THE ECONOMIC FEASIBILITY OF TREE FRUIT INTEGRATED PEST MANAGEMENT IN THE NORTHEAST

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ABSTRACT

A pilot tree fruit pest management program in Wayne County, New York was evaluated. Thirty-three blocks of fruit were matched for 26 participants in the pilot program and for 23 nonparticipants. Participants reduced pesticide costs and total pest management costs in comparison to nonparticipants. Factors which will affect the adoption of Integrated Pest Management in other locations include the attitudes of growers, farm size, and the density of fruit production. Integrated Pest Management programs are economically feasible for several other areas of high tree fruit density in the Northeast.

INTRODUCTION

Fruit growers in the Northeast produced about 28 percent of the nation's deciduous fruit in 1978, but applied about 32 percent of the total pesticides used for these crops [Webb]. Integrated Pest Management (IPM) offers the potential for reducing pesticide use without reducing fruit yield or quality. In this paper, results are reported from a research project designed to assess the economic feasibility of IPM for tree fruit production in the Northeast.

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.]. Tactics include chemical, biological, cultural, physical, and genetic procedures. IPM delivery systems are typically based on information which substitutes for prophylactic applications of pesticides. A pilot tree fruit pest management program has been in operation in Wayne County, New York since 1973. Trained farm advisors monitor participants' orchards weekly and advise on spray programs [Tette, et al.]. In conducting our research, we had the following objectives:

1. To estimate costs and benefits for growers who participated in the Wayne County IPM program.
2. To assess the potential for grower adoption in the Northeast.
3. To estimate regional savings if programs similar to the Wayne County pilot project were implemented in the Northeast.

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This research was supported by cooperative agreement 58-319V-02702 between Cornell University and the Economic Research Service, USDA.

METHODS

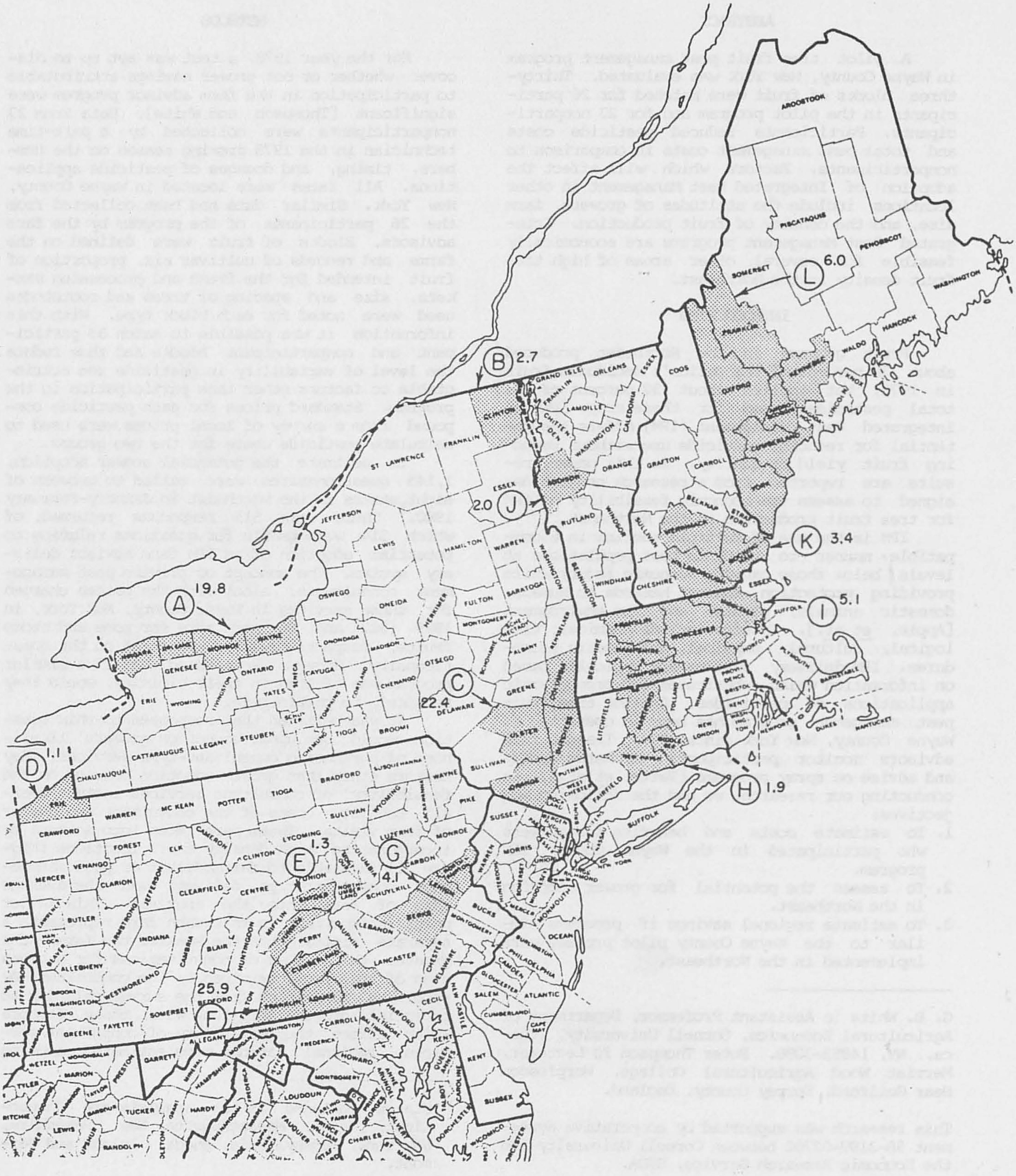
For the year 1978, a test was set up to discover whether or not grower savings attributable to participation in the farm advisor program were significant [Thompson and White]. Data from 23 nonparticipants were collected by a part-time technician in the 1978 growing season on the numbers, timing, and dosages of pesticide applications. All farms were located in Wayne County, New York. 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 were used to calculate pesticide costs for the two groups.

