An evaluation of cotton pest management practices in Pinal County, Arizona, 1974

AN EVALUATION OF COTTON PEST MANAGEMENT PRACTICES IN PINAL COUNTY, ARIZONA, 1974

by

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A Thesis Submitted to the Faculty of the

DEPARTMENT OF AGRICULTURAL ECONOMICS

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

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ACKNOWLEDGMENTS

I wish to express my sincere appreciation to my advisor, Dr. Robert C. Angus, for his valuable assistance in the organization and preparation of this study. Appreciation is extended to Dr. William E. Martin and Dr. James C. Wade for their comments and suggestions in the final review of this paper.

The assistance of Dr. Leon Moore and Mr. Michael Lindsey, Department of Entomology, is appreciated for supplying data and suggestions for this study. Great appreciation is extended to Mr. Ray Bankston, Supervisor for the Growers Pest Management Corporation, for his valuable assistance provided during the field survey.

Special recognition and thanks goes to Dr. Louise Arthur and Dr. Russell Gum for their assistance in the computer operations.

A special thanks to Mrs. Ginger Garrison for typing the rough draft and to Mrs. Paula Tripp for typing the final paper.

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ABSTRACT

Integrated pest management is a procedure used to manipulate insect populations, both harmful and beneficial, through selection of various control techniques. Biological, cultural, chemical, and other control methods are used together to achieve solutions to economical, ecological, and social probelms associated with insect control.

Cotton growers in Pinal County, Arizona have organized the "Growers Pest Management Corporation," an organization that practices integrated pest management. The purpose of this study was to determine the pest management practices of the members of the Growers Pest Management Corporation and compare them to pest management practices of cotton growers who were not in the corporation. The findings in this study indicate that members of the Growers Pest Management Corporation spent an average $13.66 per acre less on insecticide treatments than growers not in the corporation. An additional objective in this study was to compare the effects that different pest management consultants had on insect control practices of the cotton growers in this study. The comparison of pest management consultants was in terms of the number of insecticide treatments, types of insecticides used, and insecticide treatment costs involved with the growers in the study. Findings indicate that the corporation's consultants and independent consultants were able to keep insecticide treatment costs lower than other consultants.

CHAPTER I

INTRODUCTION

Integrated pest management is a procedure used to manipulate insect populations, both harmful and beneficial, through selection of various control techniques. Biological, cultural, chemical, and other control methods are used together to achieve solutions to insect control problems.

Integrated pest management is not a new concept. Research in this area started over fifty years ago in Arkansas with an entomologist, Dwight Isely, studying natural methods of controlling cotton insects (Watson, Moore and Ware, 1975). Integrated pest management is a viable input in the production of cotton today. However, in Arizona, cotton growers are slowly realizing the importance of having a well-rounded pest management program.

Several problems associated with large-scale insecticide usage on cotton have sparked the development of intensive pest management programs. Chemical residues, insect resistance, animal toxicity, and the increasing costs of chemical control are the problems that have caused farmers to become more concerned with their pest control practices. Cotton growers are beginning to adopt pest control practices which minimize insect control costs, yet maintain crop yields and quality.

Cotton growers in Pinal County, Arizona have organized into the "Growers Pest Management Corporation," an organization which advises its

participating members on pest management practices in cotton production. The Growers Pest Management Corporation has developed integrated pest management programs with the aid of entomologists and pest management specialists from The University of Arizona. The objective of the program is to control harmful insects at minimum cost without loss in yields or quality. A side benefit of the program is the minimal environment contamination with insecticides.

A study by Lawrance (1972) comparing pest control practices of growers in the Pest Management Corporation demonstrated that growers who adopted the pest management practices in the program made an average 3.4 fewer insecticide treatments per acre and spent an average $10.58 per acre less in total pest control costs than the growers who did not adopt the pest management practices. The results of the Lawrance study are clearly significant in the support of the pest management program.

The purpose of this study is to determine whether growers who participated in the pest management program were able to lower the cost of pest control compared to growers not participating in the pest management program. Further, it is important to determine how growers make pest control decisions with respect to the type of pest management consulting they receive. Cotton growers' attitudes and suggestions toward pest control practices will be evaluated to aid in the development of future pest management programs. It is the intention of this study to provide economic insight into current pest management practices of cotton growers in Pinal County, Arizona.

Pest Management Principles and Concepts

Pest management can be defined as "the practical manipulation of pest populations using sound ecological principles to keep pest populations below the level causing economic injury" (Watson et al., 1975, p. 5). A broader definition for integrated pest management is "the intelligent selection and use of pest control actions that will insure favorable economic, ecological, and sociological consequences" (Rabb, 1972, p. 3).

Integrated pest management uses several control factors, which together, maintain pest damage below the level required to prevent economic losses. Combination of these practices include (Glass, 1975):

1. Insect resistant varieties.
2. Cultural practices, such as early harvesting.
3. Biological control by the use of natural enemies.
4. Autocidal control through genetics or radiation.
5. Selective insecticide control by means of properly timed applications based on valid field scouting records.
6. Insect growth hormones.
7. Insect attractants such as sex pheromones.
8. Quarantines to prevent introduction of harmful pests.
9. Eradication in emergency situations.

Cotton agrosystems are complex and dynamic in nature and require constant evaluation in order to control harmful insects. Basic methods to determine the need for insect controls is the use of field scouting techniques and adaptation of economic thresholds. Field scouting is a routine systemic collection of information from the crop area in order

to ascertain the physical damage presently caused by harmful insects, to estimate the potential physical damage, and to determine the relative populations of harmful and beneficial insects. The information gathered can be used to determine if pest control measures are needed.

The key element in integrated pest management that is used as a guideline for pest control measures is the concept of economic threshold. The economic threshold, often called the economic injury level, is defined as "the lowest pest population level at which damage can no longer be tolerated and therefore the level at or before which it is desirable to initiate deliberate pest control measures" (Headley, 1972, p. 23; Metcalf and Luckman, 1975, p. 12). The economic injury level is inversely related to the product price, and directly related to the cost of pest control (Headley, 1972). Factors that are essential for determination of the economic injury level are (Metcalf and Luckman, 1975):

1. Amount of physical damage related to various pest populations.
2. Monetary loss associated with levels of physical damage.
3. Amount of physical damage that can be prevented by pest control measures.
4. Monetary value of portions of the crop that can be saved by the pest control measures.
5. Monetary cost of the control measure.

This information will provide a basis to determine the pest population level that control measures can be used to protect a crop value equal to or exceeding the cost of the control. This concept does not include the social or ecological costs with pest control.

Economic injury levels are dynamic because of the fluctuations in market prices of the commodity. It is very difficulty to establish a precise economic injury level for an individual grower and his particular marketing situation. Most injury levels are established as a result of research which identifies the insect populations or plant damage levels at which yield or quality loss begins. Therefore, general injury levels are usually used as a basis for a control decision, with market prices having little impact on the level established. A grower can choose to make an insecticide treatment before the scouting information indicates the level has been reached. This type of insurance treatment may be necessary for that grower if it appears that increasing market prices for the commodity would make such a treatment profitable by saving a portion of the crop (Metcalf and Luckman, 1975).

Integrated pest management practices in cotton also include control measures in other crops. For example, the treatment of insects in safflower or strip-cutting of alfalfa reduces the movement of harmful Lygus bugs into neighboring cotton fields. The selective use of insecticides on target pests can increase the kill potential, help prevent insecticide resistance build-up, as well as minimizing the destruction of beneficial insects or causing undesirable ecological effects. Timing of insecticide applications is essential in pest management for maintaining insect population control once the injury level is reached. Premature treatments may cause outbreaks of secondary pests, or in the case of early season treatments for Lygus spp. in cotton can cause outbreaks of bollwork, Heliothis spp. (Barnes et al. 1972).

A basic economic goal of cotton growers is to maximize profits. Pest management programs attempt to achieve this by preventing crop losses and minimizing expenditures for crop protection. Not all the implications of pest controls can be easily measured in monetary terms. Therefore, it may be more applicable to think in terms of benefit-cost analysis. Control measures that indirectly affect the cost of insect management are better expressed in this type of analysis. The benefits should outweigh the costs or at least be equal. The integrated pest management programs attempt to achieve this idea by conscientious efforts to insure that benefits of a practice will be more than the realized costs (Metcalf and Luckman, 1975). It is important, therefore, that growers obtain the expertise to achieve their economic goals. In a recent study, Norgaard (1976) compares growers who employed independent pest management consultants versus growers that employed consultants associated with insecticide sales. Growers using independent consultants had cotton lint yields six percent greater and had 34 percent less in insecticide treatment expenditures than growers using insecticide sales consultants. Norgaard found that the insecticide sales consultants were recommending routine schedule insecticide treatments, rather than utilizing the proper field scouting techniques and economic injury levels. Independent consultants used more integrated pest management principles and were able to cut chemical control costs by a third.

