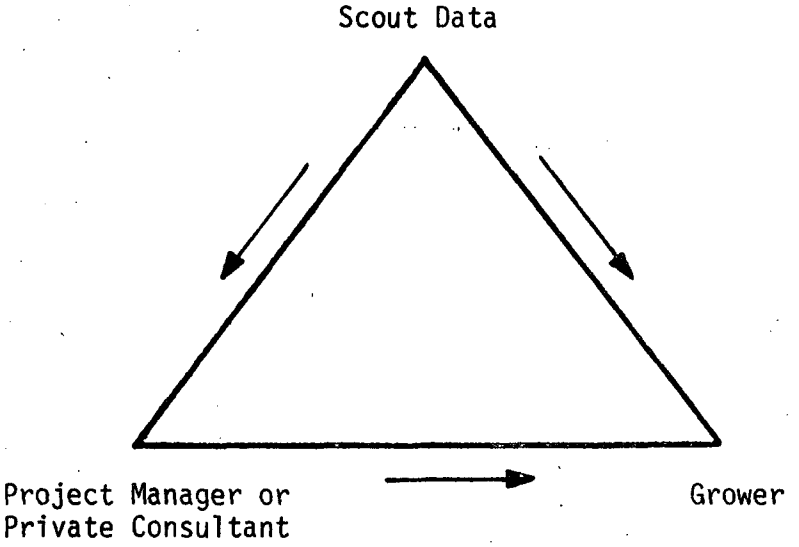
Data from category 3, cultural and phenological, are collected as they occur and include things such as plant growth stages, fruiting levels, and activities on target or adjacent crops which might directly or indirectly affect pest insect situations. Examples of these activities would be cutting an adjacent alfalfa field or irrigation of the target crop.

Category 4 information is mainly collected on a once a year basis and includes grower and field identification, plant variety, row pattern, plant density, yield data, and the like. Category 3 and 4 data are collected to aid in defining some of the situations that arise, both locally and areawide. They can also be used in measuring the impact of certain farm practices and pesticide use patterns on pest problems.

The National Data Format as developed for the cotton projects is included in the appendix. Provisions were made for the collection of data covering most aspects of crop production. In many cases, because of disagreement between APHIS and ES, there has been a lack of attention to certain aspects of this information. While this has not adversely affected the short-term objective of scouting, it will have a decidedly deleterious affect upon the long-term objectives of using these data to work out the relationships between such things as genetic differences, adjacent crops, adjacent ground cover, production practices, and the many other factors which have a bearing on pest populations. It is hoped that in the future we will, in these sponsored programs, collect the data which will be needed to assist in the development of action and predictive models. It is further recognized that, in most cases, all data being collected are not necessary to make an immediate decision on whether or not to use chemicals. However, if we are truly going to develop a pest management approach in which the many interactions of crop production are considered, we must know the relationship between all the various production practices and our pest population outbreaks in order to take the proper corrective action.

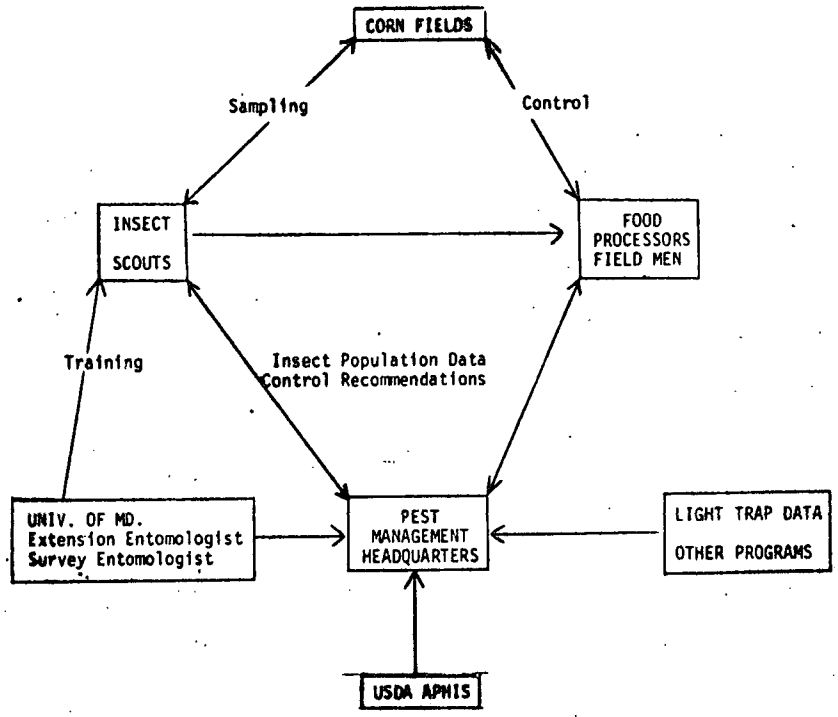
<u>After the scouts collect the raw data, what is the decisionmaking process used by managers to make recommendations?</u>

The decisionmaking process can best be explained through the use of simple flow diagrams. The following data flow diagram is generalized and varies slightly from project to project.

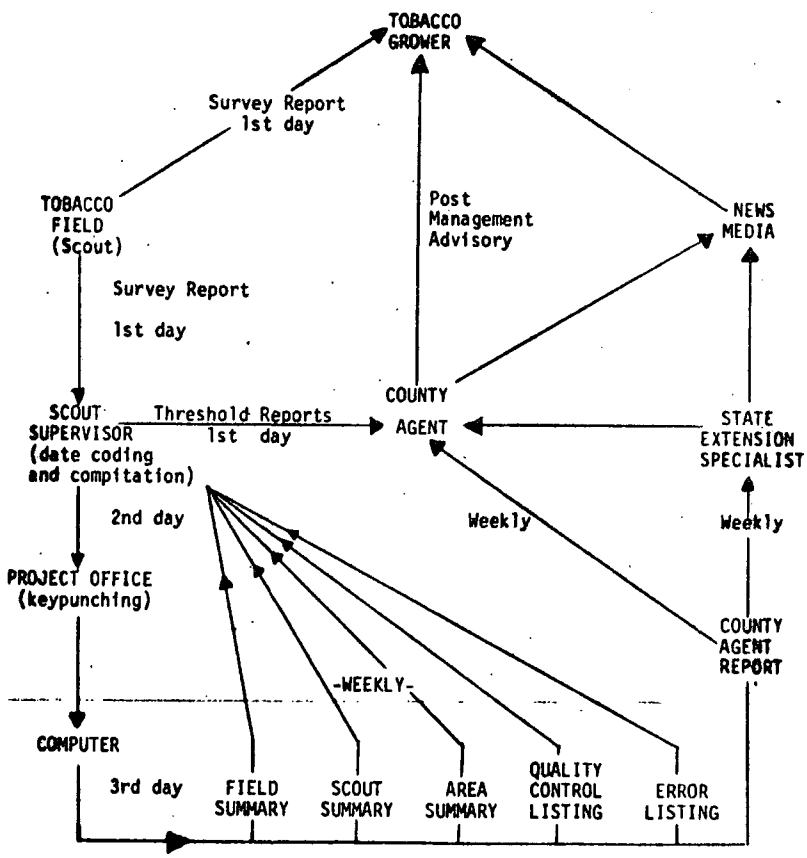


Basically, portions of the raw scouting data relating to economic thresholds of pests are given directly to the cooperating grower in the form of a grower report. By comparing this information to established economic thresholds, the grower can make his own decision to treat or not treat. A complete set of data goes to project managers where, in the absence of firm economic thresholds, treatment recommendations can be formulated and conveyed to growers.

