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Economic Research Service

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Economic Implications of Using Zinc Phosphide
To Replace Endrin in Apple Orchards 1/

Walter L. Ferguson 2/

Consideration is being given to suspend or restrict the use of endrin for controlling mice in orchards. If endrin were not available for this use, State extension and experiment station personnel in 6 Eastern States and 2 Western States estimated that apple production losses would increase from mice injury on 33,400 endrin-treated bearing acres, (12,500 acres in the Eastern States and 20,900 acres in the Western States). The 6 Eastern States include Georgia, Maryland, North Carolina, South Carolina, Virginia and West Virginia; the 2 Western States are Idaho and Washington.

Estimates of production changes without endrin were made assuming zinc phosphide is the only feasible Federally registered chemical alternative to endrin. Chlorophacinone and diphacinone, potential alternatives to endrin are being used in some States under special permits. State registrations are in effect for one or both of these rodenticides in all of the 8 States, except Georgia and Maryland. Research data on these 2 materials are limited and although the efficacy results appear promising, it would be premature to consider them as alternatives to endrin for control of mice under a wide range of field conditions.

Methodology

State cooperators estimated potential acreage that may require endrin treatment, application rate per acre, and changes in production that might occur if zinc phosphide were substituted for endrin. The average amount of endrin sold for use in apple orchards during 1972-75 (63,000 pounds) was used as a base to determine acres treated. This amount was proportionately distributed among the 8 States based on the estimates of potential acres that might require treatment. The recommended per acre treatments by State were used to estimate the acres by State that would be affected (33,400 total acres).

This acreage estimate provided the base for estimating possible production losses without endrin. For the 8 States, the average annual weighted loss in production is 6.2 percent, 10 percent in the Eastern States and 5 percent in the Western States. Estimates of bearing acreage as a percent of total acreage were based on data from the 1969 Census of Agriculture. Published data from the U.S. Department of Agriculture were used to derive the average value of production per acre.

1/ This article is adapted from a section in the "Addendum to Pesticide Impact Assessment, Endrin of Nov. 4, 1976." The report was prepared by the Endrin Impact Assessment Team as authorized by the National Agricultural Pesticide Impact Assessment Program.

2/ Agricultural Economist, National Economics Analysis Division, Economic Research Service.

State extension and research personnel also estimated harvest and nonharvest production costs using endrin and zinc phosphide (as an alternative). The nonharvest costs were weighted by the number of endrin-treated acres in the Eastern and Western States. After the first 3 years of zinc phosphide use, it was assumed that nonharvest production costs would increase at an annual rate of 1 percent. The increase covers the additional cost of replacing trees, grafting, and associated labor and miscellaneous costs that would not be incurred if endrin were used. Harvest costs are assumed to be 11 percent of the per acre value of production. Included in the estimate are the losses from current bearing trees and potential bearing trees that are damaged by mice before bearing age.

Difference in returns using zinc phosphide

To estimate the change in returns to apple orchardists when zinc phosphide is substituted for endrin, a composite acre approach was used. Several factors were considered: (1) production lost from increased damage to trees that have not reached bearing age, (2) variations in initial bearing ages, and (3) variation in production of different apple varieties and types of trees (dwarf, standard, and so on).

The gross return per acre per year without the use of endrin is expressed as a function of the gross return using endrin in a base year and the cumulative effect of using zinc phosphide in place of endrin in subsequent years. The loss of endrin would cause net returns to gradually decrease from \$716 per acre with endrin to a loss of \$83 per acre in the 8th year after zinc phosphide has been substituted (table 1). Without endrin the total loss in gross returns for the 8 States over an eight year period is estimated to be about \$135 million. The last column of table 1 shows net returns for the 8 States; the decline over the 8-year period can be noted.

While the individual orchardist is primarily interested in net revenue (value minus total costs), economic theory suggests that orchardists will continue to produce as long as they can cover variable costs. In table 2, net revenue and operating revenue (value minus variable costs) are shown separately for Eastern and Western States.

Since yield per acre in the Eastern States is lower than in the Western States and greater damage from mice would be expected using zinc phosphide, orchardists in these States would experience losses in revenue earlier. These orchardists would, on the average, have net losses in the third year following a ban on endrin, but would not abandon acreage and substitute other crops until the sixth year when variable costs of production are no longer covered by returns. Western orchardists would experience negative net returns in the tenth year following a ban and abandon acreage in the fifteenth year.