In general, studies in pest control have shown that programs which follow the integrated management principles and concepts will aid cotton growers in preventing crop losses due to insects, while lowering the pest control costs.

CHAPTER II

METHODOLOGY

Hypothesis and Objectives

Insecticide expenditures for Pinal County cotton growers who participated in the Growers Pest Management Corporation's 1974 pest control program were less than the expenditures of growers who did not participate in the program. This hypothesis will be examined in this study. An examination also will be made of the hypothesis that the source of pest management strategies by different consultants can affect the control expenditures for cotton growers.

The objectives of the study used to test the hypotheses are:

1. To examine and compare insecticide usage and expenditures of participants and nonparticipants.
2. To determine what effect each of the following information sources had on the insecticides used, number of treatments made, and cost involved in the insect control programs.
   A. Grower himself -- acting alone.
   B. Pest Management Corporation's field scout.
   C. Independent field scout.
   D. Insecticide salesman.
   E. Combinations of the above.
3. To obtain growers' current attitudes toward pest management and suggestions for future improvements in pest management programs.

Research Methods

Selected Growers

Cotton growers selected for this study were divided between growers who were members of the Growers Pest Management Corporation, and those growers who were not members. There were 54 members in the corporation during 1974, of which 25 were randomly selected for the study. These growers were participants in the pest management program (see Appendix A). Twenty-five growers were also randomly selected in the county who were not members of the corporation in 1974 and were nonparticipants in the pest management program.

Selection of growers for the economic analysis was based on the availability of adequate records. Not all the growers surveyed had insecticide records that could be used in the analysis. Therefore, 24 of the participants were used in the analysis, while only 15 of the nonparticipants were used. All the growers surveyed were used in the evaluation of pest management attitudes.

Fifty percent of the participants used in the analysis had been in the pest management program four years. Thirteen percent had been in the program three years, while thirty percent had been two years. There were only two participants or eight percent in the program for the first time in 1974.

Only two of the fifteen nonparticipants had associated with the pest management in years previous to 1974.

Data Collection

Data for this study were obtained from four main sources. They were: (1) a field survey; (2) records of the Growers Pest Management Corporation; (3) records of pesticide applicators operating in Pinal County; and (4) previous research in cotton pest management.

A field survey was conducted with the selected growers in the Fall of 1975. This survey was designed to obtain information about the growers' cultural practices, harvest data, insecticide use, field checking practices, and attitudes towards pest management (see Appendix B).

Records maintained by the Growers Pest Management Corporation in 1974 were used to gain information on the selected participating growers. This information included the number of insecticide treatments, acres treated, chemicals used and yield data.

There were twelve custom pesticide applicators used by the final selection of growers. Only eight applicators kept adequate records that were useful for this study. These records provided information on insecticide materials used, application rate and acres treated.

Analytical Procedure

This study deals with only one crop, cotton, over a single production season. Cost survey analysis is used to compare the selected growers' pest control practices. Costs of chemical insect control associated with the different pest management consultants are examined. The two groups of growers are compared, which provides a basis of inference of the most viable pest control strategy. Data collected and

computed are tested for significant differences for each category of information examined (Steel and Torrie, 1960; Alder and Roessler, 1964).

CHAPTER III

GROWERS' CULTURAL PRACTICES

Characteristics of the Area Studied

Pinal County covers approximately 5,400 square miles in south-central Arizona. It is an irrigated desert area with mean temperatures in the 70's to high 80's through cotton production season. The annual mean precipitation is 8.1 inches, most occurring from July to October. The usual planting period for cotton is March 15 to April 25, while the usual harvest period is October 25 to December 5. This provides a growing season of approximately 250 days (Mayes, 1975).

Pinal County ranks second in terms of cotton acreage in Arizona. Cotton is the county's major cash crop, followed by wheat and barley. In 1974, Arizona's second largest record production year of cotton, Pinal County harvested 145,150 acres, at an average yield of 1,113 pounds of lint per acre. Arizona's total cotton production for 1974 was 426,700 acres harvested, at an average 1,179 pounds of lint per acre (Mayes, 1976).

Characteristics of the Farms Surveyed

Cotton acreage harvested in 1974 for each growers surveyed varied, according to the different data source used in this study. Cotton acreage for participants was obtained from the survey, Growers Pest Management Corporation and the custom applicators. Nonparticipants

acreage was obtained from only the survey and custom applicators. Comparison of data due to the different sources is made in this study to provide a clear interpretation of the results.

Cotton acreage for the growers was divided between Upland -- short staple and Pima -- long staple cottons. Participants acreage records show the range of Upland cotton harvested to be zero acres to 3,366 acres, with the mean of 610 acres. Pima cotton acres harvested ranged from zero to 419 acres, with the mean of 46.3 acres. Growers Pest Management Corporation records show for the participants a range of both cottons harvested as 56 acres to 3,785, with a mean of 582 acres. Applicators' records were used to estimate all cotton acreage treated. Cotton acreages for only eighteen could be accurately used from this source. Applicators' records show for participants a range of cotton as 59 acres to 1,200, with a mean of 354.6 acres. Total acreage for the 24 participants who farm both Upland and Pima cotton was 15,744 acres. These data are shown in Table 1.

Nonparticipants' records of Upland cotton harvested show a range of 130 acres to 3,100 acres, with a mean of 1,015 acres. Pima acres harvested ranged from zero acres to 325 acres, with the mean as 46.5 acres. Applicators' records were the only source of cotton acreage for the nonparticipants. These records show a range of 130 acres to 3,425 acres, with the average as 1,069 acres. Total acreage for the 15 nonparticipants was 13,924 acres. These data are shown in Table 1. The location of the final selection of farms in both groups is in Figure 1.

Table 1. Acres of Cotton Harvested, Samples of Pinal County Growers, 1974.

Source of Data	Upland			Pima			All Cotton		
	Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
Participants									
Grower Records	0	3,366	610	0	419	46	--	--	--
Growers Pest Management Corporation Records	--	--	--	--	--	--	56	3,785	582
Applicator Records	--	--	--	--	--	--	59	1,200	355
Nonparticipants									
Grower Records	130	3,100	1,015	0	325	47	--	--	--
Applicator Records	--	--	--	--	--	--	130	3,425	1,069