Following are the data flow diagrams for the sweet corn project in Maryland and that for the tobacco project in North Carolina.

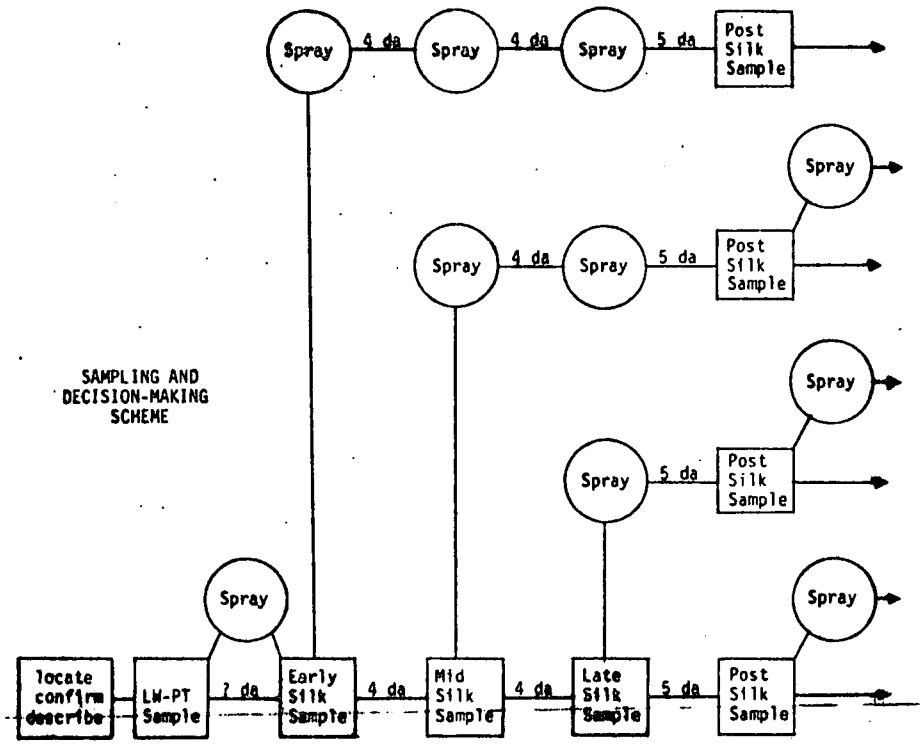


MARYLAND DATA FLOW



NORTH CAROLINA DATA FLOW

A decisionmaking scheme utilized by managers in the Maryland sweet corn project is one of the few that has been documented.



MARYLAND SAMPLING AND DECISION-MAKING SCHEME

Pest management decisions at each sampling step in this scheme are based on the following action thresholds:

1. 15 egg masses of the European corn borer per 50 plants after the late whorl stage.

2. 5-10 percent of the silks with corn earworm eggs with at least 10-20 per 100 silks.

3. 5-10 percent of the silks with dusky sap beetle eggs with at least 10 to 20 eggs per 100 silks.

4. 25 percent of the silks with Japanese beetles which only applies to the early to midsilking period.

5. 5-10 percent of the silks with fall armyworm larvae. (Above excerpted from 1972 Maryland annual report).

This illustrates the complexity of this type of decision where five different insect species are involved. Similar schemes are used in other projects. Schemes for making other control decisions (nematode, diseases or weeds) or production decisions must be superimposed upon each other to come up with the best overall answer to any given set of circumstances.

Do the scouting programs consider climate, genetic differences, and/or adjacent crop interactions?

Factors such as climate, genetic difference, and adjacent crops are but a few of the diverse considerations in setting up the scouting activities of a pest management program. The reason for consideration of these factors is the relationship they have with the pest problems in a given cropping system.

Climate, more specifically, weather, is the driving force behind many pest and disease problems. Dry weather promotes buildups of spider mites in grain sorghum and the lesser corn stalk borer in peanuts. Wet weather can initiate scab and other disease outbreaks in apples and other crops. Temperature and humidity, or moisture, also influence the effectiveness of pesticides. For these reasons, many of the sponsored projects rely heavily on weather data to guide their scouting and control programs.

Genetics is of prime importance when one considers the narrow genetic base of many hybrid crops being grown today. The southern corn blight outbreak of a few years ago emphasized this when the entire U. S. corn crop was seriously threatened because of the heavy reliance upon blight susceptible germ plasm in our hybrid corn breeding program. The importance of using plant varieties genetically resistant to various pests and diseases is well known.

Data on crop variety is being collected in all the pest management projects and is of particular importance in the fruit projects where varietal susceptibility to various diseases is important in guiding control programs. Certain varieties of sweet corn are also more susceptible to corn earworm damage. As agronomists and plant pathologists become more involved in these programs, genetics is receiving more and more consideration.

The importance of adjacent crop interactions has been recognized for some time and data on this have been collected since the initiation of the cooperative pest management programs in 1971. Harvest of adjacent safflower or alfalfa fields is known to present a potential threat to Arizona and California cotton fields from lygus bugs. Maturation of corn crops planted next to cotton can be responsible for increased levels of bollworm damage in the cotton. Chemical control activities in an adjacent field or crop could have disastrous effects on beneficial insect populations in another crop.

Factors, such as a dirt road next to an orchard, can have a tremendous effect on the pest situation because of the adverse effect of dust on host acceptance by beneficial insects. Other suspected interactions of this type are mentioned in a report on "Data Evaluation" by Ganyard and Worley, which is included in the appendix.

Are the environmental impacts assessed? How?

Scouting programs, per se, do not usually assess environmental impact. However, this is being done in all of the cooperative pest management programs. Data are being collected that will allow assessment in the following ways:

1. Documentation of pesticide use to enable assessment of possible shifts in pesticide use patterns and the impact on the environment.

2. Collection and analysis of environmental samples (soil and small rodents) for pesticide residue and environmental impact data.

3. Monitoring of cholinesterase activity levels of all scouts and certain supervisory personnel.

In the assessment of changes in pesticide use patterns, we have seen a shift away from "calendar" approaches of pesticide (insecticides in particular) applications to treatment based on need. This is documented in the Mississippi Cotton Project Annual Report for 1972 where they state . . . "Cooperators sprayed only 72 percent of the potential spray acreage as compared to 94 percent of the potential spray acreage by noncooperators." In the Arizona cotton project, 57 percent of the growers in 1972 treated on the basis of need. In 1973 the percentage of growers treating on the basis of need increased to 78 percent. In situations, cotton production for example, where overuse of insecticides is common, the above response means less insecticide is being put in the environment.

