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AN ECONOMIC EVALUATION OF THE POTENTIAL FOR TREE FRUIT INTEGRATED PEST MANAGEMENT IN THE NORTHEAST

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THE ECONOMIC POTENTIAL FOR TREE FRUIT INTEGRATED PEST MANAGEMENT IN THE NORTHEAST

by
Peter Thompson and G. B. White*

INTRODUCTION

This research was aimed at the economic feasibility of Integrated Pest Management (IPM) for tree fruit crops in the Northeastern U.S. IPM is the use of multiple tactics in a compatible manner to maintain pest populations at levels below those causing economic injury while providing protection against hazards to humans, domestic animals, plants and the environment (Apple et al., 1980). The research gives insight into the rationale for IPM and the design and practicality of delivery systems for promoting IPM. The objectives of this research were as follows:

1. Compare the costs of pest control for participants in the New York State Tree Fruit Pest Management farm advisor project with nonparticipants using data collected for the project since 1973.

2. Evaluate the potential savings in costs and in quantities used from adopting the New York State Tree Fruit Project throughout the Northeastern region.

3. Make suggestions as to changes in the type and method of pest management delivery.

The two delivery systems were in operation until 1977. Apple growers were divided into three groups: a) advisor participants, b) specialist program participants, and c) nonparticipants. The first of these groups received advice through full-time farm advisors trained in insect, disease and mite management by research and extension personnel. The system continued to operate through 1981 with two advisors. Participants of the farm advisor program acquire pest management education and recommendations from pre-season grower conferences, strategy meetings, and consultations with the advisors. Between the years 1973 and 1975 there were 16 participants, though only 6 followed advice closely. With the renaming of the apple project in 1976, the farm advisors gave pest management recommendations on other tree fruits. In the same year growers agreed to pay $10 and $5 per acre participation fee for pome and stone fruits, respectively. Thirty-four growers with over 2500 acres participated in 1976 and 1977. In 1978, a corporate firm with 6 managers employed a pest management trainee from the farm advisor program and a grower with less than 20 acres of apples left the program. In the same year, the participation fee was increased to $12 and $6 for pome and stone fruits, respectively. Participation fell to 26 growers with 1,435 acres of apples.

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The second group, participants of the regional fruit specialist program, obtained advice from extension fruit specialists. Pest management assistants (or scouts) collected data on a daily basis and subsequently delivered the information to the specialist who was then able to render advice. Beyond the direct benefit derived by participating growers in the scheme, other growers, through publications, radio programs and telephone messages and, less directly through chemical fieldmen, benefitted from improved information transfer.

The procedures used to carry out this research were as follows:

1. New York Tree Fruit Pest Management

   i) Farm Advisor Program (Wayne County)
   A statistical analysis was conducted to determine whether or not observed differences in spray costs between participants and nonparticipants of the program were significant. Costs of operating the program were estimated.

   ii) Grower education and general extension
   Savings to growers from applied research and education carried out by the cooperative extension service were investigated. Costs of operation were estimated.

2. Survey of Growers (Northeastern U.S.)

   A survey was conducted from Cornell University and supported by the Institution's College of Agriculture and Life Sciences. The survey was designed to assess potential grower adoption in the Northeastern U.S. of farm advisor (consultant) and general extension delivery systems for tree fruit pest management.

3. Delivery Systems

   Alternative delivery systems for tree fruit pest management in northeastern U.S. are examined in light of the costs of operation and potential adoption by the growers.

NEW YORK STATE TREE FRUIT PEST MANAGEMENT

As part of a national extension service effort, an apple pilot pest management project was initiated in New York State in 1972. In 1976, the project was termed the New York State Tree Fruit Pest Management (NYSTFPM) program. The objectives stated in a brief summary of the project (1973-75) were as follows:

> ". . .to determine:
>
> 1. if a pest management system could be established to integrate all the useful known and new pest management techniques,
>
> 2. if New York fruit growers could reduce their pesticide use through efficient pest management without reduction of the quality and quantity of fruit, and
>
> 3. if a core of specialists could be trained in fruit pest management to continue and expand the practices demonstrated in this system."

In the preliminary years, effort was focused on training personnel, cataloguing spray practices and establishing systems for orchard sampling and organizing data. Primarily, the pest management staff concentrated their work in Wayne County, the leading apple-growing county in New York; subsequently other counties were included. Two forms of delivery of pest management education and advice were tried: a) the farm advisor program operating entirely within Wayne County, and b) the regional fruit specialist program, at one time operating in other western counties and the Hudson Valley (Figure 1). The latter program was discontinued in 1977 and greater emphasis was placed on pest management interaction with all relevant extension personnel including county agents, specialists, researchers, etc.

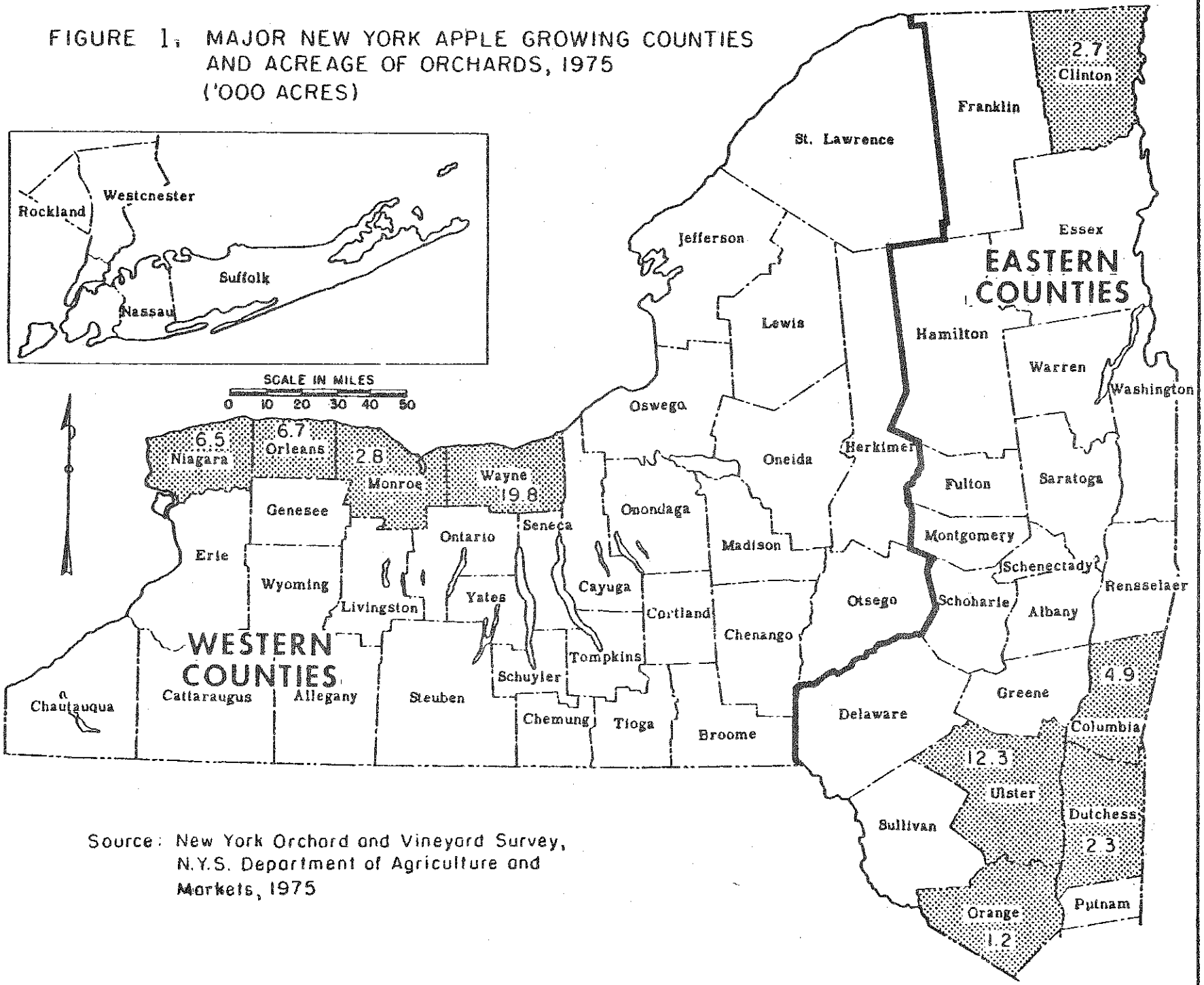
There were 21 participants in the regional fruit specialist program with 337 acres of fruit in 1975. In 1976, participation was increased to 36 growers with over 600 acres of fruit. However, in 1977 and 1978 emphasis was placed on a more general dissemination of information to all relevant groups. Computer services previously of relatively minor import began to play a more prominent role. It will be several years before the computer is central to New York pest management, but its rise in significance is shown in Figure 2. Notably, representatives from all elements now have access to the computer services via telephonic remote access systems. This broader general education, information dissemination and applied research in tree fruit pest management is discussed in a subsequent part of this report.

Some Achievements

Most of this section is drawn from NYSTFPM program progress reports. Between 1973 and 1975, accomplishments were stated as follows:

a) Continuous monitoring of orchards for data on weather, pests, use of chemicals and beneficial organisms was initiated.

FIGURE 1. MAJOR NEW YORK APPLE GROWING COUNTIES AND ACREAGE OF ORCHARDS, 1975 ('000 ACRES)



Source: New York Orchard and Vineyard Survey, N.Y.S. Department of Agriculture and Markets, 1975

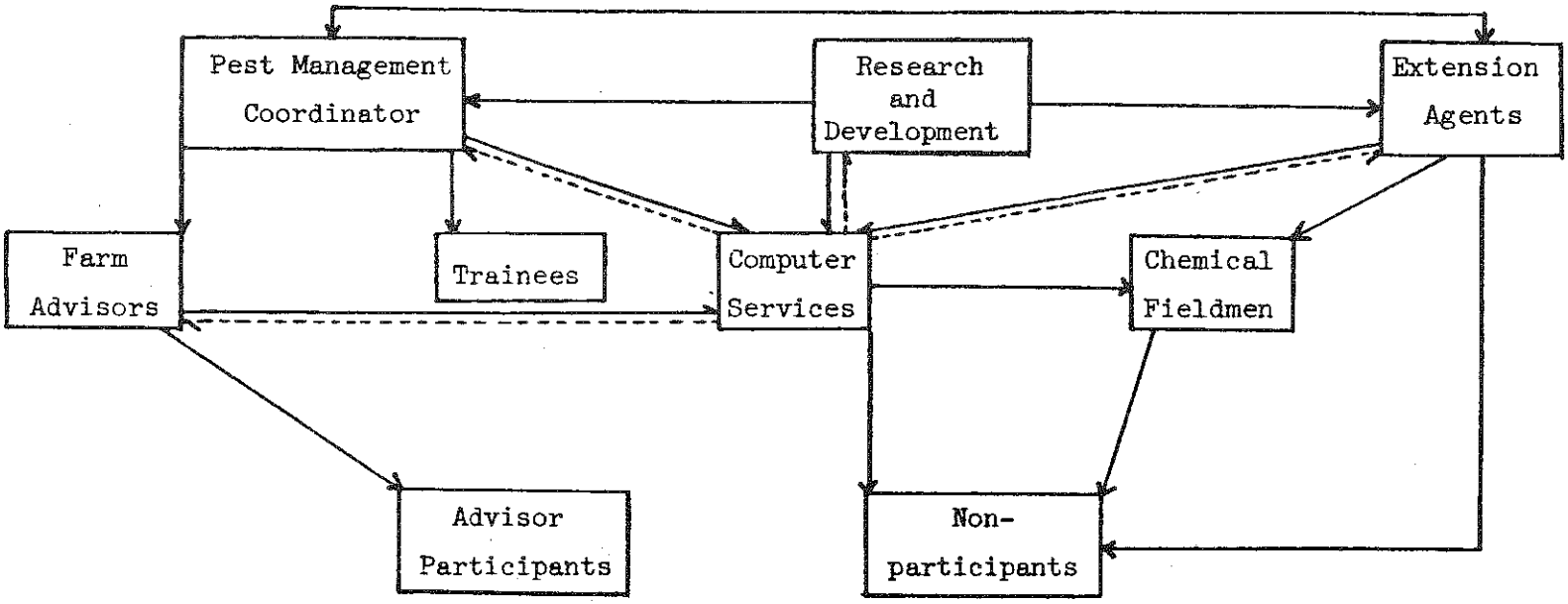


Figure 2 NEW YORK STATE TREE FRUIT PEST MANAGEMENT: DELIVERY SYSTEMS FOR 1979

b) A strategy for the control of apple scab was developed using monitoring of temperature and periods of leaf wetting to determine the likelihood and severity of scab infection and controlling at the primary ascospore stage. A sound basis for the need of fungicide application to control scab was made possible, and in 1975 a scab spray advisory service was established in New york State.

c) The bacteria fireblight was monitored and amelioration of spray timing was possible in 1975.

d) Apple maggot was monitored using a yellow sticky bait trap. More efficient insecticide use resulted because of data provided by trapping.

e) Codling moth and some leaf rollers were monitored through the use of sex pheromone traps. Data from the traps indicated emergence patterns and predicted population outbreaks which improved pesticide application timing.

f) Few details seem available, but predatory mites were encouraged with a view to a "more natural" control of European red mites.

g) Other monitoring techniques were used including emergence cages and orchard inspection.

