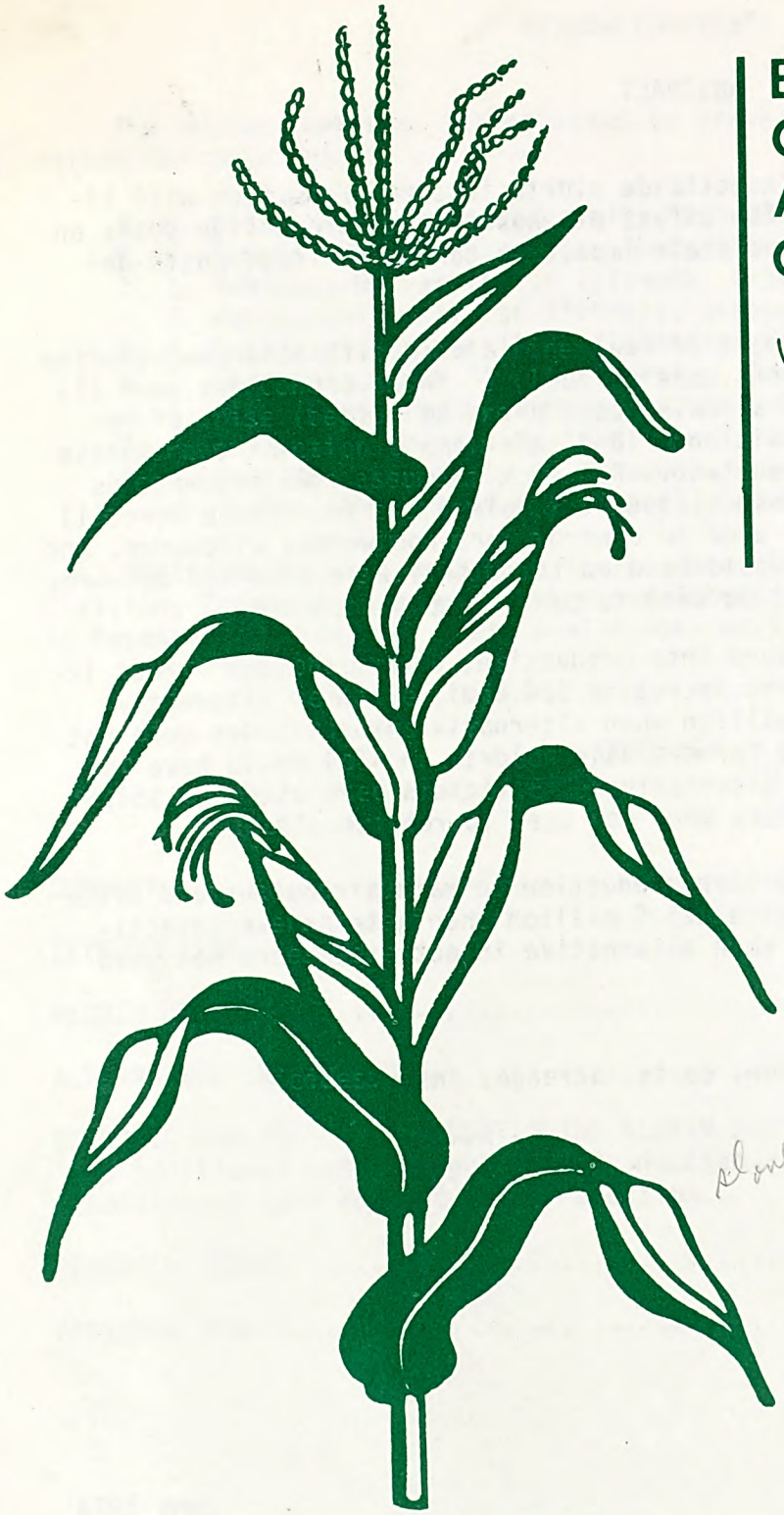

ECONOMIC IMPACT OF DISCONTINUING ALDRIN USE IN CORN PRODUCTION

U.S. DEPARTMENT OF AGRICULTURE

ECONOMIC RESEARCH SERVICE

ERS-557

ABSTRACT

Restricting the use of the insecticide aldrin in corn production will affect farmers' production costs. The effect of these higher production costs on producers' gross and net income and their impact on consumers' food costs depends on assumptions made.