With the loss of persistent insecticides, such as DDT and dieldrin, new nonpersistent materials are being used and monitored to assess their impact. Initially, numerous environmental components were being sampled and analyzed for residues of these materials. These environmental components included fish, birds, frogs, turtles, lizards, beetles, small rodents, water, crop residues, and soil. The main objective was to collect sufficient data to determine if a detectable trend existed in the pesticide load within the environment inside project areas, as compared with areas outside the project. The cost of monitoring all these components was prohibitive and it was decided to limit the monitoring of the pest management projects to two major components--soil and one biological organism.

Information gathered to date indicates no appreciable difference in pesticide load in the environment between areas inside the project areas and those outside. There are two possible reasons for this. First of all, the nonpersistent chemicals being used may not persist long enough to be picked up by the sampling plan being used. Secondly, the slight differences resulting from pesticide use that have occurred to date in the two areas may not be detectable. Nevertheless, no environmental problems have been identified to date through the use of the present monitoring scheme.

Another important area of assessment is that of monitoring scouts' exposure to pesticides by checking cholinesterase activity levels. Overexposure to organophosphates, the major class of pesticides being used in the pest management programs, brings about depressed levels of cholinesterase activity which can be detected through chemical tests. Throughout the 1972 and 1973 crop years in the cotton projects, approximately 583 pest management scouts had their cholinesterase activity levels monitored. No medically significant depressions in activity levels were found (medically significant, in this instance, refers to a depression of 50 percent from base line or more). This appears to support the soundness of the recommended reentry intervals established in these programs.

D. Resource Implications (Cost of Programs)

How many scouts were required in programs to date? Is the number of scouts determined on the basis of acreage, number of farms or some other factor?

In the 3 years that the cooperative pest management programs have been underway, somewhere between 800 and 1,000 scouts have been

employed. Approximately 400 scouts per year have been utilized in cotton projects alone.

The number of scouts necessary for a given project is determined mainly on the basis of acreage to be scouted. Scouts can handle from between 200-225 acres per man in tobacco to as many as 2,500-3,000 acres in field or sweet corn. By knowing the acre/scout ratio for a specific crop and the acreage to be scouted, the number of scouts necessary for the project is reduced to a problem of division.

A number of different factors do go into deciding how many acres a scout can effectively cover. Average field size is an important factor, since in many cases, as much time is required to collect data from a 4-acre field as is needed for a 20 to 40-acre field. The small average size of the fields in the North Carolina tobacco project is the main reason for their low acre/scout ratio.

The intensity of the scouting is another factor to be considered. The acre/scout ratio (ca. 435A) in the Texas peanut project can be accounted for by the fact that a scout must pull 100 plants per field to check for soil borne pests. In addition to checking for these soil borne pests, the plants are examined for foilage feeders and plant diseases. This requires 2 to 4 hours per field. By contrast, approximately 1 hour is required to scout the average cotton field.

The last important consideration is that of field density within a given area. It stands to reason that a scout traveling less than 2 miles between fields can cover more fields in a given period of time than one traveling 5 to 6 miles.

The following information on scout workloads, excerpted from Womack's cotton project evaluation (see appendix), illustrates the range and variation in workloads among the cotton projects in 1972.

State	Acres per scout	Fields per scout
North Carolina	807	79
South Carolina	1031	52
Georgia	1407	64
Tennessee	335	55
Alabama	1436	55
Mississippi	1000	68
Arkansas	1365	38
Louisiana	933	38
Missouri	1655	46
Oklahoma	1306	37
Texas	1692	43
New Mexico	906	50
Arizona	1000	32
California	986	20

How and by whom are the scouts paid? Is the basis for pay an hourly rate, acreage, or some other factor?

Scout pay is handled in a number of different ways. Initially, in practically all of the projects, scout salaries were paid from the cooperative project funds handled by the State cooperative extension service (CES). To some extent this is still being done today, but as growers are assuming the responsibility of scout salaries, new ways of handling this are developing.

There are very few instances of a scout being paid directly by a grower. In situations where private consultants use scouts or field checkers, as they are sometimes called, the consultant collects his fee from the grower and pays his scouts accordingly. This system is used in Mississippi. In other areas of the Cotton Belt, North Carolina and Arizona for instance, grower organizations hire their own scouts. The grower group assesses each member a fee on the basis of the acres scouted. The scouts are paid by the organization from these funds, usually on a weekly basis.

In other areas local business concerns, such as gins or farmer cooperatives, are handling funds for paying scouts. In west-central Oklahoma in 1973, one group of participating growers paid one-half the cost for a scouting program and the local cotton gin paid the other half. The scouts in this case were trained and supervised by CES. On the eastern shore of Maryland, vegetable

processors are hiring and paying CES trained and supervised scouts. There is no limit to the number of ways that scout pay can be handled.

Generally, scouts in the pest management projects are paid on a weekly basis. In most cases, they are assigned a given number of fields to survey on a given schedule, the schedule usually being once a week. For this he receives a set amount which in some projects, South Carolina for example, starts at $75 per week for a "first-year" scout. Scouts who furnish their own transportation (the rule rather than exception) are paid 7-12 cents per mile in addition to their salary. The Michigan apple project in 1972 started its scouts at $115.50 per week and furnished travel expenses and meals. Although it varies, a week generally means 5 workdays but ranges from 4 to 7.

Scouts are also paid on a daily, hourly, or acreage basis. The Maryland vegetable project starts its scouts off at $25 per day plus 10 cents per mile for transportation. The Delaware vegetable project pays its scouts $2.65 per hour plus 10 cents per mile. A variation based on acreage is the Tennessee cotton project where scouts are paid $1.50 per acre for the season and average 1,200 acres per person. This includes all expenses.

Another variation, based upon acreage and a guarantee, is a system being tried this year in one area of North Carolina on cotton. The scouts are paid $1.50 per survey on a field basis with a guarantee of $165 per week. This is somewhat more complicated than the other pay systems, but is is felt that it will provide an incentive not present in the pay schemes already mentioned since the opportunity to gross in excess of $200 per week exists.

Some projects provide a bonus at the end of the season to encour age scouts to finish out the season, or to reward a job well done.

Is there a large turnover in scout personnel? What factors seem to cause turnover? What are the cost implications?

A high rate of scout turnover has been encountered in a number of the pest management projects. Not only has the turnover rate from year to year been high in some cases, but inseason turnover has also been high. Arizona had 25 percent of their 1971 scouts return in 1972, but only about 10 percent of the 1972 scouts returned in 1973. In 1973 their inseason turnover approached 50 percent. Louisiana project personnel have also experienced a high rate of turnover, 67 percent for 1974, from season to season.

For reasons not readily discerned, there are also a number of projects that have no appreciable problem with scout turnover. The apple project in Michigan has six out of seven scouts returning for 1974. About 70 percent of Maryland's 1973 scouts are returning for 1974.

It is easy to hypothesize why some projects have high rates of scout turnover, but an indepth study would be necessary to confirm any of these reasons. Briefly, some possible reasons for high turnover are:

1. The temporary nature of the job.

2. The fact that in many cases the work is physically very demanding.

3. The low skill/knowledge level necessary for some scouting positions.

4. Summer vacation schedules for students do not coincide with scouting periods in many cases.

The converse of some of these reasons may be why turnover is low in some of the projects.