In 1976, for growers not participating in the farm advisor or the regional fruit specialist programs, a "Code-A-Phone" system was installed. This provided crop protection information for each county through a telephone message system and was updated by the farm advisors and the county agents as situations changed.

For some growers in the apple pest management farm advisor program, benefits were accruing not only in the reduction of pesticide use but also through a) the purchasing of chemicals in a group to receive quantity discount, and b) purchasing such chemicals without chemical fieldmen advice for which companies provided further discount. However, correlated with the two latter benefits was the disadvantage that the growers no longer received advice from chemical fieldmen for other fruit crops such as pears, peaches, cherries, plums and prunes. It was partially for this reason, plus the farm advisors' ability to monitor pests on participating farms, that the program was expanded to include all tree fruit crops and become known as the New York State Tree Fruit Pest Management Program.

A further development in 1976 was an increase in the efficiency in monitoring. Prior to 1976, sex pheromone traps had been placed on a 10-acre grid system across farms. Research results indicated that such a density was not necessary and fewer traps were used on a 50-acre basis.

In 1977, greater emphasis was placed on three areas as follows:

a) In the 1977 progress report of the NYSTFPM program, it was noted that four large growers hired their own pest managers. As a result, greater significance was attached to education and training at all levels; firstly a new training scheme for growers was implemented in an attempt to encourage use of IPM techniques;

secondly, the program incorporated training of graduate and undergraduate students in practical aspects of crop protection; and thirdly, IPM workshops were made available to fieldmen, extension agents, growers and new pest management personnel.

b) In an attempt to reduce the number of applications and the total quantity of fungicides used on apples, attention was paid to a tree's susceptibility to apple scab at various stages of growth, and the weathering of fungicide residues was examined with a view to assessing disease protection.

c) Importance was attached to alternative models. Specifically a mite model developed in Michigan was found partially applicable in Western New York and prediction of apple maggot emergence and oblique-banded leaf roller egg hatch was improved using models developed in New York.

In 1978, pest management workshops were presented to fruit extension specialists, fieldmen, and growers. However, it has been difficult to evaluate how well the pest management concept has been applied at the farm level. Action thresholds were articulated by the farm advisors as a means of recording criteria used for spray recommendations. At this stage these criteria are being informally tested at the farm level by agents cooperating with growers. It will be several years before a manual can be written stating applicable action thresholds which cover the relevant combinations of pest population levels with their predators and parasites and alternative weather and tree-growth conditions. This form of work helps lay the foundations for eventual incorporation of economic thresholds.

Savings to Growers, 1973-77

Data have been collected since 1973 on the quantity, timing and number of pesticide applications for groups of growers in Wayne County. Using standard prices for chemicals, these data are summarized in Tables 1 and 2. In the first three years of the farm advisor program, growers were categorized according to the extent to which recommendations were followed. Average spray material costs per acre from the groups indicate savings to growers following advice closely over those following some or little advice. In those three years in the pilot stage, growers were unsure of results and only six followed recommendations closely.

In 1976 and 1977 (Table 2), growers made contributions to the program. Results are no longer displayed within three categories on the assumption that in the main, growers followed recommendations for which they had paid. Savings were of the order of $20 or $30 per acre for both fresh and processed fruit. Yield is assumed unaffected by the quantity of pesticide used, percentage clean fruit, however, varies according to pest damage. Variation in the average percent clean fruit between farm groups in 1973 and 1975 was relatively large, whereas in 1976 and 1977 was small. The insignificant variation in recent years suggests that either the system of recording damage is poor, or risk aversion is still built into crop protection.

Table 1. Average Spray Material Costs per Acre, Number of Applications and Percentage Clean Fruit for the Apple Pest Management Pilot (Farm Advisor) Project, 1973-75

Year	Amount of Advice Followed by Growers	Farms	Acres	Spray Material Costs		Average Applications	Average Percent Clean Fruit
				Average	Range		
		----number----		--dollars per acre--		---number---	
1973							
	a) Most	6	509	70.02	34-95	10	94.3
	b) Some	6	410	61.33	34-107	10	75
	c) Little	4	207	89.89	83-115	12	90.3
1974							
	a) Most	6	619	65.81	44-85	9.6	N.A.
	b) Some	6	430	57.76	42-80	10	N.A.
	c) Little	4	183	85.05	72-105	12	N.A.
1975							
	a) Most	6	657	68.68	45-95	8	94
	b) Some	6	459	79.76	52-111	9	85
	c) Little	4	211	98.72	82-126	11	94

N.A. = Not Available.

Table 2. Average Spray Material Costs Per Acre, and Percentage Clean Fruit For the New York State Tree Fruit Pest Management Farm Advisor Program 1976 and 1977

Year	Participation	Farms	Acres	Spray Material Costs		Average Percent Clean Fruit
				Average	Range	
		---number---		--dollars per acre--		
1976						
	Participants					
	Fresh	26	728	77.50	49-164	96
	Processing	29	1,793	65.84	49-113	95
	Nonparticipants					
	Fresh	4	67	105.44	51-133	98
	Processing	5	191	101.79	80-113	98
1977						
	Participants					
	Fresh	34	631	72.12	41-122	98
	Processing	34	1,900	62.86	38-101	99
	Nonparticipants					
	Fresh	11	104	104.81	59-123	98
	Processing	11	424	80.61	60-110	99

The wide variation in range of pesticide costs per acre indicates differences in: a) the type and intensity of pest problems, b) levels of risk aversion, and c) efficiencies in pest management. One of the key problems in testing for grower savings from a pest management program is attempting to differentiate between possible alternative reasons mentioned above. The duplication of savings over several years suggests greater confidence may be attached to the hypothesis of realized savings through increased pest management efficiency.

Savings to Growers, 1978

For the year 1978, a test was set up to discover whether or not grower savings attributable to participation in the farm advisor program were significant. Data from 23 nonparticipants were collected by a part-time technician in the 1978 growing season on the numbers, timing and dosages of pesticide applications. All farms were located in Wayne County, N.Y. Similar data had been collected from the 26 participants of the program by the farm advisors. Blocks of fruit were defined on the farms and records of cultivar mix, proportion of fruit intended for the fresh and processing markets, size and spacing of trees and rootstocks used were noted for each block type. With this information it was possible to match 33 participant and nonparticipant blocks and thus reduce the level of variability in pesticide use attributable to factors other than participation in the program. Standard prices for each pesticide compound from a survey of local prices was used to calculate pesticide costs for the two groups (Thompson, 1980).

Table 3 presents results for all blocks in the sample. Total spray material costs for participants range from $29 to $96 whereas for nonparticipants range from $46 to $248. The average costs of nonparticipants exceed those of participants by $25 per acre. Spray material costs are subdivided into insecticide, miticide and fungicide categories. Tables 4 and 5 present the findings when blocks are categorized by market type, fresh and processing respectively. In each table tests of equal variance and equal means are presented using an F-test and separate variance estimate t-test, respectively.

Using the results of the F- and t-tests to put a measure of confidence on the difference in pesticide use between participants and nonparticipants, the following observations may be made.

a) In each of the pesticide groups for both the fresh and processing blocks and for the aggregated cases of total spray material costs per acre for all blocks, mean spray costs of the nonparticipant exceeded those of the participant. The formal tests indicated that in all but two cases the hypotheses of equal means in the two groups were rejected at the 10 percent level and their one-sided alternatives accepted. The first exception was on fresh blocks where the participation fee of 12 dollars per acre was added to total spray material costs. There, the hypothesis of equal means was just accepted at the 20 percent level. Average savings were still positive, around $8 per acre, but insufficient to reject the hypothesis. The second exception was in insecticide use for processing blocks where the hypothesis of equal means was just accepted at the 10 percent level.

Table 3. Survey Results (1978): Tests of Differences Between Means and Variances of Spray Material Costs - All Blocks

	No. of Blocks	Costs per Acre			F-Value	2 Tail Probability	Separate Variance Estimate		
		Mean	Variance	Range			t-Value	d.f.	1 Tail Probability
		---------dollars---------							
Total Spray Materials									
Participants	33	67.67	232.87	29-96	6.24	0.000	-3.60	42.00	0.000
Nonparticipants	33	93.39	1452.47	46-248					
Total Spray Material and Participation Fee*									
Participants	33	79.67	282.87	42-108	6.24	0.000	-1.92	42.00	0.031
Nonparticipants	33	93.39	1452.47	46-248					
Insecticides									
Participants	33	20.45	49.29	9-45	4.97	0.000	-4.15	44.38	0.000
Nonparticipants	33	32.84	244.97	12-75					
Miticides									
Participants	33	9.87	36.93	0-23	2.80	0.003	-1.88	52.28	0.033
Nonparticipants	33	13.74	103.35	0-54					
Fungicides									
Participants	33	37.36	101.24	18-60	3.37	0.001	-2.58	49.43	0.006
Nonparticipants	33	46.18	341.66	17-119					

* Participation fee is $12 per acre.

Table 4. Survey Results (1978): Tests of Differences Between Means and Variances of Spray Material Costs - Fresh Blocks

	No. of Blocks	Costs per Acre			F-Value	2 Tail Probability	Separate Variance Estimate		
		Mean	Variance	Range			t-Value	d.f.	1 Tail Probability
		---------dollars---------							
Total Spray Materials									
Participants	11	71.91	315.35	30-93	2.15	0.242	-2.07	17.64	0.026
Nonparticipants	11	91.56	678.88	55-138					
Total Spray Material and Participation Fee*									
Participants	11	83.91	315.35	42-105	2.15	0.242	-0.80	17.64	0.216
Nonparticipants	11	91.56	678.88	55-138					
Insecticides									
Participants	11	22.57	48.95	9-31	2.49	0.166	-1.44	16.92	0.084
Nonparticipants	11	28.24	121.88	12-49					
Miticides									
Participants	11	8.28	20.57	0-17	3.21	0.080	-2.15	15.69	0.024
Nonparticipants	11	14.31	64.95	4-28					
Fungicides									
Participants	11	41.07	94.12	18-59	1.30	0.682	-1.79	19.96	0.044
Nonparticipants	11	49.01	122.81	28-67					

* Participation fee is $12 per acre.

