APPLE PEST MANAGEMENT: A COST ANALYSIS OF ALTERNATIVE PRACTICES

Daniel Rossi, Pritam S. Dhillon and Laura Hoffman

INTRODUCTION

Pest control efforts for tree fruits, as well as other agricultural crops, have intensified in the U.S. during the past few decades. This increase is the result of the increase in pest population, the Food and Drug Administration's reduction in tolerance levels of insect parts permitted in foods, and the raising of cosmetic standards by food wholesalers and retailers (Hough and Gallahan).

Since the advent of DDT in the 1940s, efforts to control pests have increasingly relied on synthetic chemicals. However, the effectiveness of these pesticides in many situations has been reduced by increased pest resistance and outbreaks of secondary pests. In addition, the effects of pesticide use on human health and non-target organisms have been a primary concern. Finally, escalating petroleum prices have caused uncertainty about the future availability and prices of petroleum-based organic pesticides (i.e., chlorinated hydrocarbons, organophosphates and carbamates). Therefore, alternative pest control strategies which can substitute for chemical control need to be examined.

Integrated Pest Management (IPM) is thought of as an intermediary step between a chemical method of pest control and a non-chemical method of pest control. IPM relies on a variety of biological, physical, cultural and chemical methods to control pests which are coordinated into a cohesive program designed to provide long-term protection from pests.

IPM can be viewed as a new decision-making process, not a new product (Hepp, 1976). Farmers who adopt IPM principles realize that information can partially substitute for pesticides as an insurance against risk (Norgaard, 1976).

In 1980, an IPM program for apples and peaches was instituted by the New Jersey Cooperative Extension Service. This program includes twenty-five growers from Gloucester, Salem, Cumberland, Camden and Atlantic Counties.

The goals of the program are:

1) to lower pesticide cost without a decrease in yield or quality;
2) to maximize pest control through a monitoring system;
3) to make efficient use of existing chemicals.

The program is directed towards meeting these goals by the following approaches:

1) using an alternate middle system of spraying;
2) using lower rates of insecticide, fungicide and miticide applications when possible;
3) choosing chemicals with selected effects;
4) monitoring levels of all important pests and predators;
5) spraying only when necessary.

In the first approach a grower sprays every other middle rather than spraying every middle. Alternate middles cover 100 percent of the tree from the side being sprayed and roughly 75 percent of the side not sprayed. Growers utilizing this technique tend to spray more frequently, perhaps every seven to ten days rather than every two to three weeks. However, the grower will use a lower rate of application which, because of reduced toxicity, can allow for mite predator populations to become established and thus reduce the need for miticides. Theoretically, alternate middles when used in conjunction with pest monitoring can lead to reduced chemical use and reduced number of passes along each row.

The purpose of this paper is to report the results of a detailed examination of the costs of producing apples (Hoffman 1983). More specifically, the pest management costs of apple producers in southern New Jersey using conventional pest management practices are compared to those using integrated pest management. Pest management costs are presented in context of total production costs and in light of previous published results.

METHODS

Budgeting techniques were utilized to estimate the production costs for apple growers in New Jersey. A grower survey, in the form of personal interviews, was undertaken to collect data from 20 producers for the 1981 growing season. Twelve of these producers participated in the New Jersey IPM program while eight did not. In addition, detailed data on pesticide costs were obtained from annual spray schedules of the growers.[1]

Two model farm operations -- an IPM and non-IPM farm -- were developed using the responses to the survey as a basis. The two models differed only with respect to pest management practices. No significant difference in labor, machinery and materials used in other farm activities or in varietal mix or yields were found between the IPM and non-IPM growers in the survey.

Daniel Rossi and Pritam S. Dhillon are Assistant Professor and Associate Professor, respectively, Department of Agricultural Economics and Marketing, Cook College, New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, NJ 08903. Laura Hoffman is Marketing Research Assistant, Department of Horticulture, Purdue University, West Lafayette, Indiana.

New Jersey Agricultural Experiment Station, Publication Number D-02110-1-83, supported by State funds and U.S. Hatch Act. The authors would like to thank Dean Polk of the New Jersey Cooperative Extension Service for his support during the data collection phase of the project.

[1] Spray schedules for the IPM participants were provided by Dean Polk, the Coordinator of the New Jersey program. Spray schedules for non-participants were collected by the researchers with the assistance of the Program Coordinator.

Therefore, costs not related to pest management were assumed to be equal for the two models.