In analyzing the economic impact of replacing aldrin with nonorganochlorine insecticides, two general conditions were evaluated. These conditions were (1) holding corn acreage constant and allowing corn price to rise (because of reduced output) and (2) bringing additional land into corn production to maintain corn output and hold corn price constant. For each condition two assumptions were made regarding alternative insecticides to replace aldrin. These were (1) alternative insecticides would be used to control corn rootworms, wireworms, and cutworms and (2) no insecticides would be used to control wireworms and cutworms but alternative insecticides would be used to control corn rootworms.

Without bringing additional land into production, corn producers' gross income and consumers' costs would have increased $24.8 million when alternative insecticides were used and $83.2 million when alternative insecticides were not used to replace aldrin. But those farmers using aldrin in 1971 would have had added costs of $31.5 million when alternative insecticides were used and $54.5 million when alternative insecticides were not used to replace aldrin.

Bringing additional land into corn production to maintain output and price would have increased producers' costs $25.9 million when alternative insecticides were used and $31.5 million when alternative insecticides were not used to replace aldrin in 1971.

Key Words: Corn, aldrin, production, costs, acreage, insecticides.

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SUMMARY

Public hearings are being conducted by the Environmental Protection Agency (EPA) to determine if the registration of the insecticide aldrin should be cancelled.

Corn producers used about 7.8 million pounds of aldrin to treat 7.5 million acres of corn in 1971. This accounted for about 98 percent of the aldrin used in crop production. It was used primarily to control corn rootworms, wireworms, and cutworms.

The economic impact of replacing aldrin with nonorganochlorine insecticides is analyzed for two general conditions.

1. Corn acreage was held constant and corn price was allowed to rise--because of reduced output.

2. Additional land was brought into production to maintain corn output--corn price held constant.

For each condition above, two assumptions were made regarding alternative insecticides to replace aldrin.

1. Alternative insecticides would be used to control corn rootworms, wireworms, and cutworms.

2. No insecticides would be used to control wireworms and cutworms but alternative insecticides would be used to control corn rootworms.

In 1971 with corn acreage held constant the price farmers received for corn because of lower yields would have risen 1 cent a bushel when alternative insecticides to replace aldrin were used to treat corn rootworms, wireworms, and cutworms; and 3 cents a bushel when alternative insecticides were used to control corn rootworms but not wireworms and cutworms. These higher prices would have increased the aggregate income of all corn producers, but they would also have increased the cost of food to consumers about $24.8 million when alternative insecticides were used and $83.2 million when alternatives insecticides were not used. However, for those farmers using aldrin, higher corn prices would not have compensated for the loss in crop yield. In 1971, incomes of farmers using aldrin would have been lower by $31.5 million when using alternative insecticides for corn rootworms, wireworms, and cutworms; and $54.5 million when using alternative insecticides for corn rootworms but not for wireworm or cutworm control.

If additional land had been brought into production to maintain corn output in 1971, consumer costs would not have changed because of the stabilized

corn price. But farmers' costs would have increased for alternative insecticides to replace aldrin and variable production costs on the additional land. With alternative insecticides replacing aldrin for corn rootworm, wireworm, and cutworm control, corn producers would have had added costs of $25.9 million--a net of $12.3 million for alternative insecticides--aldrin cost deducted--and $13.6 million for variable production costs. Without alternative insecticides for wireworm and cutworm control (corn rootworms treated), corn producers would have had added costs of $31.5 million. This includes a net of $6.8 million for alternative insecticides--aldrin costs deducted--for corn rootworm control plus $34.2 million for variable production costs less $9.5 million not spent on aldrin for wireworm and cutworm control in 1971.

ECONOMIC IMPACT OF DISCONTINUING ALDRIN USE IN CORN PRODUCTION

by

Herman W. Delvo*

INTRODUCTION

Public hearings are being conducted by the Environmental Protection Agency (EPA) to determine if the registration of the insecticide aldrin should be cancelled. About 98 percent of the aldrin used in crop production is used on corn to control soil insects. This report is an analysis of the short-run economic impact of discontinuing aldrin use in corn production using the 1971 crop year as a base. It was chosen as the base year because in 1971 a comprehensive survey on the extent of U.S. farm pesticide use was conducted. Although the long-run impact of the restriction of aldrin on farm adjustment is important, it is beyond the scope of this study.