A high rate of scout turnover is preferred by some project managers. One in particular has stated that, "it's easy to keep them interested for 1 year. After that first year the fact that scouting is physically hard work becomes more of a factor and scouts will try to think up ways to outsmart you to get out of work." This statement surely deserves some consideration.

Generally speaking, if people are available, cost implications are negligible since it requires a very short training period, and little in the way of preparation for a scout to perform the duties required in our pest management efforts.

<u>What are the managerial costs of programs done to date? Who has paid for the programs?</u>

The managerial costs to date in the cooperative pest management programs have been as high as 50 percent of the allocated funds or more. Funds allocated for 1972 and 1973 were approximately $2.5 million and $3.5 million respectively. These managerial costs, in the sponsored programs, have been higher than would be required in an ongoing pest consultant type operation. The reason for this is the fact that we are collecting a vast amount of related data to arrive at some clear understanding of those many subtle

interactions between various production practices and pest populations. This has naturally caused the cost of these projects to be higher than an ongoing consultant type operation, but the added costs are necessary in terms of investment in the future of pest management.

Initially, this managerial input is being funded through Federal grants, or cooperative agreements, but as projects develop, more and more of this Federal support is being replaced by funds from the private sector. Tables 8 and 9 of Womack's cotton project evaluation (see appendix) contain detailed information on managerial costs and who has paid for the program.

What are the costs of evaluating the environmental impact of the program?

The environmental monitoring being done to assess the impact of the pest management programs, even in the limited sense that it is being done, is by no means inexpensive. APHIS has estimated that an average sample costs $100 to collect, ship, and analyze. Under the APHIS guidelines (see appendix), the cost per project would be $10,000 per year. At the present project level this amounts to approximately $400,000 per year.

E. Effectiveness

Were objectives of the program achieved?

In general, the short-term objectives of the program have been achieved. The programs have almost invariably met with approval by the grower and that is the criterion by which to measure the effectiveness. The growers have continued to participate and they have put greater amounts of funds into the programs each year as they see the value of the program demonstrated. The long-term objectives of developing and integrating alternate pest control strategies into the pest control system have not been achieved to a great extent at the present time. It will be necessary to have a considerable period of followthrough on the present programs in order to achieve areawide suppression techniques with the necessary accompanying education, information, and regulatory action to insure that these alternate techniques will be used effectively and in the most economical fashion. At the present time, all that has been achieved is some degree of expansion of the scouting activity aimed at making the decision of whether or not to use chemicals. We like to emphasize the fact that our job is not finished until we show the need for and see the actual use of alternate approaches with a minimal use of chemicals.

An Economic Research Service (ERS) evaluation (by Womack) of the cotton projects for 1972 is included in the appendix. The main conclusion drawn from this evaluation is that, "the available evidence is inadequate to draw any conclusions about the cotton pest management program's effects upon economic efficiency or environmental quality in 1972."

What was the level of social acceptance to these programs?

Social acceptance of the pest management programs has been very high. People, in general, tend to relate very positively to programs that offer relief from environmental contamination and especially when there is no reduction in the standard of quality of living. Pest management is that kind of program. We should add, however, that our measurement in this respect is partially related to the producer himself who is actively using the program. It would be desirable to get a better measure of the acceptance of the nonfarming public for this activity.

There is no doubt that our approach is being accepted by the general public. However, it is presently felt that the general public has little feel for what is actually being accomplished. Support by the general public would be a valuable asset in achieving our objectives in pest management. Some attention should be given to this, not only from the standpoint of getting the information out, but to measure acceptance. The information that has gone out on this program do date has been largely directed at rural populations. We should also get this information to the urban populations.

Was per acre pesticide use reduced? Why?

Insecticide use has been reduced in all but a few of the cooperative pest management projects. Examples of a few projects where this has been documented are:

North Carolina--tobacco

The average number of insecticide applications in 1971 was 2.4 per field as opposed to 1.57 and 1.9 in 1972 and 1973, respectively.

Delaware--peppers

The pre-1972 average of 11 insecticide applications per field was reduced to eight in 1972 and five in 1973.

Michigan--apples

Acaracide applications were reduced from two to three in 1972 to one or none in 1972.

Mississippi--cotton

In 1972, cooperators averaged 2.8 fewer applications of insecticides per acre than noncooperators. Producers who strictly adhered to pest management recommendations in 1973 made an average of 2.3 fewer applications of insecticide than those who did not. Cotton yields per acre have been maintained or improved, while insecticide use has been reduced from 35 to 50 percent.

Arizona--cotton

The average number of insecticide treatments went from 8.7 in 1972 to about 6.0 in 1973 amounting to a reduction of approximately 81,000 acre treatments.

Although a majority of the projects are experiencing reductions in the use of insecticides, the alfalfa project in Indiana is recommending an increase in pesticide use. The reason for this is that alfalfa and other forage crops in Indiana have been historically undermanaged. The judicious use of highly effective, yet relatively safe insecticides, such as malathion and methoxychlor along with specific herbicides, has the potential of increasing alfalfa forage yield 2.5 and 3 times. This project provides a unique opportunity to demonstrate maximizing yield through the selective use of pesticides without accompanying environmental degradation.

The reason, in most cases, that reductions in insecticide use have been possible is that they have been overused in the past. Treatments were made on a calendar basis rather than as needed which in many situations resulted in overuse. By knowing what pest species are present and the level of their presence, treatment may be withheld in instances where pests are not present or are below economic thresholds. This is the area where reduction in pesticide use become possible. Most reductions result from withholding early season applications until the presence of a pest species is confirmed or when an economic threshold is reached.

What has been the effect on crop yields?

The effect of pest management on crop yields has not been objectively assessed in very many cases. Two projects, where attempts at yield assessment have been made are the cotton projects in

North Carolina and Arizona (complete reports in appendix). Following are yield breakdowns for 2 years in Arizona.

Pounds Lint Yield/Acre

	County Average	Project Average
1971	919	1,139
1972	1,052	1,069
Both years	986	1,104

The 1973 yield study in North Carolina came up with the following information.

Estimated Average Lint Yield Per Acre

	Pest Management Group	Neighboring Fields
Northampton Co.	541	476
Halifax Co.	690	479
Edgecombe Co.	639	401

Subjective reports on yield from other projects have indicated that project yields have been comparable to countrywide averages.

Did the programs affect subsequent grower management practices? Why or why not?

There is no question that pest management programs are bringing about changes in grower management practices. The reduction in pesticide use already mentioned is proof of this since it has come about as a result of a change in grower pesticide use patterns. A specific example of this is the treatment of bloom infestations of pink bollworms in Arizona cotton. "In 1971, it was a common practice to begin treatments when pink bollworms first appeared in the blooms. Not only was this practice useless, in terms of pink bollworm control, but it was often responsible for initiating outbreaks of bollworms . . . . timely newsletter and followup action by program supervisors almost eliminated the bloom treatment practice in 1972."