The model farms were each 200 acres - 147 acres of bearing peaches and 53 acres of bearing apples (i.e., trees older than six years).[2] The 53 acres of apples consisted of late varieties - Red Delicious, 22 acres; Golden Delicious, 6 acres; Jersey Red, 11 acres; Stayman, 7 acres; and Rome, 7 acres. Only late varieties were considered in the models because: (1) they represented over 90 percent of the apples grown on the surveyed farms and (2) growers are discontinuing summer varieties over time because they compete with their peach operations.

The pesticide cost differences for the IPM participants and nonparticipants were tested for statistical significance. The data was further disaggregated by identifying those IPM participants who practiced alternate middle spraying. Total chemical expenditures and expenditures on insecticides, fungicides and miticides were analyzed for the three groups of growers (alternate middle, non-alternate middle IPM and non-IPM participants).

PRODUCTION COSTS FOR THE MODEL FARMS

The total estimated annual per acre costs of producing apples on the IPM and non-IPM model farms were $1,840.28 and $1,856.69 respectively (Table 1). Allowing for difference in years and locations, these estimates are consistent with previous results [McKibbon (1980) - $1,605; Gerling (1982) - $1,091;[3] Smith (1981) - $1,824; and Funt (1982) - $1,703].

Labor represented approximately one-half of the total cost of producing apples. Materials accounted for 21 percent for IPM farms and 22 percent for non-IPM farms. Pesticide expenditures alone represented 10 and 12 percent of the total costs for the IPM and non-IPM farms, respectively.

When comparing the costs of producing apples on the IPM and non-IPM farm, one finds differences in preharvest labor, pesticides, fuel, the IPM service fee, general overhead, management fee and short-term interest. The IPM model has slightly higher preharvest labor and fuel costs and, of course, the IPM service fee.[4] The non-IPM model has higher pesticide costs and slightly higher general overhead, management and short-term interest costs. The latter result is related to the way these items were estimated (they were calculated as percentage of other selected cost items) and represents a measurement error instead of actual cost differences.

Thus, the final difference in total cost between the IPM and non-IPM is $16.41. It is interesting to note that this figure represents only one percent of the total cost to the nonparticpant.

ANALYSIS OF PESTICIDE EXPENDITURES

The pesticide cost values reported in Table 1 are based on the means of the per acre expenditures incurred by the IPM participant and nonparticipant grower groups as calculated from their spray schedules. A more detailed breakdown of the pesticide expenditures of the two grower groups is provided in Table 2. Approximately one-half of the total pesticide expenditures were on fungicides, with one-third on insecticides and the remainder on miticides.

When one compares the expenditures between the two grower groups, one finds that on average IPM participants spend less on all three types of pesticides. The greatest savings are in insecticides and the least in miticides. The difference in total expenditures of $26.15 per acre represented 12 percent of total pesticide expenditures on nonparticipants. However, according to the analysis of variance test neither this nor any of the differences in expenditures on individual types of pesticides were significant at the 95 percent level.

In order to understand better the effects of the IPM program on grower pesticide costs, it was felt that a closer examination of the individual grower practices was necessary. It appeared that there might be a significant variation among growers in each group. Since the IPM program was only a year old in 1981, many participants were still skeptical of adopting all of the IPM practices. In addition, there can be a spillover effect with respect to IPM information and practices on the nonparticipants. Therefore, a question of level of participation can be raised.

One of the major approaches to meeting the goals of the IPM program in New Jersey is the advocation of the use of an alternate middle system of spraying. When used in conjunction with a monitoring system, an alternate middle system of spraying can result in a lower chemical rate per acre than a full cover system. In the conventional full cover system, the grower would use a relatively large chemical dose since he would spray more frequently. It is expected that the alternate middle system permits comparable protection using lower, in net, total per acre chemical rates. In addition, the lower toxicity associated with spraying lower chemical rates can encourage the establishment of mite predator pop-

---

[2] The cost estimates are biased downwards since the model farm was set up for bearing acres of late varieties, even though established farms have some non-bearing acres and their associated costs.

[3] This estimate includes only preharvest costs. When the estimates reported in the current study are adjusted to reflect preharvest costs, they are comparable to this estimate. For example, if one subtracts the cost of harvest labor from the total cost estimate for the IPM farm, the result is $1,223.50 per acre.