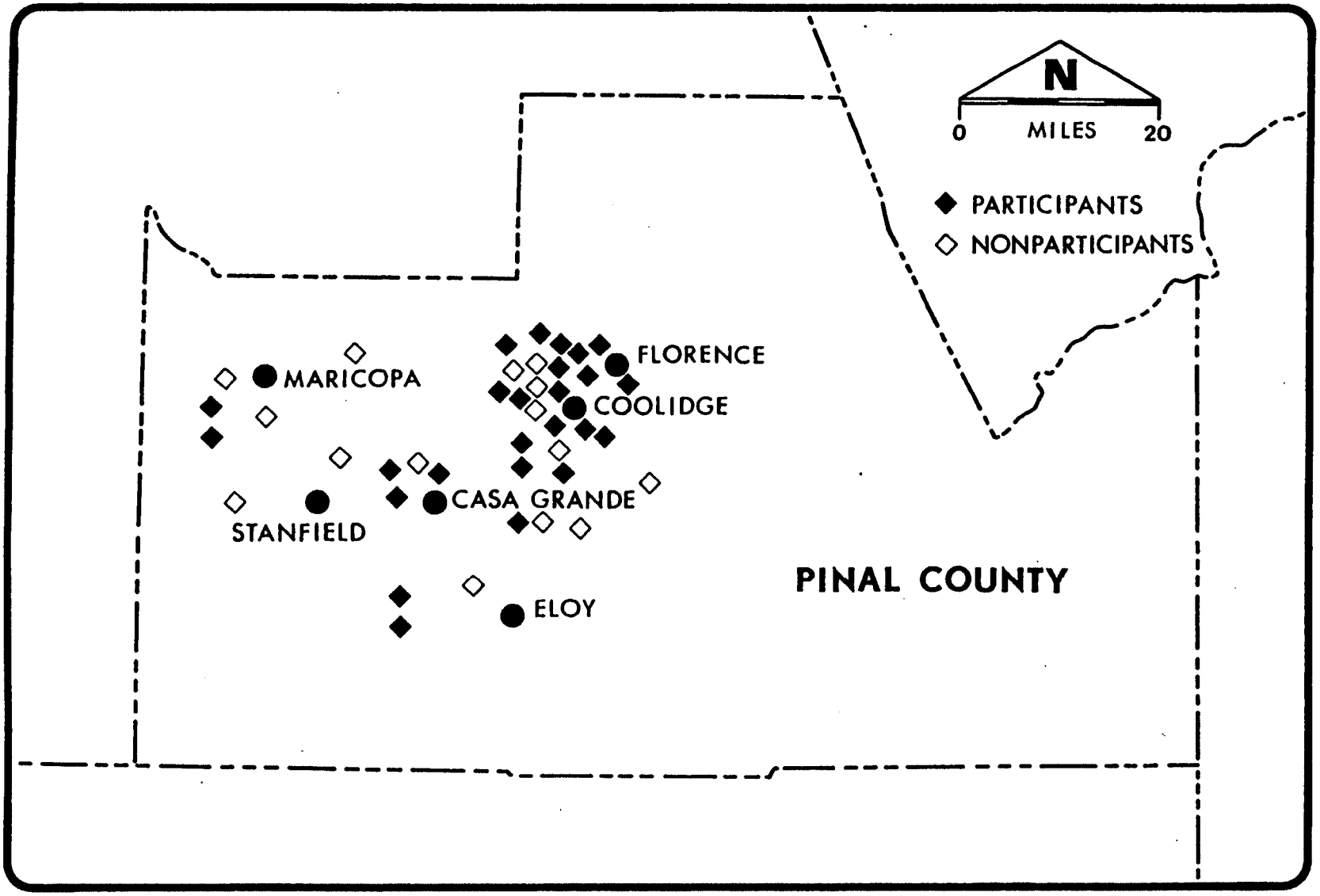

Figure 1. Map of Pinal County, Showing Location of Cotton Growers in Survey, 1974.

Planting Data

Growers' planting cotton varieties, planting dates, and rates are summarized in Table 2. Upland varieties were divided among Deltapine (DPL) 16, 61, 66, and Stoneville 213, while American Pima S-4 was the only long staple variety planted. Ninety-six percent of the participants planted Upland, with DPL 61 the most favored. Seventy-one percent of the participants planted Pima. All nonparticipants planted Upland, using all DPL varieties with no marked preferences between DPL varieties. Eighty-seven percent of nonparticipants planted Pima. The majority of growers in both groups started planting between April 1-14. Range of participants planting period was March 15 to May 15, while nonparticipants was March 15 to April 14. Seeding rates for participants were higher than those of nonparticipants. Sixty-three percent of participants planted 11-15 pounds per acre, while sixty percent of nonparticipants planted 5-10 pounds per acre. The difference in planting rates would have no affect on yields (Briggs, Patterson and Massey, 1967).

Irrigation Data

Irrigation practices were very similar between the two groups. Seventy-five percent of participants and seventy-three percent of nonparticipants applied 6-10 crop irrigations. One-third of the participants did not know the quantity of water applied to their crop, while fourteen percent of nonparticipants did not know. Acre-feet of water applied during the growing season ranged between 2.5 to 6.5 acre-feet, with twenty-one percent of participants applying 4.5 acre-feet, and twenty-seven percent of nonparticipants applying 6.0 acre-feet, Table 3.

Table 2. Selected Growers' Planting Practices, Pinal County, 1974.

Practice	Percent of Growers	
	Participants	Nonparticipants
Variety of Cotton Seed		
DPL - 16	25	20
DPL - 61	33	20
DPL - 66	4	0
DPL - 16, 61 Mix	0	13
DPL - 61, 66 Mix	8	13
DPL - 16, 61, 66 Mix	13	20
Stoneville 213[a]	17	14
Pima S-4	71	87
Planting Rates		
5 - 10 lbs/ac	29	60
11 - 15 lbs/ac	63	27
Above 15 lbs/ac	8	13
Planting Dates		
March 15 - May 31	21	47
April 1 - April 14	50	53
April 15 - April 30	21	0
May 1 - May 15	8	0

a. 75% of the Stoneville was mixed with DPL varieties. 100% of the Stoneville was mixed with DPL varieties.

Table 3. Selected Growers' Irrigation Practices, Pinal County, 1974.

Practice	Percent of Growers	
	Participants	Nonparticipants
Number of Irrigations		
1 - 5	17	0
6 - 10	75	73
11 - 15	4	27
Unknown	4	0
Acre-Feet Applied Per Acres		
2.5 - 3.5	8	20
3.5 - 4.5	34	26
4.5 - 5.5	21	13
5.5 - 6.5	4	27
Unknown	33	14

Fertilization Data

Fertilization practices between the two groups were very similar during the 1974 season. Fertilizer usage is shown in Table 4. Growers surveyed provided the types of fertilizer used in preplant and postplant applications which was converted into nitrogen and phosphate rates per acre. All growers applied nitrogen during the 1974 season. Participants applied 176.6 total average pounds per acre of nitrogen, while nonparticipants applied 142 total average pounds per acres of nitrogen. Approximately fifty-eight percent of participants applied phosphates at 98.9 total average pounds per acre. Sixty percent of nonparticipants applied phosphates at 101.6 total average pounds per acre. The difference in the averages would have no affect on cotton yields (Tucker, Abbott and Carpenter, 1966).

Cotton Yields

Average cotton yields for Pinal County in 1974 were approximately 1,138 pounds of lint per acre of Upland cotton, and 733 pounds of lint per acre of Pima cotton (Mayes, 1976). Participants' yield records show an average of 1,113 pounds of lint per acre Upland and 467 pounds of lint per acre of Pima. Growers Pest Management Corporation records show participant with an average 1,118 pounds of lint per acre for all cotton. Nonparticipants' records show an average of 1,280 pounds of lint per acre of Upland cotton, and 750 pounds of lint per acre of Pima cotton, Table 5. The difference between these means was insignificant at the five percent level.

Table 4. Selected Growers' Fertilization Practices, Pinal County, 1974.

Practice	Participants		Nonparticipants	
	N	P_2O_5	N	P_2O_5
Preplant Application				
Percent of Growers	62.5	37.5	66.6	46.6
Average Pounds per Acre	80.5	47.7	43.9	51.6
Postplant Application				
Percent of Growers	91.6	20.8	100.0	13.3
Average Pounds per Acre	96.1	51.2	98.1	50.0
Percent of Growers Making Application	100.0	58.3	100.0	60.0
Total Average Pounds per Acre	176.6	98.9	142.0	101.6

Table 5. Selected Growers' Yield Data, Pinal County, 1974.

Source of Data	Upland	Pima	All Cotton
	pounds		
Participants			
Participants Records	1,113	467	—
Growers Pest Management Corporation Records	—	—	1,118
Nonparticipants			
Nonparticipants Records	1,280	750	—

CHAPTER IV

INSECTICIDE USAGE AND COSTS

Insect Conditions

Cotton insects considered a major problem in Pinal County are lygus (Lygus spp.), bollworm (Heliothis spp.), and pink bollworm (Pectinophora gossypiella). Other insects that require control are cotton leaf perforator (Bucculatrix thurberiella) and spider mites, among others. However, cotton leaf perforator and spider mites are secondary pests requiring occasional treatments.

Insect conditions for the 1974 season varied among the growers in the study. The condition and density of a particular population of insects is dynamic in a geographical area and throughout the cotton production season. Insect conditions in cotton are dependent upon multiple factors, such as the growers' cultural practices, neighboring crops, neighboring insect control measures, and the general relationship of the populations of all insects, both harmful and beneficial. Generally, 1974 was considered a moderately light year for insect problems by growers, applicators, and local entomologists. Lygus was considered to be the most frequent problem, especially in areas associated with safflower production. Pink bollworm generally did not reach economic injury levels in 1974, though most growers treated for them (Moore, Lindsey and Robinson, 1975). Growers' rankings of the insect problems encountered during 1974 season are in Table 6.

Table 6. Growers' Rankings of Their Major Insect Problem, Pinal County, 1974.

Insect Problem	Percent of Growers	
	Participants	Nonparticipants
Lygus	32	20
Pink Bollworm	16	13
Bollworm	12	9
Others	8	9
No Opinion	32	49

Insecticide Costs

Insecticide costs for this study were estimated as the average 1974 cotton season retail prices charged by five competitive suppliers of insecticides in Pinal County. These prices are on a "per gallon" basis, with no field scouting services provided, Table 7. Growers may have purchased insecticides in bulk or used leftover supplies from previous years which would change the price structure. However, 1974 average prices were assumed for this study because it is unknown how each grower acquired insectides under the different pricing possibilities. This method places all growers on an equal basis in insecticide costs for the final analysis of pest control costs.

Aerial application is the most commonly used method of applying insecticides in Pinal County for post-planting insect control. Costs for aerial applications were estimated by averaging the fees of the five custom applicators used most often by the growers. Insecticides are generally applied as emulsifiable concentrates in 1 to 3 gallons of water to provide the required dosage per acre to effectively kill the target insects (see Appendix C). The average application fees used in this study were: 1 gallon, $1.33; 2 gallon, $1.53; 3 gallon, $1.73.