Changes also took place in the New Jersey sweet corn project as evidenced by the following statement from their 1973 annual report. "After the 1972 season and during the 1973 season many cooperating growers realized they were applying more sprays than necessary to maintain their quality standards. Therefore, the pest population monitoring information was not only used for pest management blocks, but was also applied to nonproject sweet corn acreage. . . Statewide an average of two sprays was eliminated because monitoring pest populations showed they were unnecessary." This indicates a definite shift in grower insecticide use patterns.

There are projects where no changes in grower management practices have taken place to date. This is understandable since a majority of these projects are still in the pilot phase of development.

What was the environmental impact of these programs? Were the sampling programs adequate?

On the basis of what has already been said about the reduction in pesticide use in these programs, it can be said that the environmental impact has been of a positive nature. Overall, less pesticide chemicals are going into the environment.

Results to date on the residue analysis of the environmental samples that have been collected, while not complete, indicate no problems.

As to the adequacy of the sampling program, in terms of the objectives set up for this part of the pest management programs, it is serving its purpose. Statistically and biologically the sampling plan as a whole leaves much to be desired. If environmental sampling is to be part of these programs after the pilot phases, then a different sampling program needs to be developed.

One thing to keep in mind in developing and implementing a good environmental sampling program is that the soundest program in the world will not be used unless total project funds are sufficient. If left to choice, the monitoring usually receives a low priority behind other program activities. This can be supported by the fact that in 1973 only 19 of the 39 pest management projects submitted environmental monitoring samples for analysis. Two States, Alabama and Washington, are conducting their own sampling programs.

III

FUTURE

A. Constraints

Can existing pest management programs for particular crops be applied to all other areas of the United States where those crops are grown? How and why?

In a broad sense, pest management principles can be applied to any cropping system in the United States. Pest management programs, per se and in toto, on a given crop cannot be applied across the board. An example of this is pest management in apples. The basic pest management principles behind the apple projects in the States of Washington and Pennsylvania are the same. However, the pest management program on apples in Pennsylvania cannot be applied in Washington.

The reasons a given program cannot be applied across the country are that the pest situations and the way they are effectively handled, as well as production practices, differ greatly from one area of the country to another. In some cases, differences even occur within a given State. Different pest complexes operate in different parts of given crop ranges. The key pest in cotton in Arizona is the pink bollworm, whereas in the southeastern cotton-growing areas it is the boll weevil. Even though the basic principles involved in approaching the pest problems are the same, the execution of the programs to accomplish pest management must be tailored to fit local situations and philosophies.

Scouting, as developed in the cotton projects, is not the answer to all pest control problems. Technologies are now being developed in some areas of pest management that will make it possible for control decisions to be made without a scout even setting foot in the crop. The technologies involve remote sensing, computer modeling and pest forecasting.

What is the anticipated level of public acceptance? Why? What institutional modifications such as incentives and educational programs appear to be necessary to achieve public acceptance and program implementation?

As mentioned earlier in this report, the anticipated level of public acceptance is very high. Pest management addresses itself directly to the present public concern on the issues of environmental contamination and the misuse and overuse of pesticides and other agricultural chemicals. In this time of worldwide food and energy shortages, high prices and inflation, pest management offers growers an opportunity to improve their economic position. This is done by lowering their production costs through efficient

use of available resources. This is in line with the public's best interest.

Evidence of public support has come to light in Arizona where an "environmental group" has expressed an interest in identifying with and actively supporting the pest management effort in that State.

It is not expected that institutional modifications would have much effect on public acceptance, but there is no doubt that certain modifications would have a beneficial effect on program implementation. Initially, many of the pest management programs exhibited a lopsided, single disciplined approach to pest management, that of the entomologists. There is no intent meant to fault this dedicated group of individuals who got these programs organized and running, but even now some of the programs continue to be insect oriented to the extent that pests of other types are not even given comparable consideration. In some projects it has taken 3 to 4 years for inputs from other disciplines, such as phytopathology or agronomy, to receive consideration on a level comparable to that of entomology. In limited cases where these other disciplines were represented by project leadership, these disciplines received biased emphasis.

Changes in the way the programs are organized and executed at the local level could bring about some real changes in this area. Appointment of coordinators above the departmental or disciplinary level would provide a better opportunity for development of program with appropriate disciplinary balance. This in turn would have the ptoential for increasing program efficiency and in the long run, possibly increase public acceptance.

The Ph. D. thesis, by Wayne Willey, included in the appendix of this report, contains valuable information on the dissemination of pest management information that may be of some use in future program implementation.

How many scouts will be needed and are they available?

There is no way to realistically estimate how many scouts might be required in pest management programs across the United States. Assuming these projects will continue to expand at a reasonable rate throughout the various cropping systems, there is no reason to doubt that a sufficient number of scouts will be available. Arkansas, a State using over 150 scouts each year, continues to meet its need for this type of personnel each year.

We do expect to see evolution in the techniques used to gather the information necessary to realistically estimate or predict pest populations. The product of this evolution may not involve intensive use of visual examination of plants. It is entirely possible that remote sensing techniques will fill this need in certain types of crops. There are many developments which may occur through research, which will eliminate the need for large numbers of people walking the fields. Also, as the consulting industry develops, we expect to see more efficient use of highly refined techniques in population assessment which will eliminate the need for the large number of people presently required to collect this information.

How many managerial personnel will be needed and are they available?

Ultimately one can assume that pest management will be applicable and eventually spread to most of the 50 States in the United States. Presently there are cooperative programs in 29 States, but not all of these States have full-time pest management personnel assigned. A reason for this is that initially, emphasis is being placed on the "pest" part of the programs and the "management" part goes lacking. As these programs move more into the "management" phases the real need for full-time managerial personnel will become evident.

It is felt that some form of organized, publicly supported effort similar to the modest beginning of the sponsored pest management programs will be necessary to actually achieve the integration of "management" into pest control. Each State having a pest management project or projects would have at least one full-time extension specialist charged with a continuing information, education, and advisory responsibility. In addition, an APHIS specialist would be assigned to each State to assume coleadership with the extension service specialist in the total pest management effort and as liaison and collaborator with the State department of agriculture on pest management activities. This level of staffing is considered to be essential and will serve as a nucleus for a continuing expansion of pest management into all aspects of agricultural pest control in the State. Also to be considered are the managerial personnel, that would be the pest consultants who deal directly with the farmers, discussing their pest situation and making recommendations. A real problem exists in this area because a sufficient number of people with the necessary background are not available. These managers will require both academic training, and field experience. Once the basics have been obtained in a university pest management training program, it may take 2 years

or more of practical experience in the field before a man is adequately qualified and has the necessary feel for the problem to advise the farmer with real confidence. Therefore, it will be a long-term project to develop people with the expertise to handle pest management.

B. Projected Costs

Cost of personnel required.

Pest management projects were conceived as action oriented programs. With this in mind, the funding intent was that the major portion be directed toward personnel costs. In some of the projects, these costs amount to as much as 95 to 97 percent of the total project funds.

It must be emphasized at this point that present projects are basically pilot or demonstration projects. Managerial and personnel costs are understandably disproportionately high during the initial stages of these projects. As the programs develop, growers are expected to participate financially more and more until the projects are mainly grower supported.

As projects progress to this point, the only cost to the government is expected to be that necessary for the salary and support of two pest management professionals per State.