To estimate the potential grower adoption, 1,145 questionnaires were mailed to growers of eight states in the Northeast in January-February 1980.[1] There were 515 responses returned, of which 314 were usable for questions relating to potential adoption of an IPM farm advisor delivery system. 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. Growers were asked that if a similar program was offered in their vicinity, would they be likely to participate.

It was believed that responses to this question would set upper bounds on growers' 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 were taken into account by incorporating high density fruit locations (Figure 1) favorable to farm advisor or pest management consultant-type delivery and the average size of farm into the analysis. 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. By combining information from the survey relating to potential grower adoption with these factors which affect the feasibility of consultant services, regional savings were estimated assuming

[1] States included in the analysis are Connecticut, Maine, Massachusetts, New Hampshire, New York, Pennsylvania, Rhode Island and Vermont.

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



the adoption of delivery services similar to the Wayne County pilot project.

RESULTS

Savings to Growers

Results from the paired block comparisons are presented in Table 1. Total spray material costs for participants were $67.67 per acre compared with $93.39 per acre for nonparticipants. Total spray material costs for participants ranged from $29 to $96 whereas for nonparticipants costs ranged from $46 to $248. The average costs of nonparticipants exceeded those of participants by $26 per acre. Spray material costs were subdivided into insecticide, miticide, and fungicide categories. The detailed analysis was reported by Thompson and White.

Tests of equal variance and equal means were made using an F-test and a separate variance estimate t-test. In each of the pesticide groups and for the aggregated total spray material costs, mean spray costs of nonparticipants exceeded those of participants. The formal tests indicated that in all cases, the hypotheses of equal means in the two groups were rejected at the five percent level, and the one-sided alternatives were accepted. Thus, superior pest management monitoring and information was substituting for the use of pesticides in crop protection. 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 nonparticipants whereas participants relied completely on the services of the farm advisor to aid in pest management decision making.

Savings were greatest for insecticides where participants had a $12 per acre advantage over nonparticipants. This was expected because insects are visible to the naked eye and can be readily inspected and counted before damage occurs. On the other hand, diseases are not usually visible until some time after infestation (and damage). This increases the necessity for preventive sprays for fungicides; hence a smaller savings ($9) in materials was realized for participants.