Seasonal average prices per pound for 1973-75 were used to estimate value of production losses. Thus, prices were assumed constant and no consideration was given to changes in production outside the 8 States or to the effect of losses on prices. Should an expansion in apple production

outside the 8 States equal losses that result from an endrin ban prices would not be affected. However, under ceteris paribus conditions, the effect of a smaller crop would likely increase the price of apples, thus extending the number of years the orchard could remain in production and still meet variable production costs.

Table 1. --Difference in gross and net returns per year from apple orchards for initial 8 year period following endrin ban, 8 States

Number of years following ban	Value per endrin-treated acre <u>1/</u>	Loss of gross returns per acre <u>2/</u>	Total loss of gross returns 8 States <u>3/</u>	Production costs per acre <u>4/</u>	Net returns per acre <u>5/</u>	Total net returns 8 States <u>6/</u>
	Dollars	Dollars	Million Dollars	Dollars	Dollars	Million Dollars
0	2,078	0	0	1,362	716	23.9
1	1,949	129	4.3	1,347	602	20.1
2	1,828	250	8.4	1,334	494	16.5
3	1,715	363	12.1	1,322	393	13.1
4	1,609	469	15.7	1,321	288	9.6
5	1,509	569	19.0	1,321	188	6.3
6	1,415	663	22.1	1,323	92	3.1
7	1,327	751	25.1	1,325	2	.1
8	1,245	833	27.8	1,328	-83	-2.8
TOTAL			134.5			89.9

1/For base year, value of production per acre derived by dividing value of production for endrin-treated acreage by number of bearing endrin-treated acres (69.4 mil. divided by 33,400 acres = \$2,078). Each succeeding year's value is multiplied by 93.8 percent to account for the production lost in assuming zinc phosphide as the only alternative. Annual loss is based on estimates of State extension and research cooperators and weighted by 1973-75 average yields per acre.

2/Annual difference in value of production from value in base year (\$2,078).

3/Loss of gross returns per acre times endrin-treated acreage (33,400).

4/A nonharvest weighted production cost of \$1,133 per acre was estimated for the first 3 years following ban, with an increase of 1 percent of previous year's costs for remaining years. Harvest costs were estimated at 11 percent of per acre value of production.

5/Value of production per endrin-treated acre minus production costs per acre.

6/Net returns per acre times endrin-treated acreage (33,400).

Table 2. --Annual net and operating revenue of apple orchards, using zinc phosphide to replace endrin, 6 Eastern and 2 Western States ^{1/}

Number of years following ban	Value of production ^{2/}		Eastern States ^{3/}		Western States ^{3/}	
	Eastern States	Western States	Net revenue	Operating revenue	Net revenue	Operating revenue
	<u>Dollars per acre</u>					
0	1,270	2,561	303	515	979	1,317
1	1,143	2,433	190	402	865	1,203
2	1,029	2,311	89	301	757	1,095
3	926	2,196	-3	209	654	992
4	833	2,086	-94	120	544	885
5	750	1,982	-176	41	438	783
6	675	1,883	-251	-33	337	685
7	607	1,789	.	.	239	591
8	547	1,699	.	.	146	501
9	492	1,614	.	.	56	415
10	443	1,533	.	.	-30	333
11	399	1,457	.	.	-111	255
12	359	1,384	.	.	-190	180
13	323	1,315	.	.	-266	107
14	291	1,249	.	.	-338	39
15	261	1,186	.	.	-409	-28

^{1/}Estimates are derived for 12,500 and 20,900 endrin-treated bearing acres in the Eastern and Western States, respectively. Eastern States include GA, MD, NC, SC, VA and WV; and Western States include ID and WA.

^{2/}Using zinc phosphide to replace endrin, annual production losses were estimated at 10 and 5 percent for Eastern and Western States, respectively.

^{3/}On the average, farmers would abandon acreage in the sixth and fifteenth year in Eastern and Western States, respectively, when operating revenue became negative. Net revenue = Value of production - total costs. Operating revenue = Value of production - variable cost.