[4] It should be noted that the grower fee of $7.50 per acre was subsidized by the State. The program actually cost about $37 per acre in 1981. While part of these costs can be considered investment in research and education, it is possible that if the full cost of the program were borne by the growers, they could conceivably have lost money with this alternative.

Table 1 - Annual Apple Production Costs for the IPM and Non-IPM Model Farms

Cost Category	IPM		Non-IPM	
	$/acre	percent	$/acre	percent
Land[a]	213.05	12	213.05	11
Machinery, Equipment & Housing	186.38	10	186.38	10
Labor				
Preharvest	281.89	15	279.62	15
Harvest	616.72	34	616.72	34
Materials				
Pesticides	191.92	10	218.07	12
Other Chemicals	99.28	5	99.28	5
Fuel	80.55	4	78.72	4
IPM Service Fee	7.50	1	N/A	0
Bee Rental	8.02	1	8.02	1
Others				
Insurance	9.57	1	9.57	1
General Overhead[c]	22.04	1	22.23	1
Management Fee[c]	61.42	3	62.45	3
Short-term Interest[d]	61.94	3	62.58	3
Total Cost	1,840.28	100	1,856.69	100

[a] Calculated as 10 percent interest (the average rate on long-term loans by the Farm Credit Service) plus taxes on investment in land.

[b] Per hour wage rate for preharvest labor including benefits was estimated to be $5.50. Harvest labor was paid by a piece rate charge which was estimated to be $7.50 per crate.

[c] Based on a cost study of vegetable farms in southern New Jersey, general overhead was assumed to be 1.3 percent of operating costs and a management fee was assumed to be 7 percent of operating costs.

[d] Interest was charged at 13 percent on sixty-five percent of the average operating expenditures (operating cost divided by two).

ulations. Thus, there is an increase in the probability of natural or predator-aided control.

Of the twelve IPM participants included in the survey, only four utilized alternate middles in the 1981 season. No nonparticipant utilized alternate middles. The means and ranges of per acre pesticide expenditures are presented in Table 3 for the three grower groups and three pesticide types.

The IPM participants using alternate middles spent on average less on insecticides and miticides than other IPM participants and nonparticipants. The largest relative difference was in the case of miticides as would be expected given the focus of the alternate middles system. In the case of fungicide expenditures, IPM participants not using alternate middles averaged about the same as other IPM participants but less than the non-IPM group. Again, however, when one used one-way analysis of variance to examine differences in the mean expenditures between the three groups of growers for insecticides, fungicides, miticides and total pesticides, no differences were found to be significant at the 95 percent level.

While the magnitude of cost savings from adopting IPM practices is the same, the general inability to discover significant cost savings from adopting IPM practices is not consistent with previous findings [e.g., Christensen and Prokopy (1979) and White and Thompson (1982)]. One possible explanation again lies in the large variation in the growers in each group and can be explained by the varying degrees of growers participation in IPM practices. In addition, the low numbers of observations for each alternative may also influence the statistical analysis. Finally, the analysis of the alternate middles alternative only examined chemical costs and there may also be savings in labor, fuel and other application costs.

Table 2 - Per Acre Expenditures on Pesticides for Apple Production by IPM and Non-IPM Participants in Southern New Jersey, 1981.[a/]

Pesticide Type	IPM Participants Mean	IPM Participants Range	Non-Participants Mean	Non-Participants Range	F Value
		$/acres			
Insecticides	64.32	26.20-108.30	79.41	41.68-184.49	0.84
Fungicides	104.51	60.59-164.57	114.57	52.25-187.38	0.30
Miticides	23.09	4.17- 51.42	24.09	5.36- 76.05	0.02
Total	191.92	97.57-321.58	218.07	128.42-399.39	0.54

[a/] All chemical costs calculated using 1980 prices.
Source: 1981 Survey data and Polk (1982).

Table 3 - Per Acre Expenditures on Pesticides for Apple Production by Three Grower Groups in Southern New Jersey, 1981.

Pesticide Type	Grower Group: Alternate Middle IPM Participants Mean	Alternate Middle IPM Participants Range	Non-Alternate Middle IPM Participants Mean	Non-Alternate Middle IPM Participants Range	Non-Participants Mean	Non-Participants Range	F Value
			$/acres				
Insecticides	57.52	26.20- 83.56	67.61	29.81-108.30	79.41	41.68-184.49	0.48
Fungicides	104.92	67.20-164.57	104.30	60.59-161.86	114.57	52.25-187.38	0.14
Miticides	12.97	4.17- 17.71	28.15	17.19- 51.42	24.09	5.36- 76.05	1.11
Total	175.41	97.57-264.79	200.17	127.60-321.58	218.07	128.42-399.39	0.38

Source: 1981 Survey data and Polk (1982).