Total savings attributable to participation for the 22 blocks intended primarily for processing were $29 per acre. Savings on the 11 blocks intended for fresh fruit were only $19 per acre. With higher cosmetic standards for fresh fruit production, farm advisors and growers apparently take less risk than with processing fruit.

A fruit harvest quality test was conducted for 26 participant blocks and 31 nonparticipant blocks. Yield estimates were collected for 16 of participating growers' blocks and for 13 of the nonparticipating growers' blocks. No differences were observed either for fruit quality or yield; apparently the pilot program was successful in its objective to reduce pesticide costs while maintaining the quality and quantity of fruit produced. Further confidence could be attached to these results since similar results had been obtained in informal tests in 1976 and 1977 [Tette et al.].

Data regarding the total number of spray applications were also collected. Fungicides and insecticides are often mixed together in the spray tank. It was found that participants averaged 9.3 applications per acre while nonparticipants averaged 10.4 applications per acre. Thus, participants realized a net savings in reduced labor and equipment charges. Using partial budgeting, net overall benefit to participants was estimated in Table 2. Participants had a net savings of $16 per acre when participation costs and reduced pesticide costs were taken into account with no reduction in yield or fruit quality. It is believed that this was an understatement of net benefits since there was some information transfer from IPM growers to nonparticipating growers and chemical fieldmen who make recommendations to other growers.

Potential Grower Adoption

Of the 314 responses which were useable to estimate potential grower adoption, 94 growers indicated that they wished to participate in an IPM program. Forty-one growers indicated that they already did participate in a consultant type program. Thus, 135 growers, or 43 percent of the sample, were characterized as likely participants if a consultant type program were available. The remainder of the growers were equally divided between a NO response (28 percent) and DON'T KNOW (29 percent). Within the various high density fruit areas shown in Figure 1, YES responses ranged from 21 percent in Erie County, Pennsylvania, to 60 percent in Addison County, Vermont. The relatively low interest indicated in Erie, Pennsylvania is explicable by the lack of importance of tree fruit in that area where the important crop is grapes. The interest expressed by Vermont growers was not significant given the small sample size.

Potential Regional Savings

From this study it has been shown that farm advisors reduce pesticide use by $25.72 per acre (Table 1) representing a savings of 27.5 percent. For the purposes of exploratory calculations on pesticide savings 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. All calculations are made in pome acre equivalents.[2]

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 in the Wayne County pilot program in 1978.

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, New York, and

[2] 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.

Table 1. 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 2. Total Per Acre Pest Management Costs, 33 IPM Participant Blocks and 33 Nonparticipant Blocks, Wayne County, New York, 1978.

	Participants	Nonparticipants
Participation fee	$12.00	$ 0.00
Spray material costs	67.67	93.39
Machinery and labor costs for pesticide applications*	16.31	18.27
Total costs	$95.98	$111.66

* Based on labor costs of $4.00 per hour, variable tractor costs of $4.00 per hour, and variable sprayer costs of $2.50 per hour, for a total variable cost of sprayer operation of $10.50 per hour. The application rate assumed is six acres per hour; thus a single application costs $1.75 per acre.

private consultant programs in Pennsylvania. With a 27.5 percent reduction in pesticide use on the 4,000 pome acre equivalents, the total regional savings would amount to less than one percent.

Table 3 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 1. Acreages are expressed in thousand pome acre equivalents. "Other locations" refer to the acreages of tree fruit outside Wayne County, New York, 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. Total pesticide costs under the various alternatives were estimated using mean spray costs per pome acre equivalent of $67.67 for pest management participants. The costs are in 1978 dollars and are drawn from Table 1.

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 3, 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. A pest management consultant could maintain a reasonable level of service and generate sufficient income on between 2,000 and 3,000 acres of tree fruit. Consequently, if the 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 were as follows: Wayne County, New York; A; C; F; I; and 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

Consultation costs per acre increase as average farm size decreases. A typical pest manager should 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 in Table 3.