The costs of having fields checked by the different pest management consultants were not included in the final analysis of total pest costs. Their prices ranged from $1.50 per acre by independent scouts to $3.00 per acre by the Growers Pest Management Corporation scouts. It was difficult to determine what portion of growers' acreage was checked by the scouts when there was more than one consultant used.

Table 7. Average Prices for 1974 Insecticide Materials, Pinal County, 1974.

Insecticide	Price dollars/gallon
Organochlorines	
Endrin	9.20
Toxaphene	8.39
Organophosphates	
Azodrin	20.08
Bidrin	38.19
Cygon	17.58
Malathion	9.87
Monitor	46.55
Parathion - Ethyl	10.58
Parathion - Methyl	8.68
Carbamates	
Lannate (Nudrin)	20.25
Sevin	1.32/lb.
Others	
Fundal (Galecron)	33.05
Combinations	
Chlordane-Methyl Parathion (6-3) (Belt)	8.34
Toxaphene-Methyl Parathion (6-3)	9.66
Toxaphene-Methyl Parathion (8-2) (Torbidan)	8.78
Ethyl-Methyl Parathion (6-3)	10.69

Insecticide Control Expenditures

Listing of insecticide materials and costs for the participants and nonparticipants are shown in Tables 8 and 9. Insecticides listed in common chemical groups were the only insecticides used by the growers in this study. The number of growers who used each insecticide is listed, including the total number of growers who used the chemical groups in which the insecticides are classified. Application costs are not included in values on these tables.

Organochlorines

A total of five participants used an average of 0.4 technical pounds of organochlorines per acre. The average cost per acre harvested for this group was $.83 per acre. Only two nonparticipants used .04 technical pounds of organochlorines at an average cost of $.10 per acre harvested. Toxaphene was the most commonly used organochlorine. Toxaphene was also used in combination with other insecticides listed under combinations.

Organophosphates

Seven different organophosphates were used, with a total of sixteen participants using an average 0.79 technical pounds per acre at an average cost of $3.54 per acre harvested. Ten nonparticipants used a 0.71 technical pounds of organophosphates at an average cost of $3.16 per acre harvested. Azodrin and methyl parathion were the most frequently used organophosphates. Some organophosphates were used in combination with other insecticides listed under combinations.

Table 8. Insecticide Usage and Costs, Participants, Pinal County, 1974.

Insecticide	Number of Growers	Average Gallon/Acre	Average Technical Pounds/Acre	Cost/Acre Applied (dollars)	Cost/Acre Harvested (dollars)
Organochlorines					
Endrin	1	.040	.060	2.30	.35
Toxaphene	4	.060	.340	2.57	.48
TOTAL	5	.100	.400	Avg. = 2.45	.83
Organophosphates					
Azodrin	8	.070	.370	2.06	1.49
Bidrin	2	.005	.040	2.29	.19
Cygon	3	.003	.008	1.83	.06
Malathion	1	.001	.006	2.47	.01
Monitor	2	.006	.020	8.24	.27
Parathion - Ethyl	1	.005	.020	2.65	.06
Parathion - Methyl	9	.160	.320	2.19	1.46
TOTAL	16	.250	.790	Avg. = 2.26	3.54
Carbamates					
Lannate (Nudrin)	9	.100	.180	4.39	2.00
Sevin	3	.020	.010	.46	.02
TOTAL	11	.120	.190	Avg. = 4.02	2.20

Table 8. (continued)

Insecticide	Number of Growers	Average Gallon/Acre	Average Technical Pounds/Acre	Cost/Acre Applied (dollars)	Cost/Acre Harvested (dollars)
Others					
Fundal (Galecron)	15	.070	.26	1.74	2.17
Combinations					
Chlordane-Meth. Para. (6-3) (Belt)	1	.070	.45	3.15	.62
Toxaphene-Meth. Para. (6-3)	18	.590	5.28	2.83	5.73
Toxaphene-Meth. Para. (8-2) (Torbidan)	1	.007	.07	2.09	.06
Ethyl-Meth. Para. (6-3)	11	.150	1.38	1.40	1.64
TOTAL	20	.820	7.18	Avg. = 2.35	8.05
GRAND TOTAL	24	1.380	8.82	Avg. = 2.34	16.61

Table 9. Insecticide Usage and Costs, Nonparticipants, Pinal County, 1974.

Insecticide	Number of Growers	Average Gallon/Acre	Average Technical Pounds/Acre	Cost/Acre Applied (dollars)	Cost/Acre Harvested (dollars)
Organochlorines					
Endrin	1	.004	.006	1.15	.04
Toxaphene	1	.007	.040	1.08	.06
TOTAL	2	.011	.040	Avg. = 1.10	.10
Organophosphates					
Azodrin	5	.040	.210	2.65	.84
Bidrin	1	.003	.030	1.59	.12
Cygon	1	.004	.010	1.76	.07
Malathion	0	0	0	0	0
Monitor	3	.005	.020	7.24	.23
Parathion - Ethyl	1	.005	.020	2.03	.05
Parathion - Methyl	4	.210	.420	2.05	1.85
TOTAL	10	.270	.710	Avg. = 2.27	3.16
Carbamates					
Lannate (Nudrin)	14	.170	.300	3.44	3.35
Sevin	0	0	0	0	0
TOTAL	14	.170	.300	Avg. = 3.44	3.35

Table 9. (continued)

Insecticide	Number of Growers	Average Gallon/Acre	Average Technical Pounds/Acre		Cost/Acre Applied (dollars)	Cost/Acre Harvested (dollars)
Others						
Fundal (Galecron)	11	.15	.59		1.42	4.86
Combinations						
Chlordane-Meth. Para. (6-3) (Belt)	3	.20	1.19		2.49	1.65
Toxaphene-Meth. Para. (6-3)	13	.96	8.67		2.93	9.31
Toxaphene-Meth. Para. (8-2) (Torbidan)	0	0	0		0	0
Ethyl-Meth. Para. (6-3)	10	.70	7.11		3.55	8.44
TOTAL	14	1.95	16.97	Avg.	3.12	19.40
GRAND TOTAL	15	2.55	18.61	Avg.	2.55	30.87

Carbamates

Nearly all nonparticipants used carbamates, applying an average of .30 technical pounds per acre at an average cost of $3.35 per acre harvested. Eleven participants applied an average of 0.19 technical pounds of carbamates per acre at an average cost of $2.02 per acre harvested. Lannate was the most commonly applied carbamate.

Combinations

There were four different combinations of insecticides used by the growers. These were chlordane-methyl parathion (belt), toxaphene-methyl parathion (6-3), toxaphene-methyl parathion (8-2; torbidan), ethyl-methyl parathion (6-3). Twenty participants used an average of 7.18 technical pounds of combinations, at an average cost of $8.05 per acre harvested. Fourteen nonparticipants applied an average 16.97 technical pounds, at an average cost of $19.40 per acre harvested.

Total Insecticide Costs

The total amount of insecticides used by participants in the pest management program averaged 8.82 technical pounds per acre, at an average cost of $16.61 per acre harvested. Nonparticipants applied an average 18.16 technical pounds per acre, at an average cost of $30.87 per acre harvested. The difference is 9.79 technical pounds and $14.26 per acre. For all materials applied, participants paid an average $2.24 per acre per treatment, compared to $2.55 per acre per treatment for nonparticipants. The differences between these averages are statistically significant at the five percent level. These data are expanded in Appendix D.

Total Control Costs

Number of Treatments

According to the participants' records provided through the survey, actual insecticide treatments per acre ranged from 3 to 12 for the 1974 season, with a group average of 6.2 treatments per acre. The Pest Management Corporation records show the range of treatments as 2 to 9, with an average of 5.4 per acre. Nonparticipants' records give a range of 5 to 9 treatments with the group average as 7.8 per acre. The difference in the mean number of treatments is statistically significant at the five percent level.

Application Costs

Total application costs for the participants were approximately $141,270. The average application cost for the participants in the pest management program was $8.97 per acre harvested. Nonparticipants' total application costs were $196,100, with an average of $14.08 per acre harvested.

Total Treatment Costs

Total treatment costs (insecticide and application) were calculated from the acres treated, then averaged on acres harvested. The participants' average treatment cost was $27.15 per acre harvested, according to the growers' records. The costs ranged from $4.00 to $56.34 per acre. The Growers Pest Management Corporation records show treatment costs ranging from $4.12 to $44.68 per acre, with an average of $25.36

per acre. Custom applicators' records for this group averaged $25.15 per acre, with a range of $6.12 to $43.24 per acre.

Nonparticipants averaged $40.81 per acre harvested, according to their records. The range of total treatment costs was $17.45 to $67.09 per acre. Applicators' records for this group show an average $40.60 per acre, with the same range.

The difference between the total average costs for participants and nonparticipants was $13.66 per acre harvested, according to the growers' records. According to the custom applicators' records, the difference between the total average costs was $15.45 per acre harvested. The differences in the averages are statistically significant at the five percent level. These data are in Table 10.