Table 5. Survey Results (1978): Tests of Differences Between Means and Variances of Spray Material Costs - Processing Blocks

	No. of Blocks	Costs per Acre			F-Value	2 Tail Probability	Separate Variance Estimate		
		Mean	Variance	Range			t-Value	d.f.	1 Tail Probability
		---------dollars---------							
Total Spray Materials									
Participants	22	65.56	190.59	40-96	9.90	0.000	-2.96	25.20	0.004
Nonparticipants	22	94.30	1887.38	46-248					
Total Spray Material and Participation Fee*									
Participants	22	77.56	190.59	52-108	9.90	0.000	-1.72	25.20	0.048
Nonparticipants	22	94.30	1887.38	46-248					
Insecticides									
Participants	22	19.38	48.26	11-45	6.19	0.000	-3.97	27.62	0.000
Nonparticipants	22	35.14	298.63	15-75					
Miticides									
Participants	22	10.66	44.50	0-23	2.83	0.021	-1.00	34.20	0.101
Nonparticipants	22	13.45	125.83	0-54					
Fungicides									
Participants	22	35.51	98.67	23-60	4.65	0.001	-2.03	29.64	0.026
Nonparticipants	22	45.72	458.35	17-119					

* Participation fee is $12 per acre.

b) The estimated variances of spray material costs per acre of the nonparticipant exceeded those of the participant in all cases. This was not unexpected given the diversity of pest management capabilities and sources of information open to the nonparticipant whereas the participant relied completely on the services of the farm advisor to aid in pest management decision-making. Nevertheless, F-values presented for fresh blocks in Table 4 indicate acceptance of the hypothesis of equal population variances at the 5 percent level. Though the sample size is smaller for fresh blocks than for processing blocks, estimated variance of total spray material costs per acre for participants is smaller in processing blocks than in fresh blocks. This suggests that there are more divergent pest problems or pest management practices on fresh fruit than processing fruit.

c) Savings attributable to participation in the program were highest on processing blocks, particularly in the use of insecticides where the participant had average savings of $16 per acre over the nonparticipant. This is expected because firstly, insects are visible to the naked eye and can be readily inspected and counted before damage occurs, possibly reducing the necessity for calendar spraying and encouraging spraying when needed. On the other hand, diseases are not usually visible until some time after infection (and damage). This increases the necessity for preventive sprays. Secondly, on processing fruit an element of cosmetic damage can be tolerated thus providing savings in excess of those realized on fresh fruit.

d) Least savings to the participant were realized on fresh fruit, since average total spray material costs savings were $19 per acre. The one-tail probability associated with insecticide costs was 8.4 percent indicating less confidence could be attached to the difference between the two groups. With higher cosmetic standards it is possible that farm advisors take less risk with fresh fruit.

e) Savings of $9 and $4 respectively were realized by participants in fungicide and miticide use and probably arose from a general improvement in pest management such as forecasting peak pest activities thus improving spray timing, making the best choice of chemicals, carefully calibrating spray equipment and taking greater care over the dosages applied.

Further observations may be made by examining Tables 6 to 9. Table 6 presents the results of a fruit harvest quality survey carried out by the pest management personnel in 1978. The same format for testing fruit quality had been used in previous years. Ideally one would want to know the economic significance of the percentages of clean fruit; for example, to what extent does fruit quality of 96 percent hinder the fruit's marketability and value? Currently an informal experiment has been set up to test action thresholds. Years of results from this kind of experiment with relevant economic data could shed light on the trade offs between lower fruit quality (as a result of lower pesticide use) and reduced revenue from marketing the crop. The thresholds are articulated by the farm advisors for the purpose of communication to pest management trainees, interested growers and extension county agents and specialists. For the 1978 survey the results on Table 6 serve to illustrate that there is no discernable difference in fruit quality between participants and nonparticipants.

Table 6. Survey Results (1978): Mean, Standard Deviation and Range of Fruit Harvest Quality

No. of Blocks	Participants 26	Nonparticipants 31
Commercially Acceptable Fruit		
Top (percent)		
Mean	98.89	98.88
Std. Dev.	(0.862)	1.048
Range	96.80-100.00	95.60-100.00
Side (percent)		
Mean	99.07	99.22
Std. Dev.	(1.051)	(0.811)
Range	95.00-100.00	96.60-100.00
Drops (percent)		
Mean	97.58	97.84
Std. Dev.	(1.963)	(2.447)
Range	93.00-100.00	87.69-100.00
Number of Drops		
Mean	389	377
Std. Dev.	(107)	(121)
Range	162-500	111-500

Table 7. Survey Results (1978): Number of Pesticide Applications by Two Week Periods

	No. of Blocks	23 Apr-6 May	7 May-20 May	21 May-3 June	4 June-17 June	18 June-1 July	2 July-15 July	16 July-29 July	30 July-12 Aug	13 Aug-26 Aug	27 Aug-9 Sept	Total	Mean	Std. Dev.
All Blocks	66	64.5	171.5	96.5	100.0	29.5	41.0	41.5	51.0	51.5	5.0	652	9.879	1.850
a) Participants	33	33.0	81.0	41.5	58.0	7.5	12.0	19.0	29.0	25.5	1.0	307.5	9.318	2.098
b) Nonparticipants	33	31.5	90.5	55.0	42.0	22.0	29.0	22.5	22.0	26.0	4.0	344.5	10.439	1.380
Fresh Blocks	22	22.5	59.5	35.0	36.5	12.5	16..5	14.0	19.0	15.0	2.0	232.5	10.568	1.692
a) Participants	11	11.0	29.0	15.0	21.5	3.0	6.0	7.0	11.0	8.0	1.0	112.5	10.227	2.042
b) Nonparticipants	11	11.5	30.5	20.0	15.0	9.5	10.5	7.0	8.0	7.0	1.0	120.0	10.909	1.261
Processing Blocks	44	42.0	112.0	61.5	63.5	17.0	24.5	27.5	32.0	36.5	3.0	419.5	9.534	1.847
a) Participants	22	22.0	52.0	26.5	36.5	4.5	6.0	12.0	18.0	17.5	0.0	195.0	8.864	2.019
b) Nonparticipants	22	20.0	60.0	35.0	27.0	12.5	18.5	15.5	14.0	19.0	3.0	224.5	10.205	1.403

Table 7 presents the total number of applications by two weekly periods. Half applications would include perimeter of alternate row sprays and whole applications refer to spraying every row. On average, the participant saves one application over the nonparticipant with greater savings in the processing blocks. These data indicate that the period of greatest savings in pesticide applications is in June and July.

Using the results from Table 7, the calculated mean spray material costs per acre per application was $7.26 for participants and $8.85 for nonparticipants. Thus, savings in spray materials were made by making one less application by reducing the dosage of chemical in the application.

Yield data were collected from some blocks. This made possible the calculation of spray material costs per unit weight of apples. Tons were chosen as the most useful unit and results are presented in Tables 8 and 9. No formal analysis was conducted, firstly because the experiment was not set up to specifically measure such differences, secondly because the sample sizes were small and thirdly it is generally believed that in any one season, pest activity has little impact on yield and more on crop quality. However, results are of interest and re-emphasize the findings presented in earlier tables, as there appears to be no difference in yield.

Beyond the reduction in pesticide use, participants realized further savings through a reduction in the number of applications. The reduced number of pesticide applications brings about savings in labor and machinery costs. Using figures drawn from personal communication with Snyder (1979) it is possible to make exploratory calculations to illustrate the type of savings realized.

Machinery and Labor Costs Per Hour	Dollars
Labor	4.00
Tractor	4.00
Sprayer	2.50
Total machinery & labor costs per hour	10.50

Assuming an application rate of 6 acres per hour, machinery and labor costs of an application are 1.75 dollars per acre. Using Data from Table 7, total machinery and labor costs per acre may be calculated for participants and nonparticipants as follows:

Participants	9.318 applications x 1.75 dollars = 16.31 dollars
Nonparticipants	10.439 applications x 1.75 dollars = 18.27 dollars

Therefore, total pest management costs per acre for spray materials, labor, machinery and participation were as follows:

Table 8. Survey Results (1978): Mean Crop Yields - All, Fresh and Processing Blocks

	All Blocks		Fresh Blocks		Proc. Blocks	
	No. of Blocks	Mean	No. of Blocks	Mean	No. of Blocks	Mean
		(tons)		(tons)		(tons)
Yield (tons per acre)						
Participants	16	14.151	4	13.292	12	14.438
Nonparticipants	13	14.063	5	13.480	8	14.427

Table 9. Survey Results (1978): Mean Spray Material Costs Per Ton - All, Fresh and Processing Blocks

	All Blocks		Fresh Blocks		Proc. Blocks	
	No. of Blocks	Mean	No. of Blocks	Mean	No. of Blocks	Mean
		dollars		dollars		dollars
Total Spray Material Costs per ton						
Participants	16	5.092	4	5.790	12	4.860
Nonparticipants	13	6.848	5	7.237	8	6.604
Insecticide Costs per ton						
Participants	16	1.620	4	1.855	12	1.542
Nonparticipants	13	2.395	5	2.332	8	2.434
Miticide Costs per ton						
Participants	16	0.633	4	0.648	12	0.628
Nonparticipants	13	0.950	5	1.044	8	0.890
Fungicide Costs per ton						
Participants	16	2.839	4	3.287	12	2.690
Nonparticipants	13	3.503	5	3.860	8	3.280

	Participants	Nonparticipants
	- - - - - - dollars - - - - - - -	
Participation fee	12.00	0
Spray material costs	67.67	93.39
Machinery and labor costs	16.31	18.27
	95.98	111.66

Based on the assumed machinery and labor costs, calculated savings are approximately $16 per acre.

Costs of Farm Advisor Delivery

Costs of the farm advisor delivery were drawn from estimates by the pest management coordinator. The objective was to find the likely costs of administering and operating a farm advisor program on a private basis and operated as presented above. The detailed savings to growers were presented for 1978; consequently, cost estimates are given for the same year. Though there is some grower funding for the farm advisor program, the program is integrated into extension and research work. This makes disaggregation of the "private" farm advisor costs from general extension costs complex. However, best estimates are as follows:

1978 Farm Advisor Delivery

Imputed Costs	- - - - - - dollars - - - - - - -	
Salaries	28,000	
Transport (including vehicle depreciation)	2,640	
Office	1,440	
Laboratory trailer depreciation	100	
Imputed Heat & Light	200	
Misc. - insurance, etc.	500	
Total Costs		32,880
Income		
Acreage Fees		19,000

Salaries include a proportion of the two farm advisors' time estimated to be spent on tree fruit pest management consultation with paying clients, plus some secretarial help. Other costs are self-evident. Income comes from the acreage subscription fees of 12 dollars per acre for pome fruits and 6 dollars for stone fruits. With 1,487 acres of pome fruits and under 200 acres of stone fruits, income is about 19,000 dollars. There is a wide discrepancy between the costs and the income. This is not surprising given the objectives of the program. However, if the program were privately operated, with no subsidies, it would be necessary for the program's

revenues to exceed costs in order to survive. The possibilities for achieving this are as follows:

a) Increase acreage fee with the same number of growers and acreage.

b) Decrease costs without change in income.

c) Increase the acreage taken on without increasing costs.

d) All of the above.

A personal comment by the pest management coordinator indicated that out of the four options, the third seemed to be most plausible. Further issues concerning private consultant-type deliveries such as the number of acres handled by consultants and the sizes of farms visited are discussed in a subsequent section.

POTENTIAL ADOPTION OF PEST MANAGEMENT

(A SURVEY OF GROWERS IN THE NORTHEAST)

This section deals with a survey by mail of tree fruit growers in the Northeastern U.S. The objective of the survey was to examine potential grower adoption of farm advisor (consultant) type pest management services and/or their interest in education programs. There are two subsections, the first outlines the methods and procedures of the survey, the second presents and discusses the findings.

Methods

A questionnaire for a survey by mail was designed to collect data on sources of information used by tree fruit growers in pest related decisions and interest in pest management consultancy services and education programs. Pretesting of the questionnaire was not carried out on farmers; however, copies were sent to representative pest management researchers of eight states in the Northeastern U.S. In this manner at least one individual from each state in which the survey was carried out was able to give comments on the proposed questionnaire and offer or deny his support for the survey in the region. Furthermore, he was able to inform researchers at Cornell University of any problems specific to the state in which they were located. Assistance and support for the survey was also sought through the crop reporting services of New York, Pennsylvania, and New England. Each was able to provide a 50 percent sample of tree fruit (or apple) growers in their respective jurisdictions. It was believed that the crop reporting services were able to provide the most complete listings of farmers names and addresses.

The crop reporting service in New York State has had considerable contact with Cornell University and its research activities. For this reason, and on the understanding that information from farmers would be treated with the utmost confidence by releasing only averages in this report, the New York Crop Reporting Service provided a 50 percent sample mailing list of tree fruit growers in New York toward the end of January of 1980.