Farmers used about 8.0 million pounds of aldrin in crop production in 1971 (table 1). This was a decline of 46 percent from 1966 when 14.8 million pounds were used. Corn farmers used about 7.8 million pounds of aldrin in 1971. It was used primarily to control corn rootworms, wireworms, and cutworms. Farmers used 67,000 pounds of aldrin in sorghum production and 31,000 pounds on other field crops. Citrus producers used 35,000 pounds of aldrin on 11,000 acres to control the larva of fullers rose beetle. A small amount of aldrin was used in soybean production (11,000 pounds) and on other crops (4,000 pounds) in 1971.

Between 1966 and 1971 corn acreage increased 12 percent and the corn acreage treated with any insecticide increased 16 percent (table 2). But during the same period the corn acreage treated with aldrin decreased 44 percent.

Cancelling farm use of aldrin for corn production would (1) increase farmers' costs for alternative insect control and (2) reduce yields where alternative insecticides are less effective than aldrin. In addition, farmers would have higher variable production costs if additional land was brought into corn production to maintain output to keep corn prices stable. If additional land is not brought into production, corn prices would rise and consumers would pay more for products utilizing corn.

The following sequence of analysis will be followed:

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Table 1--Farm use of aldrin on crops, United States, 1966 and 1971

Crop	1966			1971		
	Pounds of active ingredient	Acres treated	Percent acres treated	Pounds of active ingredient	Acres treated	Percent acres treated
	1,000 pounds	1,000 acres	Percent	1,000 pounds	1,000 acres	Percent
Corn	14,244	13,386	20.2	7,759	7,540	10.2
Sorghum	57	27	.2	67	57	.3
Other field crops	125	131	1/	31	39	1/
Citrus	--	--	--	35	11	1.0
Soybeans	45	43	.1	11	9	1/
Other crops	280	234	2.3	4	2	1/
United States	14,751	13,821	4.0	7,907	7,658	2.2

-- = none reported.
1/ Less than .05 percent.
Sources: Theodore Eichers and others. Quantities of Pesticides Used by Farmers in 1966. U.S. Dept. Agr., Econ. Res. Serv., Agr. Econ. Rpt. No. 197, April 1970; and 1971 Farm Production Expenditure Survey, U.S. Dept. Agr., Econ. Res. Serv. and Statis. Rptg. Serv., unpublished.

Table 2--Corn grown, use of insecticides, and use of aldrin on corn, United States, 1966 and 1971

Item	1966	1971	Percent change, 1966 to 1971
	1,000 acres		Percent
Corn planted	66,306	74,055	12
Corn treated with:			
Any insecticide	22,080	25,623	16
Aldrin	13,386	7,540	-44

Sources: Acreage planted for all purposes. Crop Production Annual Summary 1967 and 1972. U.S. Dept. Agr., Statis. Rptg. Serv., CrPr 2-1 (67), Dec. 1967 and CrPr 2-1 (72), Jan. 1973; and Theodore Eichers and others. Quantities of Pesticides Used by Farmers in 1966. U.S. Dept. Agr., Econ. Res. Serv., Agr. Econ. Rpt. No. 179, Apr. 1970.

1. The acreage treated with aldrin for corn rootworm, wireworm, and cutworm control in 1971 will be estimated.

2. Alternative insecticides to replace aldrin and changes in per acre corn yields will be determined.

3. The added cost of alternative insecticides, value of yield losses, and change in corn price--without bringing additional land into corn production--will be estimated.

4. The additional insecticide and variable production costs for additional land needed to maintain corn output--no price change--will be estimated.

The information for the 1971 crop year presented in this report is based on personal interviews with about 8,600 farmers in the 48 contiguous States and Hawaii. About 1,700 farmers were interviewed in the five Corn Belt States where most of the aldrin is used.

ALDRIN USE ON CORN

The planted corn acreage treated with aldrin decreased from 20.2 percent in 1966 to 10.2 percent in 1971 (table 3). The rather extensive use of aldrin on corn in the mid-1960's was probably the result of a shift to more continuous corn production which was conducive to the build-up of corn rootworm populations. The western corn rootworm (a problem primarily in Nebraska and Iowa) had already developed resistence to aldrin, but in the rest of the Corn Belt the northern corn rootworm was the predominate species and susceptible to aldrin. The decrease in aldrin use between 1966 and 1971 may be partially explained by the spread of the resistent western corn rootworm into northern Illinois and the development of resistence by seed corn beetles and seed corn maggots. In addition, some farmers may have stopped using the insecticide on corn cut for silage because of possible residues showing up in milk.