Cost of training required.

Training costs associated with pest management projects involve mainly scout training. Data on these costs are difficult to retrieve since separate figures have not been kept. In projects where formal training sessions have been held, an estimate can be made on the basis of the professional man-hours involved.

The length of the various formal pest management training sessions varies from 1/2 day to 3 days. At that rate, anywhere from 1 to 8 or 10 professional man-days are involved per session. Practically all projects use some type of on-the-job training throughout the scouting season. The maximum period of time given to this activity is about 1/2 day per scout or scout team per week. Usually this on-the-job training is carried out by project supervisors during the course of carrying out their supervisory responsibilities.

On the basis of the foregoing discussion, it can be seen that scout training costs are minimal when compared to other project costs.

Other system costs to include administration, equipment, and incentives.

Other system costs can best be illustrated by inclusion of representative financial breakdowns from various projects. Following are proposed 1974 budgets for the Arizona and Mississippi cotton projects, the Maryland bean and corn project, and the New Jersey corn, lettuce, and potato project. Complete information on the cotton projects for 1972 is included in table 8 of Womack's cotton project evaluation (see appendix).

1974 Proposed Budget for Cooperative U. S. Department of Agriculture - Arizona
Agricultural Extension Service Cotton Pest Management Project

Classification	Est. Man Years	FUNDS: SOURCE AND AGENCY — Requested USDA Pest Management Funding: Cooperative Extension Service	APHIS	Other Funds: Cooperative Extension Service	State Research	State Dept. of Agric.	Producer
Project Leader	1/3	----	----	$ 8,000	----	----	----
County Extension Agents	1/2	----	----	10,000	----	----	----
Research Entomologist	1/5	----	----	----	$4,000	----	----
Pest Management Specialist	6	$16,000	$25,000	----	----	----	$30,000
Entomology Aids (Scouts) - For 3 months	12	----	----	----	----	----	46,500
Personnel Health Monitoring		----	----	----	----	----	1,000
Supplies (traps, nets, forms, etc.)		----	----	----	----	----	700
Clerical Help	1 2/3	----	----	----	----	----	6,900
Regulartory Personnel	1/2	----	----	----	----	$8,000	----
Data Processing		1,000	----	----	----	----	----
Communications		----	----	----	----	----	1,200
Sub-Total		$17,000	$25,000	$ 18,000	$4,000	$8,000	$86,300
TOTAL		$42,000		$116,300			

Example Budget Format [1/]

1974 Budget for Cooperative U. S. Department of Agriculture Mississippi
Agricultural Extension Service Cotton Pest Management Project

Classification	Est Man Years	FUNDS: SOURCE AND AGENCY — Requested USDA Pest Management Funding: Cooperative Extension Service	State Dept. of Agriculture	APHIS	Other Funds: Cooperative Extension Service	State or USDA Research	State Dept. Agriculture	Producer	Cotton
Project Leader	1/6	$ 600			$ 3,666				
Extension Crop Specialists	1/3	600			5,333				
County Extension Agents	1 1/3				8,843				
Extension Administration	1/30				690				
Research Entomologists						$640			
Research Plant Pathologists									
Experiment Station Administration									
Pest Management Specialist(s)	3	51,244		$24,000					
Entomology Aids (Scouts) - For 3 months		14,625						$90,700	
Personnel Health Monitoring									
Supplies (traps, nets, forms, etc.)		1,000							
Clerical Help	1 3/10	6,250							
Regulatory Personnel	1/30						$345		
Data Processing		4,000							
Environmental Monitoring									
Ongoing Research Input									
Sub-Total		$ 78,319		$24,000	$ 18,532	$640	$345	$90,700	
Total		102,319			$110,217				
Grand Total		$212,536							

Funds to be used to help support supervisors and scouts in new county programs yet to be developed; 9 county programs

1974 Budget for the Cooperative USDA - Maryland Bean and Corn Pest Management Program

Classification	Est. Man Years	SOURCE OF FUNDING		
		Requested USDA Funds	Md. Cooperative Extension Service	Food Processors
SES Technical Consult.	1/4	----	$ 4,000	----
CES Ext. Entomologist	1/4	----	4,000	----
Survey Entomologist	1/12	----	1,000	----
Business and Accounting Services	1/5	----	2,400	----
Pest Management Spec.	1	$15,810	----	----
Benefits		3,000	----	----
Travel		2,000	----	----
Clerical Help	1	6,100	----	----
Benefits		1,060	----	----
Corn Scouts (10)	2	12,500	----	$2,000
Travel		4,000	----	750
Bean Scouts (4)	1	4,000	----	1,000
Travel		950	----	250
Scout Supervisors (2)	1/2	5,000	----	----
Travel		1,500	----	----
Data Technician	1/4	1,200	----	----
Telephone Services		500	----	----
Data Processing		300	----	----
Supplies and Equipment		750	----	----
Personal Health Monitoring		330	----	----
Environmental Monitoring		1,000	----	----
Sub-Totals		$60,000	$11,400	$4,000[a/]
TOTAL		$75,400		

[a/] contributions depend on the number of companies which employ their own scouts.

Proposed 1974 Budget for Cooperative U. S. Department of Agriculture - New Jersey
Agricultural Extension Service Fresh Market Sweet Corn, Fall Lettuce and Potato Pest Management Project

FUNDS: SOURCE AND AGENCY

Classification	Est. Man Years	Requested USDA Pest Management Funding: Coop. Ext. Serv.	State Dept. of Agric.	APHIS	Other Funds: Coop. Ext. Serv.	State or USDA Research	State Dept. of Agric.	Producer	Other
Project Leader	1/5	--	--	--	$ 4,000	--	--	--	--
Ext. Pest Management Specialist	1/10	--	--	--	2,000	--	--	--	--
County Extension Agents	1/2	--	--	--	10,000	--	--	--	--
Extension Administration	1/4	--	--	--	6,000	--	--	--	--
Research Entomologist	1/3	--	--	--	--	7,000	--	--	--
Research Plant Pathologists	1/2	--	--	--	--	8,000	--	--	--
Extension Plant Pathologists	1/4	--	--	--	5,000	--	--	--	--
Pest Management Specialist(s)	1	$ 24,547	--	--	--	--	--	--	--
Entomology Aids 12 (scouts) - For 204 man wks.		--	$36,000	--	--	--	--	--	--
Pest Management Assistant	1	10,000	--	--	--	--	--	--	--
Personnel Health Monitoring		--	--	--	--	--	--	--	$1,000
Supplies (traps, nets, forms, etc.)		6,000	--	--	--	--	--	--	--
Clerical Help	1	6,667	--	--	--	--	--	--	--
Regulatory Personnel & Scout Supervisors	1	--	--	--	--	--	$15,000	--	--
Data Processing	1/10	2,000	--	--	--	--	--	--	--
Environmental Monitoring	1/10	--	--	$2,000	--	--	--	--	2,000
Ongoing Research Input		--	--	--	--	3,000	--	$5,000*	--
Sub-Total		$ 49,214	$36,000	$2,000	$27,000	$18,000	$15,000	$5,000	$3,000
Total		87,214			$68,000				
Grand Total		$155,214							

*utilities, risk and cost of control in Pest Management area

Incentives are not reflected in these budget breakdowns, but are used in some projects. In 1973, the corn and bean project in Maryland paid $50 bonuses to black light trap tenders who submitted collections on a timely basis throughout the entire season. Certain other projects have paid small bonuses to scouts who complete the entire scouting season. In 1974, cotton scouts in one area of North Carolina are being paid on an incentive plan, but this is meant to cut actual scouting costs by as much as 40 percent, rather than add cost.