The crop reporting services for Pennsylvania and New England had had less contact with Cornell University and for this reason were prepared to cooperate as long as the mailing list was not released to Cornell University researchers. In addition, the Pennsylvania Crop Reporting Service agreed to cooperate if two further conditions were met. Firstly, it was required that the letter to the farmer enclosed with each questionnaire was on official Pennsylvania State University notepaper and that secondly, the letter was signed by a researcher from Pennsylvania. Therefore, envelopes were prepared at Cornell University containing a) the questionnaire, b) a letter explaining the reason for the survey and asking for farmer cooperation, and c) a preaddressed, postage-paid envelope for returning the questionnaire. Over 300 and over 400 envelopes with contents were sent to the New England and Pennsylvania Crop Reporting Services, respectively. There, they were addressed and mailed to growers in the two regions. No identification marks were placed on the questionnaires or return envelopes, consequently it was not possible to follow up on the survey to encourage extra response nor to query individual responses or ommissions on the

questionnaire. The questionnaires were mailed to growers in late January and February of 1980. Numbers mailed to each state were as follows:

	Questionnaires Mailed Out
New York	400
Pennsylvania	425
Connecticut	58
Rhode Island	12
Massachusetts	90
Vermont	35
New Hampshire	40
Maine	85
TOTAL	1,145

Over 590 questionnaires were returned, of which 79 were not applicable for the analysis. Most of the 79 no longer grew fruit in commercial quantities or had retired from farming completely; a few returned the questionnaire completely blank suggesting that the farmer no longer grew tree fruit or was refusing to participate in the survey, and two were not willing to participate in the survey and stated opinions in a letter to the survey coordinator.

There were 515 responses with all or part of the questionnaire completed; therefore, 515 makes up the sample. For any specific analysis on responses to questions the sample size may be smaller and is stated in the relevant tables. For an examination of the sample size in relation to the tree fruit area in the northeast, see Table 10. Because a more indepth survey had been carried out in Wayne County, New York only 18 months earlier, Wayne County had been omitted from the survey by mail. Other relevant issues about the total population of growers, the estimated tree fruit areas and the sources of the data are footnoted in the table.

The survey by mail had a response rate of 49 percent. This represents about 22 percent of the growers in the northeast and about 33 percent of the apple acreage. This suggests that there was a higher response rate by the growers with larger acreages of tree fruit than for growers with relatively small acreages. There may be a tendency for the growers with relatively little dependence on tree fruit to ignore the survey because of the lack of importance he may attach to the crop. Furthermore, a high response rate by a relatively small number of growers with very large farms would cause such a bias. For the purposes of the analysis, it must be borne in mind that the fruit acreage bias does exist and is accentuated in Pennsylvania.

Findings

The results of the survey are given below with respect to sources of information, consultants, and educational programs.

Sources of Information

Data were collected on the sources of information used by farmers in decision making on selection, timing and rate of pesticides and/or farm

Table 10. Tree Fruit Area in Northeastern U.S.: Total and Sample

	Farms		Apples		Pears		Cherries		Peaches[b/]		Plums[c/]		Total[d/]	
	Total[a/]	Sample	Total	Sample	Total	Sample	Total	Sample	Total	Sample	Total	Sample	Total	Sample
	number		acres											
New York[e/]	825	197	46,977	10,823	3,324	599	3,382	852	1,944	749	1,142	279	56,769	13,302
Pennsylvania	850	182	32,858	15,381	1,500	635	2,546	1,127	10,309	3,980	387	156	47,600	21,285
Maine	170	37	6,710[f/]	1,545	n/a	11	n/a	2	n/a	3	n/a	3	n/a	1,563
New Hampshire	80	17	3,876[f/]	1,390	n/a	11	n/a	1	n/a	31	n/a	2	n/a	1,434
Vermont	70	15	3,841[f/]	1,308	n/a	13	n/a	4	n/a	7	n/a	2	n/a	1,334
Massachusetts	180	37	5,540[f/]	2,100	n/a	61	n/a	0	236[f/]	96	n/a	6	n/a	2,263
Connecticut & Rhode Island	140	30	2,966[f/]	949	313[f/]	104	n/a	1	406[f/]	96	n/a	9	n/a	1,160
TOTAL	2,315	515	102,768	33,496										

[a/] These totals comprise of best estimates from the crop reporting services tree fruit surveys and personal communications with statisticians preparing the reports.

[b/] Includes nectarines.

[c/] Includes prunes, apricots, and damsons.

[d/] Includes other tree fruits and nuts, e.g. quince and walnuts.

[e/] Excludes Wayne County.

[f/] Acreage estimated from tree numbers using planting densities i) 45, ii)110 and iii) 90 trees per acre for i) standard apples, ii) dwarf & semi-dwarf apples and iii) pears and peaches, respectively.

practices for the purpose of controlling pests. Tables 11a and 11b present the responses to the question by region. The sources of information listed on Tables 11a and 11b were also presented on the questionnaire. The respondent was provided with a choice of the proportion of advice followed or information used, as follows: NONE SOME LARGE. Consequently the responses tabulated represent the proportions of farmers circling SOME or LARGE.

The sample size is 513. Over 80 percent of the growers use extension personnel as a source of information, and just under 80 percent claim to use their personal experience. The main deviation from these proportions is found in Southern Pennsylvania (see Figure 3 for definition of regions). This region is one of the most important tree fruit growing regions in the Northeastern U.S. For this reason it is a favorable location for a pest management consultancy business. From Table 11a it can be seen that 34 percent of the Southern Pennsylvania growers use a consultant paid by subscription; consequently, less reliance is placed on the extension service and personal experience.

Fifty-two percent of the growers used their chemical retailer as a source of information and 47 percent used a representative of a chemical manufacturer. In areas of low fruit concentration the representative of chemical manufacturers probably visited farms less frequently. This is shown up in the lower incidence of use in Western Pennsylvania and Central New York.

No processor's fieldmen work in Northeastern New York or Western Pennsylvania. Otherwise a relatively small proportion of growers indicate that they use their services. Of sources of information including sales leaflets, chemical packaging, farm magazines, newspapers, and television, the instructions and notes on the label or container of the chemical are most frequently used. The region where least importance was attached to the label or container was Southern Pennsylvania where growers are relatively more dependent on consultants. In Northwestern New York 36 percent of the growers listen to the radio as a source of information in pest related decision-making. The extension service in the region runs a radio program which updates growers in the region on current pest problems and possible measures to control the pests. About 30 percent of the growers use friends and neighbors and relatives as a source of information. Only 16 percent of Maine growers claim to use their neighbors, etc. as a source of information. Maine growers usually supplement personal knowledge with information from extension fruit specialist and/or chemical company representatives. In addition, there is a major broker in the state with a field representative who contacts a majority of commercial growers (Stiles, 1981).

Comments made above and data in Tables 11a and 11b refer to grower responses of both SOME and LARGE when answering the proportion of advice followed from each source of information. Consequently, there is no separation betweeen the two responses if the source of information was used. Table 12 breaks down the responses into the proportion and quality of advice followed. For example, 269 growers used their chemical retailer as a source of information in pest-related decision-making. Of the 269 growers, 66 percent followed SOME of the advice or recommendations and the

FIGURE 1. LOCATIONS OF HIGH TREE FRUIT DENSITY IN THE NORTHEASTERN UNITED STATES AND THE ASSOCIATED TREE FRUIT ACREAGES.

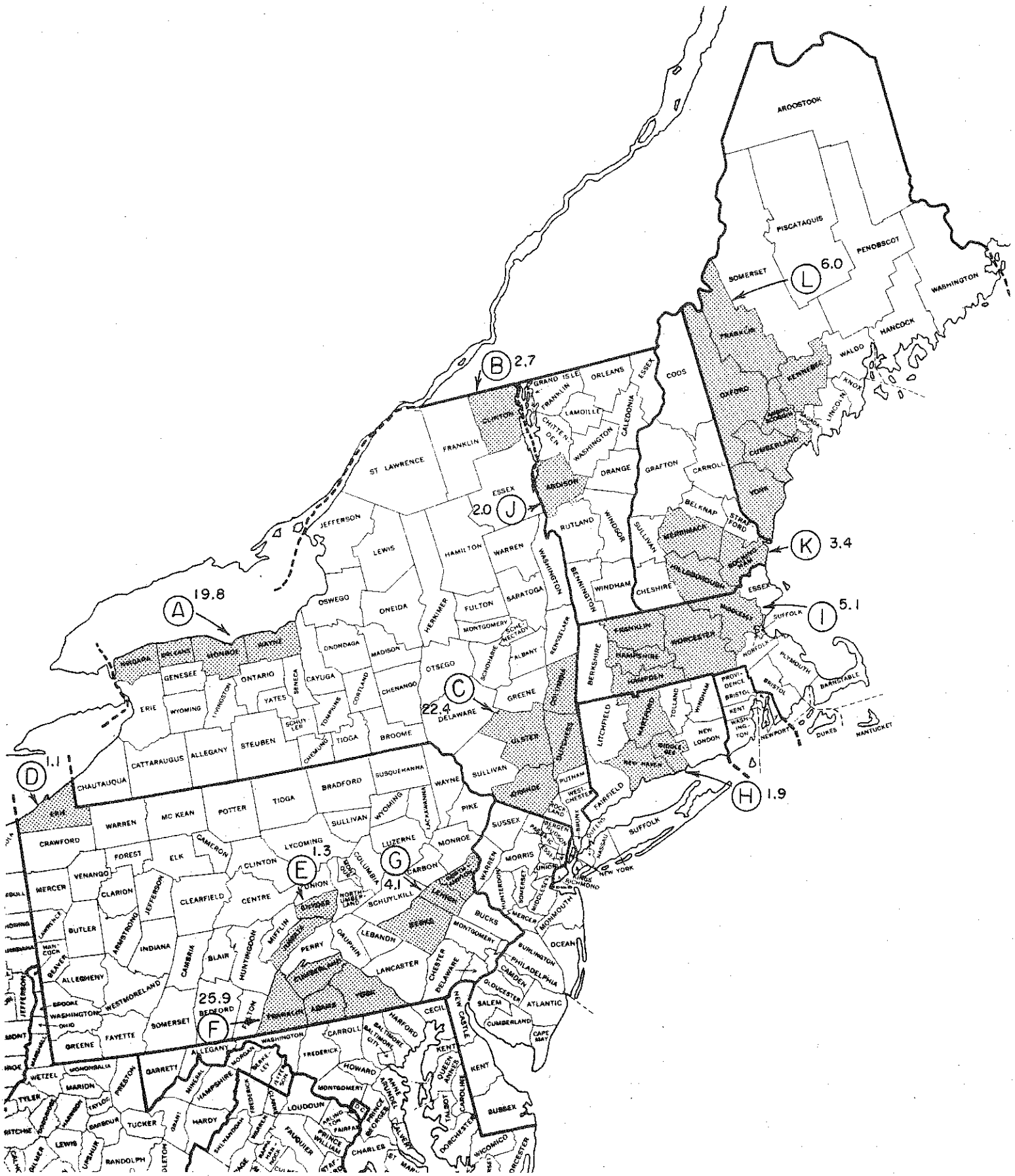


Table 11(a). Proportion of Farmers in the Sample Using Alternative Sources of Information in Pest Related Decisions: New York and Pennsylvania

	New York					Pennsylvania				
	Southeast	East	Northeast	Central	Northwest	South	East	Central	West	Northwest
	number									
Sample	63	11	7	35	80	73	46	32	16	14
Sources of Information	percent									
i) Chemical retailer	63.5	45.5	71.4	74.3	53.8	54.8	37.0	56.3	50	64.2
ii) Representative of chemical manufacturer	54.0	72.8	57.2	28.6	53.8	41.1	52.2	37.5	18.8	57.2
iii) Processor's fieldmen	11.1	27.3	0	5.7	8.8	20.5	4.3	3.1	0	35.7
iv) Sales leaflets, etc.	31.7	36.4	42.9	22.9	32.6	24.7	30.4	31.3	43.8	14.3
v) Label or container	69.8	72.8	71.4	60.0	60.0	42.5	56.5	65.7	56.3	71.5
vi) Farm magazines	41.3	63.6	28.6	31.5	42.6	30.1	41.3	62.5	62.6	50.0
vii) Newspaper	4.8	9.1	0	0	3.8	5.5	2.2	6.3	12.5	0
viii) Television	3.2	0	0	2.9	1.3	0	0	3.1	0	0
ix) Radio	33.3	27.3	0	22.8	36.3	2.8	0	3.1	0	0
x) Other publications	19.1	27.3	28.6	25.8	16.3	20.6	26.0	18.7	25.1	28.6
xi) Extension personnel	92.1	81.8	100.0	85.7	78.7	64.4	87.0	87.5	87.5	92.9
xii) Consultant or advisor paid by subscription	3.2	9.1	0	0	2.5	34.2	17.4	9.4	0	14.3
xiii) Neighbors, friends, relatives	34.9	36.4	42.9	28.6	37.5	21.9	32.6	31.3	43.8	50.0
xiv) Personal experience	77.8	90.9	85.7	68.6	87.5	65.8	80.4	75.0	75.0	85.7