Impact of Pest Consultants

Growers in both groups had their cotton checked for insects by different field scouts. All participants had their cotton checked by scouts employed by the Growers Pest Management Corporation. However, some participants had their cotton additionally checked by insecticide salesmen, independent scouts, or by themselves. Nonparticipants employed insecticide sales representatives, independent consultants or they checked their fields themselves. Growers were asked which cotton field scouts they utilized for the 1974 season. The following are the choices growers provided: Self only; Pest management scout and self; Pest management scout only; Pest management scout and Insecticide salesmen; Pest management scout and independent scout; Insecticide salesmen only;

Table 10. Average Treatment Costs, Pinal County, 1974.

Source of Data	Participants	Nonparticipants	Difference
Total Acres Harvested	15,744	13,924	1,820
Average Treatment Cost per Acre Harvested — Growers' Records	$27.15	$40.81	$13.66
Average Treatment Cost per Acre Harvested — Pest Management Records	$25.36	—	—
Average Treatment Cost per Acre Harvested — Applicators' Records	$25.15	$40.60	$15.45

Independent scout only; Independent scout and self; and Independent scout and insecticide salesmen.

Tables 11 through 15 show the frequencies of the different field scouts used with respect to the number of insecticide treatments, insecticide usage, and total treatment costs. The average number of treatments and total average costs can be used as a reference on these tables to show the relationship between the different combinations of field scouts.

Participants that used only Growers Pest Management Corporation scouts were below the average number of treatments per acre and the total average cost per acre, relative to the other participants that used other combinations of scouts, Tables 11 and 12.

Nonparticipants that used only independent scouts were at or below the average number of treatments and total average cost than the other nonparticipants that used the other combinations of scouts, Tables 13 and 14.

Examination of Table 15 will show the frequency of scouting combinations with respect to the different insecticides. Insecticide types were widely used regardless of the source of scouts, however, there was a tendency toward more expensive ones when insecticide salesmen served as scouts.

Table 11. Number of Participants in Relation to Treatments per Acre and Type of Field Scout, Pinal County, 1974.[a]

Number of Treatments per Acre	Field Scouts			
	Pest Management and Self	Pest Management Only	Pest Management and Sales	Pest Management and Independent
3	0	2	2	0
4	0	1	0	0
5	2	3	1	0
6	0	3	2	1
7	0	0	1	0
8	0	0	1	0
9	0	0	0	1
10	1	1	1	0
12	0	0	1	0
TOTAL	3	10	9	2
Percent of Participants	12.5	41.7	37.5	8.3

a. Mean Number of Treatments per Acre = 6.2

Table 12. Number of Participants in Relation to Treatment Cost per Acre and Type of Field Scout, Pinal County, 1974.[a]

Total Cost per Acre (dollars)	Field Scouts			
	Pest Management and Self	Pest Management Only	Pest Management and Sales	Pest Management and Independent
0 - 10	0	1	1	0
10 - 20	0	3	1	0
20 - 30	1	3	3	1
30 - 40	2	3	2	0
40 - 50	0	1	0	1
Above 50	0	0	1	0
TOTAL	3	10	9	2
Percent of Participants	12.5	41.7	37.5	8.3

a. Mean Total Cost per Acre = $27.15.

Table 13. Number of Nonparticipants in Relation to Treatments per Acre and Type of Field Scout, Pinal County, 1974.[a]

Number of Treatments per Acre	Field Scouts				
	Self Only	Sales Only	Independent Only	Independent and Self	Independent and Sales
5	0	0	0	0	1
6	0	1	0	0	0
7	0	0	2	0	0
8	0	2	3	1	1
9	1	1	1	0	1
TOTAL	1	4	6	1	3
Percent of Nonparticipants	6.7	26.6	40.0	6.7	20.0

a. Mean Number of Treatments per Acre = 7.8.

Table 14. Number of Nonparticipants in Relation to Treatment Cost per Acre and Type of Field Scout, Pinal County, 1974.[a]

Total Cost per Acre (dollars)	Field Scouts				
	Self Only	Sales Only	Independent Only	Independent and Self	Independent and Sales
0 - 10	0	0	0	0	0
10 - 20	0	0	0	0	1
20 - 30	0	1	1	0	1
30 - 40	1	0	1	0	0
40 - 50	0	1	2	1	1
50 - 60	0	1	2	0	0
Above 60	0	1	0	0	0
TOTAL	1	4	6	1	3
Percent of Nonparticipants	6.7	26.6	40.0	6.7	20.0

a. Mean Total Cost per Acre = $40.81.

Table 15. Number of Growers Using Specific Insecticides Recommended by Type of Field Scouts, Pinal County, 1974.

Insecticides	Field Scouts								
	Self Only	Pest Management and Self	Pest Management Only	Pest Management and Sales	Pest Management and Independent	Sales Only	Independent Only	Independent and Self	Independent and Sales
Organochlorines									
Endrin	-	-	-	-	1	-	1	-	-
Toxaphene	-	1	-	3	-	1	-	-	-
Organophosphates									
Axodrin	1	1	2	3	2	1	3	-	-
Bidrin	-	1	-	1	-	-	1	-	-
Cygon	-	1	1	1	-	1	-	-	-
Malathion	-	1	-	-	-	-	-	-	-
Monitor	-	-	1	1	-	1	-	1	1
Parathion - Ethyl	-	1	-	-	-	1	-	-	-
Parathion - Methyl	-	3	3	2	1	1	2	1	-
Carbamates									
Lannate (Nudrin)	1	2	2	5	-	4	6	-	3
Sevin	-	1	2	-	-	-	-	-	-
Others									
Fundal (Calecron)	1	4	4	6	1	4	4	1	1
Combination									
Chlordane-Meth. Para (6-3)	-	-	-	1	-	1	-	-	2
Toxaphene-Meth. Para (6-3)	1	2	7	7	2	3	6	-	3
Toxaphene-Meth. Para (8-2)	-	-	-	1	-	-	-	-	-
Ethyl-Meth. Para (6-3)	1	3	3	3	1	4	4	-	2

CHAPTER V

GROWERS' OPINIONS AND SUGGESTIONS

An Overview

Cotton growers' opinions and suggestions about current pest control practices can be a valuable asset toward improving future cotton pest management strategies in Arizona. Everyone involved in cotton production and pest control can gain direction and insight for improvements by studying growers' attitudes and understanding of integrated pest management principles.

Pest management strategies vary depending on the crop, location of the farms, needs of the growers, and whoever administers the program. Services offered to cotton producers by today's pest management consultants range from making only recommendations on chemical insect control to advising on fully integrated crop management programs (Nemec, 1975). Basic goals for most cotton pest management programs are:

1. Acceptance and use of economic thresholds for applying insecticide treatments.
2. Use of natural biological control agents, such as beneficial insects.
3. Development of careful and proper cotton field scouting methods.
4. Integration of biological, cultural, chemical, and other control methods in crop production, including the proper timing of chemical insect control and control of pests in neighboring crops.
5. Education for the individual cotton growers in the concepts of integrated pest management that meets the needs for the grower.

There have been several studies in the past few years which have evaluated growers' attitudes and opinions toward pest management programs. Many have dealt with the flow of pesticide information to growers. One such study (Turin, Reese and Kempter, 1974) found that pesticide labels and pesticide retailers provided the most information and had the greatest impact on the growers in the study. Also, it was found in this study that extension specialists and extension publications had little impact on growers, but much more impact on those people in the pesticide trade. The difference between extension and retail impact occurred because there were more retailers than extension agents working with the growers.

In another recent study (Ryan, 1973) it was found that farmers in Pinal and Pima Counties in Arizona used retail dealers for information about insecticides and usage more often than any other source; extension agents were the next most commonly used source. Growers in this study felt that insecticide usage was necessary to maintain proper crop yields and good quality.

A study of independent pest management consultants in California (Hall, Norgaard and True, 1975) showed that cotton growers that used pest management consultants were found to be more experienced cotton producers than those who did not use consultants. These growers tended to see greater risks from pests than those who did not use consultants. The growers that used the independent pest management consultants spent an average $8.62 per acre less on insect control than other growers.

In an evaluation of the Texas Pest Management program (Frisbie et al., 1974), growers were requested to answer questions to help evaluate their program. One-hundred and four growers participated in the

survey. All agreed that the cotton pest management program during the 1974 season helped improve their farming operation, helped with insect control decisions, made them more aware of timing of pest control measure, and gave them more time for other farming operations. Only one grower did not think field scouting costs were worthwhile in his program. All but twenty growers were certain that their pest management program reduced pest control costs and prevented yield losses. Only nine growers felt that the field scouts were not reliable, while only three growers were not satisfied with the supervision of the field scouts.