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, Pennsylvania) 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 (acres of apples per farm) has been calculated by state.

Without information on the size distribution it was difficult to assess the number of farms over a given critical size that would constitute a pest management program. However, it was 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, New York) contains a relatively small number of large farms. If the grower adoption rate were higher than indicated in the survey, 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, New York, 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 man-

Table 3. Pesticide Savings from Pest Management: Alternative Scenarios.

Locations of High Tree Fruit Density	Acres of Apples Per Farm	Thousand Pome Acre (equiv.)	Alternative Scenarios A	B	C
			- -th. pome acre equiv.- -		
New York					
Wayne Co.	58	22.7	9.76	9.76	2.5
A. Niagara, Orleans, Monroe	47	19.8	8.51	8.51	2.5
B. Clinton	183	2.7	1.16	0	1.5
C. Ulster, Columbia, Orange, Dutchess	76	22.4	9.63	9.63	5.0
Pennsylvania					
D. Erie	12	1.1	.47	0	0.5
E. Juniata, Snyder	44	1.3	.57	0	5.0
F. Franklin, Adams, York, Cumberland	76	25.9	11.14	11.14	
G. Berks, Lehigh, Northampton	53	4.1	1.76	0	0
Connecticut & Rhode Island					
H. Hartford, Middlesex, New Haven	21	1.9	.82	0	0
Massachusetts					
I. Franklin, Hampshire, Hampden, Worcester, Middlesex	30	5.1	2.19	2.19	0
Vermont					
J. Addison	53	2.0	.86	0	1.5
New Hampshire					
K. Merrimack, Hillsborough, Rockingham	48	3.4	1.46	0	0
Maine					
L. Oxford, Franklin, Kennebec, Androscoggin, Cumberland, York	38	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 ($)		13.15M	11.84M	12.02M	12.67M
Savings (% of Regional Total)		0	9.9	8.6	3.7

agement 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, New York: Continuation of the farm advisor program - 2,500 pome acre equivalents.

Niagara, Orleans, Monroe Counties, New York: One private consultant or cooperative pest manager - 2,500 pome acre equivalents.

Clinton County, New York: Grower cooperative employing a pest manager - 1,500 pome acre equivalents.

Ulster, Orange, Dutchess Counties, New York: Two full-time pest managers - 5,000 pome acre equivalents.

Erie County, Pennsylvania: Some tree fruit acreage brought into an existing grape pest management program - 500 pome acre equivalents.

Juniata, Snyder, Franklin, Adams, York, and Cumberland Counties, Pennsylvania: Two full-time pest managers - 5,000 pome acre equivalents.

Addison County, Vermont: Grower cooperative employing a pest manager - 1,500 pome acre equivalents.

We feel that these results, or Scenario C, are a realistic assessment of the potential for IPM programs in the Northeast. This analysis was based on certain assumptions which were made explicit. 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. However, it is possible that in the future more growers will turn to IPM for partial solutions to the problems of pest resistance to pesticides, secondary pest outbreak, target pest resurgence, rising cost of chemicals, demands for the grower to concentrate on other management problems, and regulation which may result in a reduced supply of chemicals with which to combat pest problems.

Already these problems have changed farmer attitudes away from preprogrammed 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, et al.]. Christensen and Prokopy also reported on a technique (alternate middle spray) which greatly reduced pesticide costs as well as energy costs.

CONCLUDING OBSERVATIONS

We have demonstrated that savings of about $26 per acre (27.5 percent) were realized through participation in the farm advisor program in Wayne County, New York. By considering potential grower adoption, tree density, the discrete nature of a pest management unit, farm size, and other qualitative factors, regional savings of about four percent of total pesticide use (.5 million dollars) were estimated to be potentially obtainable.

The assumption was made that a supply of fully trained private pest management advisors is readily available. In reality, the availability of trained personnel is a serious impediment to expansion of IPM efforts. If IPM is to be made readily available to large numbers of growers in the Northeast, public policies and funding should be directed toward organizing and financing regional training efforts.

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