Table 11(b). Proportion of Farmers in the Sample Using Alternative Sources of Information in Pest Related Decisions: New England States and Northeast

	Connecticut & Rhode Island	Massachusetts	Vermont	New Hampshire	Maine	Total[a/]
	number					
Sample	30	37	15	17	37	513
Sources of Information	percent					
i) Chemical retailer	63.3	43.2	60.0	23.5	27.0	52.4
ii) Representative of chemical manufacturer	50.0	43.2	46.7	58.8	40.5	46.6
iii) Processor's fieldmen	16.7	5.4	20.0	11.8	29.7	12.7
iv) Sales leaflets, etc.	36.7	13.5	33.3	29.4	18.9	28.3
v) Label or container	63.3	64.9	60.0	64.7	51.4	59.5
vi) Farm magazines	50.0	40.5	46.7	29.4	24.3	40.7
vii) Newspaper	6.7	0	26.7	5.9	0	4.5
viii) Television	10.0	2.7	6.7	0	2.7	2.1
ix) Radio	10.0	2.7	0	0	5.4	13.6
x) Other publications	40.0	21.6	20.0	17.6	13.5	21.6
xi) Extension personnel	80.0	94.6	100.0	100.0	81.1	83.8
xii) Consultant or advisor paid by subscription	6.7	5.4	0	0	0	9.2
xiii) Neighbors, friends, relatives	46.7	21.6	33.3	41.2	16.2	32.0
xiv) Personal experience	83.3	81.1	93.3	82.4	75.7	78.6

[a/] Includes New York and Pennsylvania.

Table 12. Proportion and Quality of Advice or Recommendations from Sources of Information in Pest Related Decisions

Sources of Information	Growers	Proportion Advice Followed		Quality of Advice Followed			
		SOME	LARGE	GOOD	SATISFACTORY	UNSATISFACTORY	NOT SPECIFIED
	number	percent					
i) Chemical retailer	269	65.8	34.2	45.0	50.2	2.2	2.6
ii) Representative of chemical manufacturer	239	66.9	33.1	43.1	50.6	4.2	2.1
iii) Processor's fieldmen	65	80.0	20.0	40.0	50.8	6.2	3.1
iv) Sales leaflets, etc.	145	97.2	2.8	23.4	69.0	3.4	4.1
v) Label or container	305	62.6	37.4	38.4	53.1	2.6	5.9
vi) Farm magazines	209	94.7	5.3	23.4	67.0	2.4	7.2
vii) Newspaper	23	95.7	4.3	13.0	73.9	4.3	8.7
viii) Television	11	90.9	9.1	18.2	72.7	0	9.1
ix) Radio	70	71.4	28.6	34.3	62.9	2.9	0
x) Other publications	111	83.8	16.2	26.1	64.0	1.8	8.1
xi) Extension personnel	430	51.2	48.8	61.9	31.4	2.1	4.7
xii) Consultant or advisor paid by subscription	47	21.3	78.7	76.6	19.1	0	4.3
xiii) Neighbors, friends, relatives	164	92.1	7.9	29.9	61.6	3.1	5.5
xiv) Personal experience	403	41.7	58.3	47.4	41.9	1.7	8.9

remainder, 34 percent, largely followed the advice. When asked about the quality of advice, 45 percent responsed that it was GOOD, 50 percent SATISFACTORY, 2 percent UNSATISFACTORY and 3 percent did not respond to that part of the question. Thus Table 12 presents the overall incidence in use of each information source from the sample and provides measures of the farmers dependence and his satisfaction with each source of information.

It was not unexpected to find that when growers hired the services of a pest management consultant, they largely followed his recommendations and found that the quality of this advice was good. Out of the 513 responding to the question on sources of information, 403 used their personal experience in decision-making and more than half of these growers largely depended on their experience. Just under a half felt that the quality of their personal experience was good. Information from extension personnel was considered mainly good whereas for other well-used sources of information, including the label or container, chemical retailer and the representative of a chemical manufacturer, the quality of information was generally considered satisfactory. Only a small number of growers claimed that the quality of any source of advice or information was unsatisfactory. This was not surprising since responses to estimation of quality were only invited if the source of information was used. Consequently, if a source of advice was found to be unsatisfactory it was generally not used.

Consultants

The following paragraphs discuss potential grower adoption of consultant type pest management services. Results are drawn from responses to questions on the questionnaire. The concept of private pest management consultants, along with the prices charged for those services in Wayne County, New York in 1979 ($12 and $6 per acre for pome and stone fruits, respectively) was presented on the questionnaire. This was followed by three questions. Firstly, growers were asked whether or not they were aware of private pest management consultants (or farm advisors such as in Wayne County, New York). Secondly, if a program were offered in their vicinity they were asked whether they would be likely to participate. Alternative responses were specified as YES, NO, and DON'T KNOW. Thirdly, if the response was DON'T KNOW, the grower was asked to specify to what extent he wished to find more information.

It was believed that responses to questions of this sort would set upper bounds on the grower's likelihood of purchasing consultant type services. Key factors other than grower adoption bearing on the feasibility of consultant services include overall mobility costs of the consultant and number of farm visits. These can be taken into account by incorporating locations favorable toward farm advisor or pest management consultant-type delivery and by considering the average size of farm. This latter point is important in that each farm represents a separate visit; thus the smaller the farms, the greater the number of consultations for a given area of tree fruit serviced by the consultant. In the subsequent paragraphs these factors are aggregated. High density tree fruit growing locations are identified and subsequently, responses to the questions given above are presented for each location. Average farm size and other factors may then be incorporated.

Figure 3, showed the high density tree fruit locations in the northeastern U.S. Each location encompasses one or more counties and a measure of tree fruit area is given. The pome acre equivalent is a measure of revenue potential for a location. In the Wayne County farm advisor program, stone fruits generate half the revenue per acre of pome fruits. (In computing pome acre equivalents, an acre of apples and pears each received a weight of 1.0 and an acre of cherries and peaches each received a weight of .5.) Information on stone fruit acreages was not available in Vermont, New Hampshire and Maine, therefore, dollar potential is given by the number of acres of apples. It is believed that acreages of stone fruits in these locations is insignificant. Location B, Clinton County, NY, does not contain any stone fruit. Each location of high tree fruit density presented in Figure 3 has at least 1,000 acres of apples or pome acre equivalents. This is a minimum size that could support one full-time pest manager on tree fruit at the prevailing participation fee.

There is a measure of subjectivity in defining the boundaries of any one location and occasionally arbitrary decisions were made as to whether to include or exclude specific counties in a location. In some instances, counties surrounding are almost devoid of tree fruit. For example, Location A is bordered by Lake Ontario in the North, Wayne County in the East and Erie, Genesee, Livingston and Ontario Counties with little tree fruit in the South. Niagara, Orleans and Monroe Counties are sufficiently well grouped and isolated to form an identifiable location. On the other hand, in Massachusetts the tree fruit acreage appears to be relatively well dispersed across the state; consequently the decision to include or exclude Essex and Norfolk Counties was more arbitrary. In Figure 3, the lines drawn to define the boundaries envelope the entire counties. In some cases the locations of the tree fruit may lie within a relatively small area within the county or counties. The actual land areas of the counties represent the maximum possible land area any pest management consultant may cover in the location. Because the tree fruit may lie in one or two pockets, the consultant may be required to cover only 10 or 15 percent of the maximum land areas. These maximum land areas are listed as follows:

	Land Area (sq. miles)
New York	
A Niagara, Orleans, Monroe	1,603
B Clinton	1,059
C Ulster, Dutchess, Orange, Columbia	3,432
Pennsylvania	
D Erie	813
E Juniata, Snyder	713
F Franklin, Adams, York, Cumberland	2,744
G Berks, Lehigh, Northampton	1,586

	Connecticut	
H	Hartford, Middlesex, New Haven	1,716
	Massachusetts	
I	Franklin, Hampshire, Hampden, Worcester, Middlesex	4,198
	Vermont	
J	Addison	784
	New Hampshire	
K	Merrimack, Hillsborough, Rockingham	2,514
	Maine	
L	Oxford, Franklin, Kennebec, Androscoggin, Cumberland, York	7,017

Findings from the survey are presented in Table 13. Locations correspond to those identified in Figure 3. Alternative responses to the question on interest in consultant type services were YES, NO and DON'T KNOW, as stated above. However, a small number of growers responded DON'T KNOW without answering the third part of the question as to how much they would seek more information. These were rejected from the sample. A further point is that some growers who had claimed to use a private pest management consultant and paid an acreage subscription for his services were unsure of their response to these questions. These growers were given a default response of YES. Therefore, the sample for Table 13 includes (a) those who answered YES or NO to the question of wishing to participate in a consultant-type program, (b) those who answered DON'T KNOW and gave some indication of whether they would seek further information and (c) for those who used the services of a pest management consultant a YES response was imputed.

Of the 314 making up the sample, 94 wished to participate and 41 claimed they already did participate in a consultant type program. Thus, 135 or 43 percent of the sample are categorized under YES in response to participation in a consultant program. The remainder are equally divided between NO (28 percent) and DON'T KNOW (29 percent). Of the latter group consisting of 91 growers, one claimed he would pay 100 dollars for a 2-day visit to get more information, 50 were willing to attend a conveniently timed evening meeting and 40 were only prepared to look at more literature if it came through the mail. Within the various locations listed on Table 13, the YES responses ranged from 21 percent in Erie County, Pennsylvania to 60 percent in Addison County, Vermont. The relatively low interest paid in Erie, Pennsylvania is explicable by the lack of importance of the tree fruit crop; the most important crop in that region is grapes. The interest expressed by the Vermont growers is not significant given the small sample size.

Farm size for each of the regions varies considerably. Larger farms tend to be located in Clinton County, NY; Franklin, Adams, York and Cumberland, PA; and Addison, VT. The second of these three regions already has consulting services. The other two fall into locations where the overall acreage of tree fruit may be marginal to support a pest manager. Consequently, it would appear unlikely that a private pest management consultant would open his business in either location without income from other sources. However, if cooperation between a relatively small number of

Table 13. Levels of Interest in Pest Management Consultants for Locations of High tree Fruit Density in the Northeastern U.S.