Participant Evaluations

Growers in this study were requested to explain why they followed the pest management strategy they follow, how this method helped their cotton production, and what improvements they would like made in their pest control practices.

During the 1974 season, all participants received consultation for their cotton insect problems from representatives of the Growers Pest Management Corporation. In addition to these consultations, some participants received services from independent cunsultants and insecticide salesmen.

Participants were asked if they understood how their consultants made recommendations and at what infestation levels the recommendations were made. Only eight growers knew and understood how the recommendations were made. Five growers partially understood the concepts and nearly fifty percent or twelve participants did not know or understand the field scouting methods. Those growers that were involved in the program for

three to four years had better conceptual understanding of pest management practices than those who were new to the pest management program.

Ten participants stated that they were involved in the pest management program because they wanted to save money with their insect control expenditures. Another eight growers stated that they participated because they felt that the field scouts and supervisors provided excellent information to make application decisions, along with the overall information about integrated pest management. Additional reasons for participating included the reduction of number of applications and because the information provided made a good comparison to other consultants employed by the growers. The general feeling among the twenty-five participants interviewed was that they wanted pest management consultation not associated with insecticide sales. This reason, they felt, gave them an unbiased evaluation of the insect problem. Growers were especially pleased with the chemical recommendation by the pest management consultants, because the insecticides recommended were less expensive and provided more adequate control than recommendations by other consultants.

There were two participants who dropped the pest management program after 1974 because they were dissatisfied by the performance of the field scouts. One of these growers employed an insecticide sales consultant along with the pest management scouts, while the other used only the pest management scouts. Both had total pest control costs above the average $25.15 for 1974.

Suggestions for improvement in the pest management program by participants were mostly in the area of better communications between the grower, the field scout, and scout supervisors. These growers felt that

they would like more direct communication from the field scouts rather than the present system of only the supervisors making insecticide recommendations. Another group of participants would like to see more experienced field scouts that could take on a wider range of responsibilities. Other growers would like to see the pest management program implemented in other crops. They also asked for recommendation in weed control and for suggestions for fertilization programs. About twenty percent of the participants stated that they were satisfied with their present pest control program offered by the Growers Pest Management Corporation consultants.

Nonparticipant Evaluations

Nonparticipants received pest management consultation during the 1974 season from independent or insecticide sales representatives. Many of the consultants were the same ones that provided additional services to the participants. The nonparticipants also were asked if they understood how their field scouts made recommendations and at what infestation levels the recommendation were made. Seven nonparticipants fully understood the field scouting methods their pest management consultants used and the infestation levels used. Only three nonparticipants partially understood the field scouting methods. Fifteen of the twenty-five nonparticipants surveyed did not understand the field scouting methods or the economic injury concepts with infestation levels. Three nonparticipants stated they had previous experience with pest management corporations. All three stated that they understood the pest management concepts and the recommendations from their independent consultant.

Ten nonparticipants stated that they used the insecticide sales consultants for field scouting and pest management because they were more experienced and had more knowledge about available insecticides than other consultants. One nonparticipant stated he was self-qualified to check his own cotton because of his previous experience as an insecticide salesman. Fourteen nonparticipants stated that they used or were going to use independent field scouts. These growers felt it important to receive recommendations that were not associated with insecticide sales.

Nonparticipants were asked why they did not participate with the Growers Pest Management Corporation pest management program. Ten nonparticipants stated they were satisfied now and did not want to change consultants. Eight growers stated that they felt that the Pest Management Corporation had too many inexperienced field scouts. Three nonparticipants did not use the pest management program because the cost of the program was greater than other available field scouts. Only two nonparticipants stated they were not familiar with the pest management program. There were two nonparticipants that stated plans to join the Growers Pest Management Corporation program in the future because they felt that this organization could lower pest control expenses.

Suggestions for improvements in pest management programs by the nonparticipants were similar to those of the participants. Most were satisfied with their present program and could not foresee any changes necessary. However, some nonparticipants thought it necessary to channel more information from research to the farmer for their use, particularly in the area of new insecticides or other methods of destroying harmful insects. Other growers stated a need for more experienced independent

field scouts that could provide a wider range of services in production of cotton, such as weed and fertilizer consultation. There were two non-participants dissatisfied with the operations by insecticide applicators and felt that the quality and services provided could be improved.

CHAPTER VI

SUMMARY

Integrated pest management is an important factor in production of cotton in Arizona. Several problems associated with large-scale insecticide usage have led to the development of integrated pest control programs used by cotton growers. Cotton growers in Pinal County, Arizona have organized into the "Growers Pest Management Corporation," an organization utilizing integrated pest management principles. Participating members of this organization seek lower cost in pest control by following the recommendations of the pest management specialist of the corporation.

The primary purpose of this study was to determine if cotton growers who participated in the Growers Pest Management Corporation's insect control programs had lower costs in pest control compared to growers who did not participate in the corporation programs. Further, it was important to examine the effect different pest management pest consultants had on control decisions, with respect to the average number of treatments, insecticide usage, and total control costs. An evaluation of the growers' attitudes toward pest management practices was made in order to gain insight for future improvements of pest management programs.

Growers examined in this study were divided between participating members of the Growers Pest Management Corporation and growers that did not participate during the 1974 cotton production season. All growers surveyed operate in Pinal County, Arizona.

Growers' Cultural Practices

Cotton growers were compared in their cultural and production practices to determine the similarities. There were no apparent differences in practices that would tend to bias the results between the two groups.

Average acreage harvested for participants was 400 acres less than nonparticipants. However, yields per acre were similar. Participants harvested, on the average, 1,113 pounds of lint per acre on 610 acre farms, while nonparticipants harvested an average 1,280 pounds of lint per acre on 1,015 acre farms. There is no statistical difference in the average yields.

Both groups used Deltapine variety cotton with nearly equal preference in all kinds. The majority of participants planted at a heavier rate than did the nonparticipants, however, the heavier rate would have little affect on yields. Nearly all growers had planted their cotton by April 15.

Most growers in both groups irrigated at least 6-10 times at an average seasonal rate of 4.5 to 5.5 acre-feet of water.

Fertilization programs in both groups were similar. All growers in both groups applied nitrogen and just over half applied phosphates. Participants applied an average 176 pounds of nitrogen per acre compared to 142 pounds by the nonparticipants. The difference of 34 pounds of nitrogen would have little affect on yields. Both groups applied on the average, approximately 100 pounds of phosphates per acre.

Insecticide Usage Costs

Prices for insecticides were based on an average of five major suppliers' 1974 retail prices. These prices were on a "per gallon" basis, with no field scouting services provided. An average application cost was assumed to be the average fee of the five applicators most often used by growers surveyed. Cost of field checking was not included in the analysis because several growers used more than one field scout with different fees per acre.

Average numbers of insecticide treatments for participants was 6.2 per acre, compared to 7.8 per acre by the nonparticipants. The difference of 1.6 treatments per acre is statistically significant at the five percent level. Participants averaged $16.61 per acre for insectcide costs, while nonparticipants averqged $30.87 per acre costs, a statistically significant difference of $14.26 per acre. Total costs of insect control (insecticides and application) varied, according to the data source used in analysis. However, according to the growers' records, participants averaged $27.15 per acre and nonparticipants averaged $40.81 per acre. The difference of $13.66 is significant at the five percent level.

Impact of Pest Consultants

A comparison of the impact of the pest management consultants was made with respect to the number of insecticide treatments, insecticides used, and total control costs. It was generally found that participants using only the pest management consultants made less applications and used less expensive insecticides compared to those who used a combination

of consultants, especially consultants associated with insecticide sales. Nonparticipants that used only independent consultants generally had lower treatment costs compared to other nonparticipating growers that employed consultants associated with insecticide sales.

Growers' Opinions and Suggestions

Growers in both groups were surveyed to determine what their attitudes are toward pest management programs and what improvements could be made to help their cotton production. A majority of participants were satisfied with the pest management program because of the realized savings in insecticide expenses. Further, the type of information received from the pest management consultants proved to be valuable in pest control decisions.

Nonparticipants generally felt that they would like a pest management program if the field scouts and supervisors are well trained and experienced. Many nonparticipants also thought it was good practice not to have pest consulting associated with insecticide sales as the primary source for control decisions. The most frequent suggestion by this group was a need for more well-trained field scouts that could independently check fields.

Limitations of the Study

This study is limited only to one cotton production season, 1974. Therefore, the results are limited to the pest conditions of one season. Furthermore, there are multiple factors of cotton production that can affect the pest problem and control practices for an individual grower. All growers in this study were considered to have the same factors, such

as managerial ability, neighboring crops affect on their cotton, weather, etc., in order to place all growers on an equal basis in cotton production. The individual grower's production practices are difficult to relate to his pest control practices without a comprehensive evaluation of all production factors.