Is the program cost effective?

No hard, objective evaluation of cost effectiveness has been made of the pest management projects at the national level. Limited evaluations at the project level have furnished information such as:

"Based on results for the 2 years (1972 and 1973), the Mississippi extension service calculates that the 3-year investment of $185,000 will return a savings of $2,129,000 to the participating farmers." (Cotton project).

". . . reductions in control costs brought about by pest management will undoubtedly pay for the estimated scouting costs of $25 per field. Furthermore, these returns do not include the possible gains in product quality and reductions in processing costs as a result of more effective insect control." (Maryland 1974 Sweet Corn and Beans Annual Report).

The profitability or cost effectiveness in 11 of the 14 cotton projects, as a whole, is such that growers are paying the entire cost of scouting. Although this does not reflect the entire cost of the program it does indicate that the cost of the scouting is worth the money to the grower. It was not expected that the pilot pest management programs would be cost effective. They were set up in an attempt to demonstrate a program that would be cost effective. This has not been possible in all cases. A case in point is the tobacco project in North Carolina. As this project progressed, it became evident that the intensive scouting approach aimed at the insect problems could not pay its way. The intensity of the insect problems on tobacco in this State is such that only one or two insecticide applications might be necessary and intensive scouting is not profitable. Program modifications involving plant pathology and nematology are being considered in an attempt to put together a program that will be cost effective.

The California pear pest management project has attempted to sell itself, almost from the beginning, on the basis of cost effectiveness.

The project has worked through commercial consultants and has told cooperating growers that if they would follow project recommendations they could make an additional $80 an acre. To sign up with the project requires an initial grower input of $8/acre (one-half of the private consultants fee). Even if the grower had to pay the total consultant fee ($16/acre) he would have the opportunity to increase this almost fivefold.

The private consulting aspect of pest management is also cost effective, at least in the sense of profitability, as indicated by the following data developed from a talk given by Dr. Wayne Willey at the annual meeting of the Association of Applied Insect Ecologists in Monterrey, California, February 1-3, 1974.

Consultant Financing 1972--California

Crop	Average charge per acre	Average cost per acre	Average profit per acre	# Acres under consulting program
cotton	$ 3.10	$ 2.34	$ .76	141,000
oranges	16.10	8.26	7.84	12,000
alfalfa	1.55	.49	1.06	54,000
grapes	4.80	3.32	1.48	3,700
tomatoes	6.05	2.03	4.02	14,500
alfalfa seed	3.30	2.43	.87	14,500
produce	4.30	1.65	3.65	39,000
beets	2.40	2.64	.24	23,900
nuts	6.80	2.10	4.70	5,800
deciduous fruits	11.40	4.70	6.70	7,500

It should further be pointed out that cost effectiveness should not be considered merely in the context of "saved pesticides" vs. the cost of the program. It should be recognized that there are certain intangibles which do not readily lend themselves to a dollar value evaluation. A few of these intangibles are less pesticide use, less environmental pollution, and also less likelihood of losing a given pesticide due to pest resistence.

C. Probable Effectiveness

Will the objectives and strategies of present programs be achieved? Are new objectives needed and are they being developed?

It is expected that the objectives and strategies of the present programs will be achieved. There is evidence of excellent progress

toward this end at the present time as indicated before in this report. However, as was also pointed out, it is highly likely that the long-term objectives will not be achieved if the projects are terminated at the end of the 3-year period. For example, in the case of most cotton projects, the cost of scouting is currently borne by the growers themselves.

It is hoped that eventually pest management, as a concept, will be adopted by the agricultural industry and supported by it except for technical advisory and research functions. However, to achieve long-range objectives of employment or integration of new pest control strategies into current programs, considerable technical and research inputs are necessary. Therefore, it is considered imperative that the necessary technical and research functions be continued and oriented toward the development of long-term pest management approaches to pest control problems. The necessary objectives should be developed and documented as a part of this program within the coming year. We have reached the point, at least in the case of the cotton projects, where we are ready to proceed to the second phase of the development of pest management. That is, the integration of new strategies into the control program. This is not to imply that the need for scouting services has been completely satisfied in the cotton area. However, the value of scouting has been demonstrated time and time again and in many cases, it is the application of the new strategies for control that will convince many growers that they need the scouting services.

Over the years, many growers have been able to handle their pest problems satisfactorily. This has involved rule-of-thumb evaluations of their fields, and has frequently resulted in excessive use of pesticides. Their use of a good population assessment program as a part of their strategy will only come when they begin to employ new techniques in pest control. The cooperative pest management program, which was initiated in 1971, has reached the point in time when it should be reevaluated within the Department and by other interested agencies. Pest management is a dynamic concept requiring continual updating. In view of the experiences of the last 3 years the necessary objectives should be developed for a continuing, on-going program in order to make this a viable, long-term approach to the solution of our pest problems.

<u>What will be the level of public acceptance of such programs?</u>

It is not only expected that these programs will be highly acceptable to the public; it is felt that the public will demand this approach to our pest control problems. In view of the real concern

by the urban population, as well as some of the agricultural community, over long-term environmental pollution, this program makes sense. Also, it makes sense from the biological standpoint and from a practical standpoint, for long-term, acceptable, and effective control of pests in agriculture. It is suggested that a part of the extension service information and education program should be devoted to the distribution of information concerning the benefits of this approach to pest control as well as documentation of the progress made to date and its impact upon the urban dweller. Although the public, or society as a whole, is not the direct benefactor of pest management, a number of benefits are received indirectly. A few examples are:

1. Lower priced agricultural goods through lower production costs.

2. Quality agricultural goods at these lower prices due to more efficient use of pesticides through more precisely timed applications.

3. An environment unthreatened by maladies brought about by misuse or overuse of pesticides.

Will the total use of pesticides be reduced? What other benefits may result?

Evaluations of these programs to date show that there is a definite reduction in the total use of pesticides if data from a scouting program are followed. However, the potential of pest management is just barely being touched if a scouting program is the total extent of, rather than just a component of, the pest management effort. It is expected that the introduction and use of alternate strategies, which are presently available, such as organized areawide pest suppression measures will substantially further reduce the amount of pesticide required to produce a crop economically. It is also obvious that this reduction in total use of pesticides may enhance the quality of the environment. This is an intangible benefit which is very difficult to measure in dollars and cents. Nevertheless, it is one of the important benefits of this program, and will be recognized as such by the general public.

Will the adverse environmental impact be reduced?