Locations of High Tree Fruit Density	Sample Size		Response to Particicpation in Consultant Program					
	Pome Equiv	Farms	YES		NO		DON'T KNOW	
	acres	number	acres	number	acres	number	acres	number
			percent of farms (in parentheses)					
New York								
A Niagara, Orleans, Monroe	4,301	72	2,167 (34.7%)	25	908 (33.3%)	24	1,226 (31.9%)	23
B Clinton	827	4	700 (50.0%)	2	127 (50.0%)	2	0 (0%)	0
C Ulster	4,356	55	1,617 (45.5%)	25	1,453 (30.9%)	17	1,286 (23.6%)	13
Pennsylvania								
D Erie	232	14	54 (21.4%)	3	39 (28.6%)	4	139 (50.0%)	7
E Juniata, Snyder	612	6	371 (50.0%)	3	98 (33.3%)	2	143 (16.7%)	1
F Franklin, Adams, York Cumberland	13,262	66	5,568 (50.0%)	33	4,785 (28.8%)	19	2,909 (21.2%)	14
G Berks, Lehigh, Northampton	1,422	17	866 (29.4%)	5	298 (29.4%)	5	258 (29.4%)	7
Connecticut & Rhode Island								
H Hartford, Middlesex, New Haven	613	11	509 (54.5%)	6	84 (27.7%)	3	20 (18.2%)	2
Massachusetts								
I Franklin, Hampshire, Hampden, Worcester, Middlesex	2,050	27	1,326 (59.3%)	16	123 (18.5%)	5	601 (22.2%)	6
Vermont								
J Addison	893	5	320 (50.0%)	3	0 (0%)	0	573 (40.0%)	2
New Hampshire								
K Merrimack, Hillsborough, Rockingham	990	10	263 (30.0%)	3	623 (20.0%)	2	104 (50.0%)	5
Maine								
L Oxford, Franklin, Kennebec, Androscoggin, Cumberland, York	1,384	27	332 (40.7%)	11	358 (18.5%)	5	694 (40.7%)	11
Total for Locations	30,942 (100%)	314	14,093 (43.0%)	135	8,897 (28.0%)	88	7,952 (29.0%)	91

growers emerged it would be possible to imagine a private pest manager seeing a measure of stability in his potential income and reap the advantages of the smallest number of individual consultations in these locations.

The acreage of tree fruit in both Eastern New York (Ulster, Columbia, Orange and Dutchess) and Western New York (Niagara, Orleans and Monroe) appears to be large enough to generate sufficient income for a consultant. However, farm size in both locations, especially the latter, would increase the number of consultations for a given total acreage (income level). Thus, the prospective consultant would need to take farm size into account when recruiting clients. Range in farm size is sufficiently wide in the two locations for a prospective consultant to find enough large farms to make up the acreage required to maintain full time employment.

Factors concerning the capacity of the pest manager to cover a geographic region and to serve a number of clients at a given level of service is discussed in a subsequent section of this report.

Educational Programs

Growers were asked to respond to a question on educational programs. The question was preceded by a statement that the educational program would be an alternative or addition to the farm advisor or private consultant pest management program. The education program was stated to include the following:

a) identification of different pest species,

b) evaluation of infestation levels by becoming familiar with traps and orchard inspections, and

c) decision-making on alternative control tactics.

Growers were provided with statements and they were asked to indicate the one with which they most closely agreed. The three statements were as follows:

1. I HAVE NO INTEREST IN A FARMER EDUCATION PEST MANAGEMENT PROGRAM FOR MYSELF OR ANY OF MY EMPLOYEES.
2. I WOULD ATTEND FREE FARMER EDUCATION PEST MANAGEMENT PROGRAM MEETINGS AND WOULD PURCHASE UP TO 20 DOLLARS WORTH OF PUBLICATIONS.
3. I AM INTERESTED IN AN EDUCATION PROGRAM ONLY IF NO OTHER SERVICES WERE AVAILABLE IN THIS AREA (e.g., CHEMICAL FIELD AGENTS, FARM ADVISOR OR CONSULTANCY SERVICES, ETC.).

Results of the survey are presented in Table 14. Regions correspond with those in Figure 3. High interest is considered as those responding with a check against 2, partial interest 3, and no interest 1. The table presents the information in terms of proportion of responses by acreage and number of farms. Overall, 55 percent of the farms were highly interested in the education programs and this represented 70 percent of the total tree fruit acreage of the sample. Consequently, it is possible to say that overall interest is positive, especially with the larger growers. This was true for all regions except Eastern New York, Connecticut and Rhode Island, where the smaller growers had a greater interest in education programs.

Table 14. Levels of Interest in Pest Management Education Programs

Locations	Sample Size		Proportion as Tree Fruit Area Levels of Interest in Education			Proportion of Farm Number Levels of Interest in Education		
	Tree Fruit	Farms	High	Partial	None	High	Partial	None
	acres	number	percent of acres			percent of farms		
New York State	12,091	175	68	28	4	53	40	7
Southeast	4,705	57	68	32	< 1	49	49	2
East	401	11	63	37	0	73	27	0
Northeast	1,327	5	90	7	3	60	20	20
Central	1,217	33	70	26	4	61	33	6
Northwest	4,441	69	62	29	9	48	39	13
Pennsylvania	19,643	162	72	25	3	52	39	9
South	14,607	62	70	28	2	45	48	6
East	2,779	42	79	17	4	62	28	10
Central	1,766	31	75	17	8	58	29	13
West	220	15	76	19	5	53	33	13
Northwest	271	12	69	31	0	42	58	0
Connecticut & Rhode Island	1,121	25	51	49	< 1	60	36	4
Massachusetts	2,168	33	53	47	0	61	39	0
Vermont	1,299	14	85	15	0	64	36	0
New Hampshire	1,221	15	86	14	0	60	40	0
Maine	1,250	33	69	29	2	61	36	3
TOTAL	38,793	457	70	27	3	55	39	6

Least interest in these programs was observed in Southern Pennsylvania and Northwestern New York. The reason for the lack of interest in Southern Pennsylvania is probably attributable to the service already received from consultants, however, the latter is not easily explained. Many growers in Northwestern New York felt that they relied heavily on personal experience, however, one would believe that personal experience is supported by education; in fact, only 68 percent of the growers in Northwestern New York attended any meetings in 1979 as opposed to 80 percent of the total sample in the Northeastern U.S. Of the larger growers highly interested in educational pest management programs, many appear to lie in Northeastern New York, Vermont and New Hampshire.

CONSIDERATIONS OF DELIVERY SYSTEMS

(A SURVEY OF PRIVATE PEST MANAGEMENT CONSULTANTS)

This section covers aspects of delivery of pest management principles and promotion of IPM in light of the possible savings and grower adoption. Alternative mechanisms for pest management delivery include the following:

1. Farm advisor extension programs
2. Private consultants
3. Grower cooperatives
4. General education

Each is not mutually exclusive of the others, and this point is made clearer in the subsequent paragraphs. For organizational purposes, however, each will be discussed separately. Finally, some inferences are drawn with respect to tree fruit production in the Northeastern U.S.

Farm Advisor Extension Programs

Savings from the NY farm advisor program appear to arise from substituting labor (the farm advisor) for pesticides and relying on expertise to increase efficiency (specialization of labor). Conditions were favorable for the success of the NYSTFPM (farm advisor) program. Farms were generally large and situated relatively close together; consequently, the number of visits and mobility costs were reduced. The primary crop was apples for processing where a measure of cosmetic damage may be tolerated. The program was operated by the cooperative extension service. This insured a high standard of competence in pest management of the farm advisors and a mechanism for promoting the program at its inception.

Savings were probably as high as could be expected under any alternative delivery system though costs of operating the program in relation to income remains in question, a topic to be explored later. A measure of subsidy seems inevitable when the objectives of the program do not explicitly include profit maximization. The subsidy by federal and state funds is made presumably so that new techniques for the integrated program may be employed and a core of specialists in pest management may be trained. This research and training role of the program may change in the future.

Currently, research in pest management has been given a higher priority relative to a few years ago. The cooperative extension services were provided with 4.4 million dollars nationally from the USDA in 1978 for pest management projects. In a report of the Extension Committee on Organization and Policy (1979), the projected needs for 1979 were $5 million and rising each year to $58.1 million for 1987 (all figures expressed in 1978 dollars). This is an indication of the rise in importance of pest management programs as felt by some individuals. However, the current mood in government is to reduce overall public spending where possible, thus making it difficult to speculate on the future of government financed pest management programs.

Should a private independent pest management consultant provide the service or the farm advisor? On the one hand, farm advisors help provide basic training for the private consultants, participate continuously with research activities which aid all growers in the long run, and provide research with the much needed direct contact with commercial growers. On the other hand, for the extension services to become involved in the activities normally provided by the private sector may constitute an infraction of the spirit of free enterprise. The private consultant delivery system is examined in the following section.

Private Pest Management Consultants

Private pest managers currently work on a consultancy basis in a number of states by providing pest management advice to clients who pay some fixed charge per acre. This system of pest management information delivery is similar to the farm advisor program. The main difference lies in the objectives of the alternative programs. Within the private pest management consultant program, it is essential that revenues from services rendered to the grower exceed costs of operating the service. This objective is implicit within any privately operated business if the business wishes to survive. There are risks in providing the service and the major factors likely to influence the potential private pest manager are; the apparent size of the market (the acreage owned by growers willing to employ his services and the dispersion of that acreage), the price paid and the level of service, the level of competition (e.g., the farm advisor program, cooperative programs, other consultants and other sources of advice and recommendations--and the costs of those alternatives to the grower), and the pest manager's perception of the business risk. The first of these points was discussed earlier in this report. The latter point is amplified by the lack of insurance open to the private pest manager for professional malpractice. The second point, the subject of the prices paid and the level of service, was considered sufficiently important to warrant a further examination.

Ten private pest managers were contacted by telephone and asked to provide information on the service they offered and the price charged. Each consultant or team of consultants was working predominantly with tree fruit and the questions asked pertained to their services and charges for 1980. The interview was carried out at hours convenient to the consultant between the 1st and 20th of May 1980. Consequently, the growing season had commenced in all parts of the country.

From Table 15, it can be seen that charges vary from state to state. Highest charges were found in California where restrictions on pesticides and regulations on pest management services are highest. Laws in California require the consultant to make written recommendations. For improved communication most consultants in other states appeared to follow this practice anyway. All the consultants claimed to use one or more of the many monitoring devices available for recording changes in pest and disease levels, some kept records of maximum and minimum temperatures and other weather data. Several consultants owned their own trapping (monitoring) equipment, others purchased and resold the equipment to

Table 15. Number of Consultants in the Survey by Telephone and Charges for Pest Management Services

State	No. Consultants	Average Charge for Service by Crop			
		Apples	Pears	Stone Fruit	Other Crops
		dollars/acre			
California	3	20	28	18	1-20[a]
Michigan	2			12	
Pennsylvania	2			11.25	
Washington	3		20	.5	0-5[a]

[a]Range.

their growers; however, all the consultants did the monitoring as opposed to relying on observation by the farmer. Most of the consultants took soil and/or leaf tissue samples (one at extra cost) and interpreted the analysis. The cost of the laboratory analysis of the soil or tissue, however, was borne by the grower in all cases. The majority of the consultants tried to visit each grower once a week throughout the growing season, some specifying that they would guarantee at least 20 visits. One or two visited their growers less regularly. Services beyond making visits, monitoring pest and disease levels and making pest control recommendations included, (a) making recommendations on pruning, (b) buying chemicals in bulk (for discount), (c) issuing newsletters, (d) providing feed for beneficial organisms (e.g., pest predators) or (e) making recommendations on fertilizer levels. These extra services were offered by some consultants and not by others; in some cases there was an extra charge.

The number of clients each consultant served ranged from 8 to over 30. The consultant with only 8 clients took other employment and felt that he could handle more accounts. Five of the consultants employed full time in pest management work took on between 20 and 30 clients with crop area ranging from 2,000 to a little over 3,000 acres per consultant. The mileage travelled by the consultants varied. In Washington, the fruit area served lies within the 4,300 square miles of Yakima County. In California, however, the fruit acreage is distributed throughout the area containing Butte in the north, San Joaquin in the south, Solano in the west and Eldorado in the east. This encompasses an area of about 20,000 square miles (i.e., an 80-mile radius from the central point).

From the evidence presented in the informal survey it is possible to surmise the typical scenario for private management consultants as follows:

1. The consultant is well trained in the plant protection sciences.

2. The consultant would make visits to each client's farm on a weekly (or a 10-day) basis. For full time employment he would serve about 25-30 growers with 2,000-3,000 acres.

3. The work would involve considerable travel, possibly 1,000 miles per week in the growing season. Locations of high tree fruit density would decrease the burden of mobility costs.

4. Written recommendations on pest control practices would be made to the grower on each visit (a copy would be kept as a check).

5. The consultant would be aware of further needs of the grower and exploit the potential for fulfilling some of those needs so that the bond between consultants and client may be cemented or the possibilities of generating further income are explored.

Cooperative Pest Management Programs

A mechanism for administering completely independent programs or maintaining close links with the cooperative extension service programs would be through grower cooperation. Grower cooperation of this type constitutes an alternative to the farm advisor program as a form of pest management information delivery. Programs exist whereby a pest management

advisor is hired and recommendations on pest control practices are made to cooperative member growers. Extensions to the pest management service are possible such as bulk purchase of chemicals and with sufficient memberships, the employment of special regional pest management techniques (e.g., sterile male release, etc.).