Implication

Research in this study has demonstrated that growers participating in the Growers Pest Management Corporation pest control programs reduced their costs associated with pest control compared to growers not participating in the program. The results of this study support the finding of the Lawrance (1972) study, where cotton growers adopting the pest management practices of the corporation spent $10.58 less per acre on pest control than growers not adopting the practices.

Cotton growers in the Pinal County area appear to be accepting the integrated pest management principles as a means to bet er control their insect problem. Interpretation of the growers' attitudes toward pest management practices indicates that they are concerned about their control practices and desire expert advice on pest management.

Expansion and improvement in pest management programs is essential provide better solutions to the economic, ecological and social problems associated with pest control. Education and training for pest management specialists are of the most important factors to promote integrated pest management principles. Further education for ptesticide retailers and growers to provide better understanding and acceptance of pest management programs is needed. Research that is conducted in pest

management programs must be made available to all persons involved in pest management, in order to expand and promote the integrated pest management principles.

APPENDIX A

PEST MANAGEMENT PROGRAMS FOR THE GROWERS' PEST MANAGEMENT CORPORATION

Training

Scouts and supervisors attended a three-day training session at Central Arizona College. Training included insect identification, insect behavior, sampling techniques, field situation (surrounding crops, stress, plant densely), insecticide names and safety measures, and public relations.

Additional on-the-job training was conducted by supervisors and assistant supervisors. Mandatory training in identification and technique, problem solving and potential forecasting (insect outbreaks due to spraying, life cycles, moistures) was achieved at weekly in-field meetings.

Scouting Procedures

Fields were scouted at least once a week. Early in the season (before pink bollworm counts) fields were checked every four to five days. When pink bollworm counts began, fields were checked once a week with the exception of kill checks and rechecks on bollworm build-up.

Two assistant supervisors with three years previous scouting experience, were each responsible for three-man teams. Their responsibilities were season-long training, field scout supervision, grower contact, kill checks, and daily liaison with the scout supervisors. Assistant

supervisors were encouraged to make insecticide recommendations if a situation required immediate decision. The scout supervisors were made aware of all recommendations made.

There were two scout supervisors that were responsible over all the scouts, insecticide recommendations, daily grower contact, kill checks, and training.

Procedures for Scouting an Average Field

A. Insects of most importance

1. Pests -- pink bollworm, lygus, bollworm, tobacco budworm, cotton leafperforator.

2. Beneficials -- orius, lacewings, big-eyed bugs, nabibs, etc.

B. Making the counts

1. Check at least four areas in the average-sized field (30-80 acres) and adjust for smaller or larger fields.

2. Areas in the field are checked in a rotating pattern that is dependent on:

a. Initial infestation level

(1) Population evenly distributed -- normal rotation

(2) Population unevenly distributed -- adjusted rotation

b. Physical condition of field

(1) Stage of plant growth (maturity, etc.)

(2) Soil type (sandy, clay)

(3) Stress (dry, heat, cold, etc.)

c. Physical location of field

(1) Adjacent fields

(a) Type (alfalfa, safflower, sugar beets, etc.)

(b) Physical condition (stress, harvest, etc.)

(c) Chemical treatment (insecticide, defoliant, etc.)

(2) Power and telephone lines

(3) Trees

(4) Dwellings

3. In each area

a. Lygus and other plant bugs

(1) 25 sweeps

(2) 25 half-grown squares

(3) look for signs of damage

b. Pink bollworm

(1) 25 bolls 15-20 days old

(2) break them open

(a) warts

(b) mines

(c) larvae (large and small)

c. Cotton bollworm and tobacco budworm

(1) 25 terminals (top and side)

(2) Part the terminal leaves

(3) Search for the live worm

(4) Open at least one square in each terminal area

(5) Note the worm size and position on plant

d. Cotton leafperforator

(1) 25 leaves

(2) Look at underside of leaf for mines, horseshoe stage or exposed larvae

e. Record minor pests and beneficials

4. Time required

   a. Depends on time of season

   b. Probably 45 minutes for average-sized field in pink bollworm part of season

Reporting Procedures

Insect Counts

After field record forms were filled out with insect counts and comments, the grower's copy was left with him or on a clipboard in a place designated by the grower. An office copy was turned in each day to the appropriate supervisor. The supervisor took action on the information provided and the copies were picked up the following day and taken to Tucson for computer evaluation.

Computer Augmentation

Daily Danger Level

The Daily Danger Level is a computer printout listing all fields checked the previous day. The fields are reported in three categories or ranges of infestation for the major pest insect species. If a field is in no immediate danger of economic infestation, there is no level of infestation listed by the field number. The next infestation level reported is intermediate. The actual insect count is listed besides the field number. This indicates an impending infestation and the situation is checked by a supervisor and discussed with the grower. The last range is the established economic threshold and above. The grower is to be contacted immediately if contact has not already been made.

Weekly Data Summary

A weekly insect summary computer printout is compiled each Saturday morning from the data recorded Monday through Friday each week. The resulting printout showed which area or areas had insect problems and the species that were increasing or decreasing when compared with the previous week.

Annual Summary

Another way in which the computer has been put to use is in the Annual Summary sent to each grower in the program. The printout shows the data for the entire season for each field by data scouted including treatment data by date of treatments.

The source for this information has been Moore, Lindsey and Robinson (1973 and 1975).

APPENDIX B

FIELD SURVEY FORM

CONFIDENTIAL

GROWER_____ DATE_____

1. How many acres of cotton were harvested for 1974?

   What were the yields for 1974?

   Short Staple Harvest _____ Long Staple Harvest _____

   Short Staple Yield _____ Long Staple Yield _____

2. Planting Data: 1974

   a. Variety _____ _____

   b. Date _____ _____

   c. Rate _____ _____

3. What crop did cotton follow? _____

4. Fertilization Program Data: 1974

	WHEN	MATERIAL	RATE
a.			
b.			
c.			

5. Irrigation Data: 1974

   a. Number of Irrigations _____

   b. Total Quantity Applied (acre-feet) _____

6. a. How many insecticide treatments were applied to your cotton fields (on an average) for 1974? _____

b. Were there significant differences in the number of treatments on different fields? Yes _____ No _____
If "Yes" - why?

c. Who determined when to apply insect control? _____
What was your role in the decision? _____
Why this method? _____

d. What was the criteria for the treatment decision?

e. At what level of infestations (in general) were the decisions made?

f. How would you evaluate your insect problem in 1974?

7. Who was your applicator?

8. What improvement would you like to see in <u>your</u> pest management program?

9. (PEST MANAGEMENT GROWERS ONLY): What has been your greatest single benefit from participating in the pest management program?

10. (NONPEST MANAGEMENT GROWERS ONLY): Why didn't you participate in the P.M.P.?

APPENDIX C

RECOMMENDED UNIVERSITY OF ARIZONA COTTON INSECT CONTROL PROCEDURES

Table C-1. Cotton Insect Control.

Pest	Insecticide	Dosage per Acre lbs. Active Ingredients
Aphids	Demeton (Systox)	0.25
	Dimethoate	0.25
	Malathion	0.5 - 1.0
	Phosphamidon	0.25
Beet Armyworm	Methomyl (Lannate-Nudrin)	0.33
Bollworm and Tobacco Budworm	Azodrin	1.0
	Methomyl (Lannate-Nudrin)	0.45
	Methyl Parathion	1.0
	Methyl Parathion + Toxaphene + Chlordimeform	1.0 + 2.0 + 0.125
	Methyl Parathion + Endosulfan (Thiodan)	0.75 + 1.5
Cabbage Looper	Bacillus thuringiensis	2-3 qts. or 2-3 lbs.
	Endosulfan (Thiodan)	1.0
Pink Bollworm	Azinphosmethyl (Guthion)	0.5
	Carbaryl (Sevin)	2.0
	Toxaphene + Methyl Parathion	2.0 + 1.0
Salt-Marsh Caterpillar	Carbaryl (Sevin)	2.0
	Methyl Parathion	1.0
	Trichlorfon (Dylox)	1.5
Seed Corn Maggot	Chlordane	3.5 ounces
	Lindane	3.0 ounces
Spider Mites	Azodrin	0.5
	Dicofol (Kelthane)	1.0
Stink Bugs	Endosulfan (Thiodan)	1.0
	Methyl Parathion	1.0

Table C-1. (continued)

Pest	Insecticide	Dosage per Acre lbs. Active Ingredients
Cotton Leaf Perforator	Chloridimeform (Fundal-Galecron)	0.5 - 0.75
	Methomyl (Lannate-Nudrin)	0.22 - 0.45
	Temik	2.0
Cutworms	Toxaphene	2.0
Darkling Ground Beetles	Carbaryl (Sevin)	0
Lygus Bugs, Cotton Fleahoppers	Azodrin	0.5
	Bidrin	0.3
	Dimethoate	0.3
	Malathion	1.0
	Methyl Parathion	1.0
	Temik	2.0
	Toxaphene + Methyl Parathion	2.0 + 0.5
Leaf Roller	Carbaryl (Sevin)	2.0
	Trichlorfon (Dylox)	1.0
Thrips		0

Table C-2. Insecticide Formulation Rates.