It stands to reason that the reduction in the amount of pesticide used with its resultant impact on nontarget organisms and residues left in the environment, will substantially reduce hazards. To date, insufficient data have been collected to obtain and document

any adverse environmental impact within or without the pest management project areas. It is expected that a trend may become evident once we get a total 3-year study in these pest management areas. It should be emphasized also that there is an adverse impact from insects, weeds, and plant diseases on the environment, particularly as it relates to the production of food and fiber. Therefore, we must reach some compromise on the environmental aspects of control of these enemies of agriculture and the procedures used to achieve that control. For that reason, it is deemed imperative that pest management be adopted as our national approach to the control of enemies of agriculture in a pest management scheme which does not rely completely upon chemicals.

Could past and existing programs yield management models?

Yes, it is expected, and the data collection format was designed in a manner, to collect reliable data for use in predictive and action models at the field level. As pointed out earlier in this report, the cost of these projects is considerably higher than that for a private consultant doing the same service. The reason for this increased cost is the time and effort required to collect all of the additional data over and above that of pese population levels. This data is collected in an attempt to arrive at an understanding of the subtle interactions which exist between pests, the agricultural crop production system, and the environment in which the crop is grown. Cost of data collected to keep the model current after it is validated will be substantially less than that required for the developmental stages. The reason for this is that the amount of data will be much less.

There is a great deal of interest at the present time in using these data in the models which are currently being produced in many of the States as a part of their pest management effort. A "decisionmaking" model used in the Maryland vegetable project was discussed earlier in this report. It is expected that some additional input into this program will be necessary to begin to use the backlog of data which has been accumulated over the last 2 to 3 years in connection with the projects.

IV

RECOMMENDATIONS

Suggested changes in strategy and objectives.

It is suggested that we have reached the point, at the present time, in our pest management effort to review the accomplishments to date and revise our immediate objectives. We have reached the point in cotton when we are ready to begin implementation of alternate strategies other than pesticide in many of our pest control situations. This is not to imply that they are not presently being used in some cases. However, they are not being used on the large-scale and in the organized fashion that they must be used in to achieve full benefit from these alternate procedures. Examples of underutilized alternate strategies are diapause control, trap crops, and pheremones, to name a few.

The framework for organized efforts is presently being developed. There is a drastic need at the present time for improved or increased input on the part of the regulatory agencies to achieve areawide approaches and to assist in the organized overall effort. Pest management appears to have little chance of succeeding in tobacco unless an areawide regulatory program of enforced plant destruction is undertaken. High overwintering populations of budworms and hornworms produced on this postharvest residue are limiting factors in carrying out an effective pest management program on this crop.

It is felt that it will be necessary to organize a nucleus in each State, of managers from the extension service and the State regulatory agencies to achieve this objective. In other words, we are now ready to begin a strategy based on the long-term objective of an integrated approach to pest control. It will require a coordinated effort of State and Federal research, extension, and regulatory agencies to achieve this objective and it is imperative that these agencies be involved in the development of the long-range strategy.

Improved training programs or techniques for scouts and managers.

The greatest need for improved training is not at the scout level but at the manager level. The simple procedure of collecting the data in the field can be obtained with a minimal amount of formal training of the scouts with a continuing followup and training by the supervisory personnel. The supervisory personnel are the key to execution of a scouting or supervised control program. Unfortunately, these people are not trained at the university level to enter the field fully effective. A system of on-the-job training is necessary. It is recommended that a system of grants or public support should be made in order to sponsor these people in on-the-job training to allow them to develop the necessary level of

competence to enter a pest situation and make a recommendation. This will not only furnish the necessary personnel to supervise the public sponsored pilot and application project, but it will also furnish the necessary trained personnel to take over the continuing need for this service in a private consultant status.

Improved data gathering and analysis procedures.

This is an area in which very little work has been done at the present time other than to attempt the development of a standardized format for data collection and an itemization of the necessary types of data to be used. Actual programming of this data into a form where it can be retrieved to answer the questions on pest control has had little attention up to the present time. Most of the data retrieval has been done in the form of summaries to be used in the information-education program at the field level. The real long-term value of this data is to identify interactions between crop production pests and develop the necessary predictive techniques and action models to be used in pest control at the field level. This will require a cooperative effort of the State leaders involved in the pilot and application projects at the field level, the people who have developed the models, and some agency designated with the responsibility for maintenance and use of the data bank in developing models both in a predictive and an action sense.

Funding requirements.

It is expected that funding requirements will be increased in the future if we are to successfully switch from a pesticide control approach to a pest management approach. This funding will be needed more in the sense of furnishing services to the State and growers in the form of pest outbreak predictions, action models, and the monitoring of the environment behind various pest control procedures to determine environmental impact. It will also require the necessary funds to keep the nucleus of a pest management team involving extension and regulatory agencies in each State to assume the leadership for the development of such organized efforts across the board. The minimum requirement for personnel would be 1 man-year for CES and 1 man-year for the regulatory agency involved. Additional requirements of up to 5 man-years per State could be expected where certain areawide practices were used requiring regulatory inputs on practices (survey, enforcement, or control trapping).

Incentives and public education for achieving public acceptance.

Most of the information-education program associated with the effort to date has been directed at the agricultural community.

This is as it should be in view of the fact that we are attempting to sell to the grower a new approach to his pest control problems. In view of the fact that in most cases existing chemical controls are doing an excellent pest control job, it will require an extensive and long-term effort in information-education to achieve acceptance of new nonchemical approaches to pest control. However, it is also felt that the time has come to expand this information-education program to include the general public. It is a logical approach and will be accepted as such by the general public, in view of the general concern over contamination of the environment and the opportunities afforded with this approach to alleviate some of this problem.

Implementation plan for a national scouting program within the confines of pest management program.

It is not recommended that a national scouting program be implemented as a part of the pest menegement program. The scouting program is merely a service and as such, it should be borne by the group or the segment of the agricultural industry which benefits from this service, namely the grower. There will be certain instances where the economics of the crop production will not be sufficient to adequately support a private industry scouting effort. In these cases, we should take advantage of the development of models based upon the data collected and the prediction of pest outbreaks to handle such situations. This, or course, will require a modest amount of data collection on a year-by-year basis to keep the models updated and to detect changes which may be occurring in response to production practices. However, this would be relatively minor activity and could be handled very adequately with the present insect survey system which is a part of the APHIS activity.

The cost of attempting a national scouting program would be prohibitive. Also, inview of the fact that this is a service activity it could be best handled by the private sector instead of a federally sponsored action. Of course, thare should be a continuing and intensive information-education program pointing out the need for this service and attempts to expand it further in all of the crops where it is an economically viable activity. From the national standpoint, it is felt that the thing that is most needed at the present time is a clear-cut and concise policy of endorsement of the pest management concept at the national level as out approach to pest

control problems. This policy and its implications, as well as the role of scouting or other surveillance in pest mangement, should be given widespread publicity in an attempt to educate the general public and agriculture as a whole to the desirability of this approach as compared with or present approach to our pest problems.

References Cited

Boyer, W. P., L. O. Warren, and Charles Lincoln. Cotton insect scouting in Arkansas. Ark. Agr. Expt. Sta. Bul. 656, 1962.

Brazzel, J. R., T. B. Davich, and L. D. Harris. A new approach to boll weevil control. J. Econ. Ent. 54(4):723-730, 1961.