Grower cooperatives with pest management services have arisen in the midwestern states for a variety of crops. Growers in southern Vermont have expressed an interest in forming such a group. The relatively small number of larger growers in Addison County, Vermont and Clinton County, New York would facilitate cooperative agreements and simultaneously reduce numbers of consultations and business risks for the pest manager. In a recent development, to be discussed later, the growers in the Wayne County, New York program have filed a certificate of incorporation as a cooperative corporation with the intent of providing services for the 1982 growing season.

Education

Education in pest management for growers falls almost entirely within the jurisdiction of the cooperative extension services of each state. Extension work and IPM have objectives including (1) the development and implementation of effective programs to prevent or mitigate losses caused by pests through the use of multiple tactics (biological, cultural, chemical, and other methods of control), (2) the development of practical methods for monitoring pests and beneficial populations, and (3) the provision of information and training in the principles and application of IPM for users and advisors (Extension Committee on Organization and Policy for IPM, 1979).

These objectives key in with the extension's role in overall crop production education serving the former and ultimately the consumer. As mentioned earlier, the functions of an extension educational program in pest management are as follows: (1) applied research is carried out, specifically in the use of trapping and monitoring devices, demonstrating the effectiveness of varietal resistance, and experimenting with other pest control measures; (2) the synthesis of large quantities of information and its dissemination via publications, telephone, newsletter and computer-link are extremely important; and (3) the extension provides education and training for growers, chemical fieldmen, and pest managers. The second of these areas, specifically the use of the computer as a processor of information was discussed in relation to New York's pest management earlier in this report.

Collecting or recording and assimilating sufficient data on the returns to the extension work would be a laborious exercise. It is implicitly assumed that the purposes of the extension work is to bring about long-term efficiency in the agricultural industry and the promotion of IPM is not an exception. This goal appears best served by disseminating the information critical to the decision-making process in pest-related problems and providing growers (and those who serve growers) with the skills and tools which they may use and gather the information, respectively. Education programs appear to provide promise with respect to the latter topic and computer information systems together with code-a-phones, and newsletters may be the best vehicles for disseminating the information.

REGIONAL PESTICIDE SAVINGS

From this study it has been shown that farm advisors reduce pesticide use by $25.72 per acre (Table 3) representing a saving of 27.5 percent. For the purposes of exploratory calculations on pesticide savings and speculating on alternative scenarios in the Northeastern U.S., assumptions are listed as follows:

a) Pesticide savings on stone fruits are equivalent to half the savings of pome fruits (Table 13 and Figure 3).

b) Fully trained private pest managers either as consultants paid by subscription or employed by grower cooperatives can produce similar savings to those attained by farm advisors.

c) There is a supply of fully trained pest managers ready and able to provide a service at $12 per acre for pome fruits and $6 for stone fruits (1978 dollars).

Currently, out of the 140,800 pome acre equivalents in the Northeastern U.S., about 4,000 pome acre equivalents fall under tree fruit pest management schemes. These include the farm advisor program of Wayne County, NY and the consultant programs in Pennsylvania. With a 27.5 percent reduction in pesticide use on the 4,000 pome acre equivalents, the total regional saving amounts to less than 1 percent.

Table 16 presents the number of acres under pest management schemes outlined under alternative scenarios. The locations listed in the first column correspond to those in Figure 3 and Table 13. Acreages are expressed in thousand pome acre equivalents. "Other locations" refer to the acreages of tree fruit outside Wayne County, NY and other locations of high tree fruit density. Consequently, 84 percent of the region's tree fruit falls into the high tree fruit density locations. The penultimate line of the table presents estimated total pesticide costs under the various alternatives. These costs are estimated using mean spray costs per pome acre equivalent of $67.67 for pest management participants. The costs are 1978 dollars and are drawn from Table 3.

Scenario A

It is assumed that tree fruit pest managers would not service fruit outside the locations of high tree fruit density. The survey by mail indicated that 43 percent of the growers would participate in a program paid for by subscription. In the column labelled scenario A on Table 16, 43 percent of the pome acre equivalents for each location is presented. A 27.5 percent reduction in pesticide use for the 50.9 pome acre equivalents results in regional savings of 9.9 percent.

Scenario B

Scenario A does not take into account the discrete nature of a pest management unit. As discussed earlier in the report, a pest manager could maintain a reasonable level of service and generate sufficient income on between 2,000 and 3,000 acres of tree fruit. Consequently, if these

Table 16. Pesticide Savings from Pest Management: Alternative Scenarios

Locations of High Tree Fruit Density	Thousand Pome Acre (equiv.)	Alternative Scenarios A	B	C
		- -th. pome acre equiv.- -		
New York				
Wayne Co.	22.7	9.76	9.76	2.5
A. Niagara, Orleans, Monroe	19.8	8.51	8.51	2.5
B. Clinton	2.7	1.16	0	1.5
C. Ulster, Columbia, Orange, Dutchess	22.4	9.63	9.63	5.0
Pennsylvania				
D. Erie	1.1	.47	0	0.5
E. Juniata, Snyder	1.3	.57	0	5.0
F. Franklin, Adams, York, Cumberland	25.9	11.14	11.14	
G. Berks, Lehigh, Northampton	4.1	1.76	0	0
Connecticut & Rhode Island				
H. Hartford, Middlesex, New Haven	1.9	.82	0	0
Massachusetts				
I. Franklin, Hampshire, Hampden, Worcester, Middlesex	5.1	2.19	2.19	0
Vermont				
J. Addison	2.0	.86	0	1.5
New Hampshire				
K. Merrimack, Hillsborough, Rockingham	3.4	1.46	0	0
Maine				
L. Oxford, Franklin, Kennebec, Androscoggin, Cumberland, York	6.0	2.58	2.58	0
Other Locations	22.4	0	0	0
Total	140.8	50.9	43.81	18.5
Pesticide Use ($)	13.5M	11.84M	12.02M	12.67M
Savings (% of Regional Total)	0	9.9	8.6	3.7

locations listed in Scenario A with less than 2,000 pome acre equivalents are rejected, the locations with sufficient acreage to support a pest manager may be listed as follows: Wayne County, NY, A, C, F, I, L. Assuming a 27.5 percent reduction in pesticide use on these acres of tree fruit, regional savings would be 8.6 percent.

Scenario C

Earlier in the report it was explained that consultation costs per acre increase as average farm size decreases. A typical pest manager may be able to handle 20 to 30 accounts, consequently farm size would average around 100 acres. Distributions of farm size and in many cases average farm sizes were not available for the various locations. As a proxy to farm size, the average apple acreage is given for each location as follows:

New York	Acres of Apples per Farm
Wayne County	58
A	47
B	183
C	76
Pennsylvania	
D	12
E	44
F	76
G	53
New England	
H [Connecticut]	21
I [Massachusetts]	30
J [Vermont]	53
K [New Hampshire]	48
L [Maine]	38

In New York State, apples represent more than 80 percent of the state's tree fruit, thus apples serve as a relatively accurate proxy for farm size. In Pennsylvania, apples represent just under 70 percent of the state's tree fruit acreage; therefore, the proxy of apple acreage tends to underestimate average farm size. Location D (Erie County, PA) is the state's leading grape producer. The average apple acreage is probably not a useful indicator of farm size, given the relative importance of the grape crop. In New England, farm numbers were not available by county, consequently average farm size (via acres of apples per farm) has been calculated by state.

Without information on the size distribution it is difficult to assess the number of farms over a given critical size that would constitute a pest management program. It is possible to introduce the factor of farm size into the array of variables affecting pest management possibilities on tree fruit in the region. For example, Location B (Clinton County, NY) contains a relatively small number of large farms. If the grower adoption rate were higher than indicated in the survey, it would appear that this location would be ideal for the employment of a pest manager. Specifically, with the relatively small number of growers concerned, it would appear that some measure of grower cooperation would be possible in the hiring of a pest

manager. Both Locations C and F contain relatively large farms and sufficient tree fruit acreage to support pest managers. The latter location is already the home of two consultants. Wayne County, NY probably contains the highest density of tree fruit in the region; however, the location ranks fourth in terms of farm size. Location A would appear to contain sufficient tree fruit acreage but unfavorable farm size; thus it is likely that only one pest manager would find sufficient acreage on large enough farms to operate a program.

By drawing the three major factors (tree fruit density, the discrete nature of a pest management unit and farm size) plus some factors unique to each location it is possible to speculate on acreages under pest management as follows:

Wayne County, NY	:	Continuation of farm advisor program 2.5(th) pome acre equivalents.
A	:	One private consultant or cooperative pest manager 2.5(th) pome acre equivalents.
B	:	Grower cooperative employing a pest manager 1.5(th) pome acre equivalents.
C	:	Two full-time pest managers 5.0(th) pome acre equivalents.
D	:	Some tree fruit acreage brought into a grape pest management program 0.5(th) pome acre equivalents.
E and F	:	Two full-time pest managers 5.0(th) pome acre equivalents.
J	:	Grower cooperative employing a pest manager 1.5(th) pome acre equivalents.

These scenarios are based on results of the surveys and the assumptions stated above. The rate of grower adoption will change. If anything, the 43 percent grower adoption rate estimated through the survey by mail probably overestimates current interest in pest management. It is possible that in the future more growers will turn to the pest manager for partial solutions to some of the following problems:

a) pest resistance to pesticides

b) secondary pest outbreak

c) target pest resurgence

d) rising cost of chemicals

e) demands for the grower to concentrate on other management problems,

and f) through regulation, a reduced supply of chemicals with which to combat pest problems.

Already, these problems have changed farmer attitudes away from pre-programmed spray schedules and toward more careful selection of active ingredients, timing and rate of application of pesticides. These factors, along with a possible improvement in the efficiency and effectiveness of some chemicals has resulted in substantial reductions in pesticide use on tree fruit in recent years (von Rumker, 1975). Annual changes in pesticide use associated with progress in pest management may be masked by dynamic factors as follows:

a) differences in annual pest problems

b) shifts in attitudes of farmers or those who serve farmers, such as chemical field agents (for example, in relation to risk of crop loss);

c) changes in relation to pesticides, such as loss through regulation or pest resistance, effectiveness of ingredients, introduction of new products; and

d) relative price changes between inputs and in relation to output.

None of these factors is easy to isolate. For example, the growth of the pest management program in Wayne County, NY has led to spin-off benefits to nonparticipants. General pest data from the program has been made available to all growers via radio programs or extension code-a-phone services. New techniques experimented in pest management have been adopted by other growers. Some growers have felt that chemical field agents have been less ready to "over recommend" when neighbors in the farm advisor program are reducing pesticide use (Thompson, 1979).

Pest management programs with farm advisors or pest managers will reduce pesticide use on participating farms. Without significant changes in current knowledge, savings in pesticide costs to the participant are likely to be around 25 to 30 percent. Spin-off benefits will arise from these programs as mentioned above and there will be mutual benefits between researchers, employees of the cooperative extension service, pest managers and growers. These kinds of benefits may be expedited by further investment in high-speed information processing systems such as SCAMP. With exchange of information, the promotion of new pest management methods and techniques and education programs as described earlier in the report, regional pesticide savings are likely to exceed those described in Table 16 over the next few years.

ORGANIZATION OF THE WAYNE COUNTY PEST MANATEMENT COOPERATIVE: A CASE STUDY

The results of this research have been directed toward an evaluation of the Farm Advisor Program operated in Wayne County through the Cooperative Extension Service. This evaluation has been based on benefits and costs computed for the 1978 growing season. The purpose of this chapter is to review the current status of the program in Wayne County.

In late 1980, a decision was made to broaden the activities of the current farm advisors to include a training role. It had initially been intended that the program would be a pilot project and one of the aims had been to encourage the spin-off organization of privately operated delivery systems. As noted elsewhere in this report, some of the farms in the Wayne County program had dropped from the extension-operated program and hired their own advisor. Budgetary considerations and the need to broaden the scope of the NYSTFPM dictated the need for the Wayne County program participants to operate their own program.