CONCLUSIONS

The model farm analysis showed that integrated pest management practices can result in a net savings in costs to apple producers of $16.41 per acre with no appreciable difference in yield. Relative to the total cost of producing apples, this figure represents less than a one percent savings even though the NJ IPM program is highly subsidized. In addition, a more in-depth analysis of estimated pesticide expenditures failed to demonstrate statistically significant differences between participants and non-participants of the program. These results, therefore, raise some doubts as to the effectiveness of IPM in reducing production costs. Perhaps other cost items, particularly labor, should be examined for potential savings.

One, however, should not be quick to discount such a program for at least four reasons. First, as it has already been discussed, the large variation among growers in the study may have masked any potential cost differences. Grower participation in an IPM program is clearly not an all-or-nothing decision. Of the twelve participants, only four utilized an alternate middles system of spraying (one of the major practices advocated in the program) in 1981. Similarly, there can be considerable heterogeneity among non-participants if there have been spillover effects of program practices and information which has not affected all producers equally.

Second, the program is still in its infancy. It has only been in operation since 1980. Confidence in the program and its personnel can still be mounting. If expectations are fulfilled, growers still will be more willing to accept the financial risk they perceive to be associated with the program. Likewise, program personnel are gaining experience in adapting IPM principles to the specific climatic conditions and growers in the region.

Third, even small per acre cost differences can have a large effect on the costs and income of the farm as a whole.

Finally, the private benefits of the program are only one dimension of its total social value. While this study could not identify significant cost savings associated with IPM, one cannot simply conclude that pesticide use was not reduced. There may have been substitution in the types of chemicals used resulting in higher costs even with less chemicals used. The data available to the researchers did not lend itself readily to an examination of this point. However, if the program successfully reduces the use of chemical pesticides, the potential for reduced exposure can have long-term benefits in terms of the health of humans and wildlife in the region. In addition, reduced pesticide use can also result in reduced use of non-renewable resources upon which many pesticides are based. A more thorough investigation of these potential benefits is necessary before a complete benefit cost analysis of the program can be performed.

REFERENCES

Christensen, R.L. and R.J. Prokopy, 1979. "Impact on Costs and Energy Requirements of Adopting Alternate Middle Spray Techniques in Apple Orchards," Journal of the Northeast Agricultural Economics Council, 8(2): 243-274.

Funt, R.C., 1982. Unpublished data. Cooperative Extension Service, The Ohio State University, Columbus.

Gerling, W.D., 1982. A Survey of the Cost of Growing and Harvesting Apples in Eastern New York in 1981 and Eleven Year Review, Cooperative Extension Service, Cornell University, Hudson Valley Laboratory, Highland, New York.

Hepp, R.E., 1976. Alternative Delivery Systems for Farmers to Obtain Integrated Pest Management Services, Agricultural Economics Report No. 298, Department of Agricultural Economics, Michigan State University, East Lansing.

Hoffman, L., 1983. The Economics of Apple Production: An Investigation of Alternative Pest Management Systems by Southern New Jersey Growers in 1981. Unpublished Master's Thesis, Department of Agricultural Economics and Marketing, Rutgers University, New Brunswick, New Jersey.

Hough, J.A. and D. Gallahan, New Directions in Pest Management, New York State College of Agriculture and Life Sciences, Cornell University, Ithaca.

McKibbon, E.C., 1980. Apple Production Costs. An Update of Standard and Size - Controlling Trees, Ontario, 1976, 1978 and 1979, Economics Branch, Ontario Ministry of Agriculture and Food Legislative Buildings, Queen's Park, Toronto.

Norgaard, R.B., 1976. "Integrating Economics and Pest Management," in Integrated Pest Management, New York Plenum Publishing Corporation.

Polk, D., 1982. Unpublished data, Cooperative Extension Service, Rutgers - The State University of New Jersey, New Brunswick.

Smith, O.C., 1981. Apples Enterprise Cost Analysis, Cooperative Extension Service, University of Georgia, College of Agriculture, Athens.

White, G. B. and P. Thompson, 1982. "The Economic Feasibility of Tree Fruit Integrated Pest Management in the Northeast," Journal of the Northeastern Agricultural Economics Council, 11(2): 39-45.