Insecticide	Pounds Technical Chemical per Gallon of Material
Azodrin	5 lbs/gal
Belt-MP	4 lbs/gal chlordane + 2 lbs/gal methyl parathion
Bidrin	8 lbs/gal
Cygon	2.67 lbs/gal
Endrin	1.6 lbs/gal
Ethyl Parathion	4 lbs/gal
Fundal (Galecron)	4 lbs/gal
Lannate (Nudrin)	1.8 lbs/gal or 90% soluble powder/lb
Malathion	5 lbs/gal
Methyl Parathion	2 lbs/gal
Monitor	4 lbs/gal
Sevin	80% soluble powder/lb
Toxaphene	6 or 8 lbs/gal
Toxaphene Methyl Parathion (6-3)	6 lbs/gal + 3 lbs/gal
Toxaphene Methyl Parathion (8-2)	8 lbs/gal + 2 lbs/gal
Ethyl Methyl Parathion (6-3)	6 lbs/gal + 3 lbs/gal

Source: Hendley (n.d.).

APPENDIX D

INSECTICIDE USAGE AND COSTS, PARTICIPANTS AND NONPARTICIPANTS

Table D-1. Insecticide Usage -- Participants.

Insecticide	Number of Growers	Acres Applied	Total Gallons	Total Technical Pounds	Average Gallon per Acre
Organochlorines					
Endrin	1	2,400	600.00	960.00	.040
Toxaphene	4	2,907	891.40	5348.40	.060
TOTAL	5	5,307	1491.40	6308.40	.100
Organophosphates					
Azodrin	8	11,427	1170.64	5853.20	.070
Bidrin	2	1,310	78.60	628.80	.005
Cygon	3	447	46.53	124.23	.003
Malathion	1	80	20.00	100.00	.001
Monitor	2	512	90.67	362.48	.006
Parathion - Ethyl	1	345	86.25	345.00	.005
Parathion - Methyl	9	10,480	2500.20	5004.40	.160
TOTAL	16	24,601	3992.89	12418.11	.250
Carbamates					
Lannate (Nudrin)	9	7,170	1555.12	2799.21	.100
Sevin	3	749	263.83	211.06	.020
TOTAL	12	7,919	1818.95	3010.27	.120

Table D-1. (continued)

Insecticide	Number of Growers	Acres Applied	Total Gallons	Total Technical Pounds	Average Gallon per Acre
Others					
Fundal (Galecron)	15	19,606	1033.04	4132.16	.070
Combinations					
Chlordane-Meth. Para. (6-3) (Belt)	1	3,103	1170.74	7024.40	.070
Toxaphene-Meth. Para. (6-3)	18	31,861	9240.88	83160.72	.590
Toxaphene-Meth. Para. (8-2) (Torbidan)	1	427	106.75	1067.50	.007
Ethyl-Meth. Para. (6-3)	11	18,452	2417.45	21757.05	.150
TOTAL	20	53,843	12935.06	113009.67	.820
GRAND TOTAL	24	111,276	21721.30	138878.61	1.380

Table D-2. Insecticide Costs -- Participants.

Insecticide	Average Technical Pounds/Acre	Total Cost (dollars)	Cost per Acre Applied (dollars)	Cost per Acre Harvested (dollars)
Organochlorines				
Endrin	.060	5,520.00	2.30	.35
Toxaphene	.340	7,478.86	2.57	.48
TOTAL	.400	12,998.86	2.45	.83
Organophosphates				
Azodrin	.370	23,506.44	2.06	1.49
Bidrin	.040	3,001.73	2.29	.19
Cygon	.008	871.99	1.83	.06
Malathion	.006	197.40	2.47	.01
Monitor	.020	4,218.36	8.24	.27
Parathion - Ethyl	.020	912.53	2.65	.06
Parathion - Methyl	.320	22,977.70	2.19	1.46
TOTAL	.790	55,686.15	2.26	3.54
Carbamates				
Lannate (Nudrin)	.180	31,491.19	4.39	2.00
Sevin	.010	348.26	.46	.02
TOTAL	.190	31,839.45	4.02	2.02

Table D-2. (continued)

Insecticide	Average Technical Pounds/Acre	Total Cost (dollars)	Cost per Acre Applied (dollars)	Cost per Acre Harvested (dollars)
Others				
Fundal (Galecron)	.26	34,141.98	1.74	2.17
Combinations				
Chlordane-Meth. Para. (6-3) (Belt)	.45	9,763.97	3.15	.62
Toxaphene-Meth. Para. (6-3)	5.28	90,196.39	2.83	5.73
Toxaphene-Meth. Para. (8-2) (Torbidan)	.07	891.36	2.09	.06
Ethyl-Meth. Para. (6-3)	1.38	25,842.55	1.40	1.64
TOTAL	7.18	126,694.27	2.35	8.05
GRAND TOTAL	8.82	261,360.71	2.34	16.61

Table D-3. Insecticide Usage -- Nonparticipants.

Insecticide	Number of Growers	Acres Applied	Total Gallons	Total Technical Pounds	Average Gallon per Acre
Organochlorines					
Endrin	1	430	53.75	86.00	.004
Toxaphene	1	808	103.90	623.40	.007
TOTAL	2	1,238	157.65	709.40	.011
Organophosphates					
Azodrin	5	4,419	583.23	2,916.15	.040
Bidrin	1	1,072	44.60	356.80	.003
Cygon	1	527	52.70	140.70	.004
Malathion	0	0	0	0	0
Monitor	3	443	68.86	275.74	.005
Parathion - Ethyl	1	324	64.80	259.20	.005
Parathion - Methyl	4	12,560	2,960.63	5,921.26	.210
TOTAL	10	19,345	3,774.82	9,869.85	.270
Carbamates					
Lannate (Nudrin)	14	13,575	2,303.23	4,145.81	.170
Sevin	0	0	0	0	0
TOTAL	14	13,575	2,303.23	4,145.81	.170

Table D-3. (continued)

Insecticide	Number of Growers	Acres Applied	Total Gallons	Total Technical Pounds	Average Gallon per Acre
Other					
Fundal (Galecron)	11	47,597	2,048.52	8,194.08	.15
Combinations					
Chlordane-Meth. Para. (6-3) (Belt)	3	9,221	2,750.09	16,500.54	.20
Toxaphene-Meth. Para. (6-3)	13	44,147	13,412.74	120,714.66	.96
Toxaphene-Meth. Para. (8-2) (Torbidan)	0	0	0	0	0
Ethyl-Meth. Para. (6-3)	10	33,076	10,998.05	98,982.45	.79
TOTAL	14	86,444	27,160.88	236,197.65	1.95
GRAND TOTAL	15	168,199	35,445.10	259,116.79	2.55

Table D-4. Insecticide Costs — Nonparticipants.

Insecticide	Average Technical Pounds/Acre	Total Cost (dollars)	Cost per Acre Applied (dollars)	Cost per Acre Harvested (dollars)
Organochlorines				
Endrin	.006	494.50	1.15	.04
Toxaphene	.040	871.72	1.08	.06
TOTAL	.040	1,366.22	1.10	.10
Organophosphates				
Azodrin	.210	11,711.26	2.65	.84
Bidrin	.030	1,703.27	1.59	.12
Cygon	.010	926.47	1.76	.07
Malathion	0	0	0	0
Monitor	.020	3,205.44	7.24	.23
Parathion - Ethyl	.020	685.58	2.03	.05
Parathion - Methyl	.420	25,698.27	2.05	1.85
TOTAL	.710	43,930.29	2.27	3.16
Carbamates				
Lannate (Nudrin)	.300	46,640.44	3.44	3.35
Sevin	0	0	0	0
TOTAL	.300	46,640.44	3.44	3.35

Table D-4. (continued)

Insecticide	Average Technical Pounds/Acre	Total Cost (dollars)	Cost per Acre Applied (dollars)	Cost per Acre Harvested (dollars)
Others				
Fundal (Galecron)	.59	67,203.59	1.42	4.86
Combinations				
Chlordane-Meth. Para. (6-3) (Belt)	1.19	22,935.75	2.49	1.65
Toxaphene-Meth. Para. (6-3)	8.67	129,567.07	2.93	9.31
Toxaphene-Meth. Para. (8-2) (Torbidan)	0	0	0	0
Ethyl-Meth. Para. (6-3)	7.11	117,569.16	3.55	8.44
TOTAL	16.97	270,071.98	3.12	19.40
GRAND TOTAL	18.61	429,712.52	2.55	30.87

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