A meeting of the participants of the extension-operated program was held on January 12, 1981. At that time, the Extension Associate who directs the NYSTFPM program explained the need for the program to evolve into an organization operated by growers. Eighteen of the 23 farms who were current participants attended this meeting. A faculty member from the Department of Agricultural Economics outlined organizational alternatives for cooperatives under New York State law. Growers were also given a questionnaire to rank the services they would like to have a cooperative perform. Questions included all the services currently offered under the extension-operated program as well as additional services which might permit the generation of additional revenue. At the end of the meeting, the grower's indicated they were definitely interested in forming a cooperative, and three growers volunteered to serve as a committee to draft bylaws for consideration.

Thirteen usable questionnaires were returned. The responses are shown in Table 17. As could be expected, most of the highly preferred services were those which were currently offered. The two exceptions were advice on fertility management (which advisors had been providing informally to some growers on request) and pesticide bids.

Considerable discussion at the January 12 meeting had revolved around the potential for cooperative purchasing of spray materials. Some members of the extension-operated organization were also members of a grower's purchasing cooperative, and these growers estimated that savings of 10-15 percent could be achieved by seeking competitive bids from chemical companies for spray materials. Strong support was apparent at the meeting for including this as one of the functions of the pest management advisor to be hired by the cooperative. This service was one that would help to keep the advisor employed during winter months, and would also enable greater savings to growers.

Other services to give winter employment and/or generate extra revenue were received less enthusiastically. These included crop estimates,

Table 17. Growers' Ranking of Services for Pest Management Cooperative (13 responses: highest possible score = 13; lowest possible score = 273)

Service	Service Currently Offered	Extra Fee	Score
Weekly orchard inspections	X		18
Advice on spraying	X		25
Advice on thinning	X		44
Weather monitoring	X		78
Advice on fertility management			82
Sprayer calibration	X		91
Leaf analysis	X	X	114
Pesticide bids			126
Advice on growth regulators	X		130
Soil analysis	X	X	131
Harvest analysis	X		136
Orchard mapping	X		140
Attend extension meetings & workshops	X		159
Advice on planting			163
Advice on mousebaiting			164
Advice on summer pruning			169
Advice on crop estimates		X	187
Harvest quality control		X	201
Advice on harvest scheduling			204
Cold storage checks		X	211
Custom pruning in winter		X	214

harvest quality control, harvest scheduling, cold storage checks, and custom pruning in the winter. These are services that might gain acceptance if growers were more aware of their value, but most growers seemed to feel that the services were too far removed from the pest management function to be included.

Several committee meetings to formulate the organization were held during January-March, 1981. Usual participants were the three growers who volunteered for the committee, the Extension Associate who directs the current program, the two farm advisors, the regional Extension Specialist who has responsibility for pest management programs in the area, and a faculty member of the Department of Agricultural Economics at Cornell. Additional input was received from faculty in the Department of Agricultural Economics who specialized in cooperatives and legal matters. The growers' committee eventually adopted a draft of bylaws and articles of incorporation to present to the prospective members of the cooperative. The committee adopted the alternative of a cooperative corporation. The proposed organization was to be nonprofit and nonstock.

The growers on the committee were very concerned about financing the initial year of operation, which was proposed for the 1982 growing season. A projected operating budget for 1982 was estimated at $28,033 (Table 18). The organizing committee decided to recommend to the prospective membership the following:

1. That the fees for the 1982 season be $20 for bearing apples and pears, $10 for bearing peaches and cherries, and $5 for all nonbearing fruit.

2. That services offered would include weekly orchard inspections during the growing season, advice on pesticide applications, advice on crop thinning, weather monitoring, sprayer calibration, orchard mapping, advice on fertilizer use, and evaluation of fruit at harvest for damage. Services which might be provided for an extra fee include soil and leaf sampling. Other services which could be added at a later date could include cooperative purchasing of pesticides.

3. That membership in the cooperative would not become binding unless 1800 acres were enrolled. This was the amount that would generate $30,000 of revenue at the expected proportional enrollment of bearing pome fruit, bearing stone fruit, and nonbearing acreage.

A meeting at which all of the current participants were invited was held on March 30, 1981. The bylaws and articles of incorporation were presented and discussed. Results of this research project, in terms of costs and benefits of IPM participation, was presented to the growers. This led naturally into a discussion of the advisability of including cooperative purchasing of pesticides as a service available to all members. (It was subsequently decided to include this service for a nominal fee, with participation being voluntary.)

The three issues which generated the most concern and debate were cooperative pesticide purchasing, the timing of payment of the acreage fees, and the mandatory inclusion of nonbearing acreage into the service

Table 18. Projected Annual Operating Budget for the Wayne County Pest Management Cooperative, 1982 Growing Season.

Expenses		
Salary		$18,000
Fringe benefits @ 25%		4,500
Transportation @ 22¢/mile		
900 mi. in Mar. and Sept.-Oct.	$ 198	
300 mi./wk. in Apr.-Aug. = 6,750 mi.	1,485	
Total transportation cost		1,683
Office expense		1,500
Telephone		1,000
Traps - Maggot: 700 @ $1.00	700	
Pheramone: 40 @ $3.75	150	
Total for traps		850
Miscellaneous		500
TOTAL PROJECTED EXPENSES		$28,033

contract. Cooperative pesticide purchasing was a problem in that a few growers were also members of another purchasing cooperative which performed the same service, and they wanted this service to be either provided at zero cost or to be voluntary. The trade-off was that the more members who are purchasing chemicals, the greater the leverage in attaining discounts. Timing of payments was a problem since the cooperative wanted to be assured of having adequate financing for the initial year, but growers were accustomed to paying for their services as the growing season progressed, with the first payment in April and the last payment in November. The group finally opted for 50 percent by April 1. In essence, the Extension Service had been providing a subsidy in financing the services at no charge. The nonbearing acreage provision was a problem for one or two growers who had substantial nonbearing acreage and had been accustomed to not paying for this service (but were getting advice either directly or indirectly by inference from advice on bearing acreage--a classic case of free-rider activity). Eventually the group approved the mandatory inclusion of all a grower's acreage, including nonbearing, in the contract.

At the conclusion of the meeting, growers were given 10 days to sign letters of intent to join the cooperative. A number of them signed immediately. At the end of the ten-day period, the enrolled acreage was still slightly under the goal of 1800, so the growers on the organizing committee contacted several growers who had not yet enrolled, and two more signed letters of intent. This brought total membership to 20 growers and approximately 1850 acres.

The necessary documents were filed with the Department of Agriculture and Markets to form a cooperative corporation. A farm advisor has been hired for the 1982 season.

The experience with the NYSTFPM program and the subsequent organization of the cooperative point out some general problems which may be anticipated as other groups consider organizing to provide IPM services. These are the following:

1. Even though all of these growers had experience with IPM from having been involved with the Extension-operated program, the decision to enter into the agreement was not easy for many of them. All were very supportive of the program as it had existed, but concern about Extension's commitment to continue in a strong supporting role was evident. This had to be satisfied before they took the step.

2. To make the delivery system self-supporting, fees had to be raised and the timing of cash flows (elimination of the operating capital subsidy) had to be tightened. It would not be fair, however, to say that the difference in costs is the difference between the 1978 fee ($12/acre) and the projected 1982 fee ($20/acre) since inflation has pushed all costs up. Correcting the $12 per acre fee in 1978 for inflation would imply an equivalent cost of $16 in 1982 at an eight percent annual increase. The operating capital subsidy was worth about $1.12 per acre annually at 15 percent interest. Another factor to be accounted for is that growers will be assessed on all acreage in the cooperative, while they were assessed on only bearing acreage in the extension-operated

program. Furthermore, in scaling this size of the delivery system against revenue, a single advisor will have to cover almost as much acreage as two advisors covered previously. This should be qualified by noting that advisors had duties other than service- oriented ones under the Extension-operated system. It is anticipated that under the projected configuration, quality of monitoring and recommendations will not suffer. Even under the most carefully designed mix of services offered, advisors will tend to be overemployed during the growing season and underemployed for the rest of the year.

3. Transaction costs to form the cooperative were rather high in terms of the time commitment from faculty and extension personnel. The knowledge gained by this endeavor should, however, make it easier to assist in organizing other groups.

4. A pool of trained IPM consultants is not yet readily available. The cooperative was not able to hire a trained consultant at the projected salary of $18,000. Alternative explanations are that the salary offered may be too low, or risks (from making incorrect recommendations) may be perceived as being high. There is no insurance currently available for consultants. The cooperative hired an inexperienced farm advisor who will work closely with the IPM staff at the Experiment Station in Geneva for the 1982 season. The initial appointment was at a lower salary and for part of the year rather than for 12 months as was originally projected.

SUMMARY AND CONCLUSIONS

According to the 1978 in-depth survey of tree fruit growers in Wayne County, NY pesticide savings of $25.72 per acre (27.5 percent) were realized through participation in the farm advisor pest management program. Program costs in 1978 were 32,880 dollars and income was 19,000 dollars from acreage participation fees. For similar programs to operate on a private basis, participation fees must exceed the costs of operating the program. The emergence of private pest management programs depends on two major factors: The rate of grower adoption which changes according to grower perception of benefits such as reduced risk, pesticide savings, the opportunity for growers to allocate more time to other management concerns and the costs of the service and the willingness of potential pest managers to provide the service. This will depend on the size and accessibility of the market. A mail survey of tree fruit growers in New England, New York and Pennsylvania in 1980 indicated that forty-three percent of the growers wished to subscribe to pest management schemes if the service were offered. By taking into account tree fruit density, farm size, and accessibility of markets for private pest managers, this study estimated that potential estimated regional savings from farm-advisor-type pest management schemes paid for by subscription probably would not exceed 4 percent. These savings would arise as private pest management schemes were initiated in locations of relatively high tree fruit density generating sufficient income to support pest managers. A typical pest manager would expect to visit orchards between 20 and 25 times per year, charge between $12 and $20 per acre for his service and consult on about 25 farms with an average size of 100 acres per farm. Variations from this may be possible by consulting on crops other than tree fruit or by modifying the type of service offered.

Extension personnel will become increasingly important as they work directly with growers not participating in special schemes and with chemical fieldmen, private pest management consultants and others who serve growers. They will become essential in such areas as disseminating information on disease and weather forecasting, informing on the availability and the advisability of using pesticides and other pest control measures and educating growers and others on advancements in methods of pest management. The rapid information turnaround coupled with the utilization of weather data in disease prediction by models will be facilitated through the use of central computers and remote access links. This kind of service will continue to contribute toward more efficient pest management.

Further research and continued monitoring will be required as follows:

a) Continued evaluation of programs will require a flow of data on costs, timing and rates of applications of pesticides from participants and nonparticipants of programs along with costs of operating the programs. In this way, it will be possible to continuously analyze the streams of costs and benefits from the programs.

b) Factors other than pesticide savings in pest management programs should be investigated. These may include risk of crop loss and possible benefits from reduced grower input into solving pest related problems,

thus allowing the grower to spend more time on other management concerns.

c) Cost-benefit evaluations of IPM should be carried out for other crops and in other locations.

d) This report focused on the farm advisor or consultant-type delivery. Alternative mechanisms need to be evaluated to identify optimal methods in pest management delivery.

The recent experience of the formation of the Wayne County Pest Management Cooperative was reviewed. Even though all of the prospective members were participants in the current extension-operated program, the organization encountered some problems. Growers wanted to be insured that extension would continue in a strong supporting role before they would commit themselves to the organization. Selecting the appropriate mix of number of acres, services offered, and the fee schedule was challenging. Transaction costs in organizing were high in terms of requirements for extension personnel involvement. Finally, a ready pool of trained IPM consultants is not currently available to staff delivery systems.

The unavailability of trained consultants will severely impede the attainment of the maximum potential for IPM in tree fruit in the Northeast unless public policies deal with the problem. We recommend that the New York Tree Fruit Pest Management Program be designated as a regional training center for the Northeast. Personnel and facilities are already available to train 4 consultants a year. The main additional funding requirement is for salary for about eight months per trainee during the training period. This would offer an inducement to interested persons and would allow more efficient use of currently available resources such as personnel, computer hardware and software and equipment.

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