Farmers in Illinois and Iowa accounted for 59 percent (4.4 million acres) of the corn acreage treated with aldrin in 1971. About 1.1 million acres of corn were treated with aldrin in Missouri. Indiana farmers treated about 750,000 acres of corn and Ohio farmers treated about 650,000 acres. Farmers in the Lake States and Northern Plains--primarily Minnesota and Nebraska--treated about 0.6 million acres with aldrin in 1971. Compared to farmers in the other States, those in Missouri treated the highest percentage of their corn acreage in both 1966 and 1971 at 47 and 32 percent, respectively.

In 1971, farmers treated about 4.7 million acres of corn with aldrin for corn rootworm and 2.0 million acres for cutworm control (table 4). These figures include 333,000 acres that farmers indicated were treated for both corn rootworm and cutworm control. In addition, 1.2 million acres of corn were treated with aldrin for wireworm control in 1971. Illinois and Iowa led all States in the acreage treated for corn rootworm control at about 1.4 million acres each. In addition, Illinois had the largest acreage treated for cutworm (0.7 million acres) and wireworm (0.5 million acres) control.

Table 3--Acreage of corn grown and treated with aldrin by selected States, regions, and the United States, 1966 and 1971

State and region	Acres of corn planted		Acres of corn treated with aldrin		Percent of acres treated with aldrin	
	1966	1971	1966	1971	1966	1971
	1,000 acres				Percent	
Ohio	3,338	3,787	595	648	17.8	17.1
Indiana	5,256	5,679	1,282	746	24.4	13.1
Illinois	10,684	10,370	4,885	2,475	45.7	23.9
Iowa	10,676	12,208	3,586	1,953	33.6	16.0
Missouri	3,108	3,332	1,461	1,081	47.0	32.4
Lake States and Northern Plains	19,705	24,069	1,217	560	6.2	2.3
Other States	13,539	14,610	360	77	2.7	.5
United States	66,306	74,055	13,386	7,540	20.2	10.2

Sources: Crop Production Annual Summary 1967 and 1972. U.S. Dept. Agr., Statis. Rptg. Serv., CrPr 2-1 (67), Dec. 1967 and CrPr 2-1 (72), Jan. 1973. Theodore Eichers and others. Quantities of Pesticides Used by Farmers in 1966. U.S. Dept. Agr., Econ. Res. Serv., Agr. Econ. Rpt. No. 179, Apr. 1970. 1971 Farm Production Expenditure Survey, U.S. Dept. Agr., Econ. Res. Serv. and Statis. Rptg. Serv., unpublished.

Table 4--Acreage of corn treated with aldrin for corn rootworm, wireworm, and cutworm control for selected States and regions, 1971 1/

State and region	Soil insects 2/	Corn rootworm 3/		Wireworm		Cutworm	
	1,000 acres	1,000 acres	Percent	1,000 acres	Percent	1,000 acres	Percent
Ohio	648	479	74	67	10	278	43
Indiana	746	432	58	251	34	70	9
Illinois	2,475	1,378	56	496	20	716	29
Iowa	1,953	1,383	71	170	9	400	20
Missouri	1,081	655	61	138	13	373	34
Lake States and Northern Plains	560	336	60	50	9	174	31
Other States	77	77	100	0	--	0	--
United States	7,540	4,740	63	1,172	16	2,011	27

1/ The distribution of acreage treated is based on the 1971 Farm Production Expenditure Survey, U.S. Dept. Agr., Econ. Res. Serv. and Statis. Rptg. Serv.. The estimated acreage treated with aldrin for corn rootworms, wireworms, or cutworms is based on the farmer's response as to what insect he was attempting to control. No check was conducted to determine if these insects were present in the field. 2/ The acreage treated for specific insects will total to more than the acreage for soil insects because farmers indicated that about 333,000 acres were treated for both cutworm and rootworm control. 3/ Includes some acreage where farmers reported wireworms but the primary insect problem was corn rootworm.

ALTERNATIVE INSECTICIDES

In determining the alternative insecticides farmers might use to replace aldrin for soil insect control in corn production, it was assumed that only phosphate and carbamate insecticides would be used. It is recognized that both the organochlorine and nonorganochlorine insecticides have benefits and hazards associated with their use. The nonorganochlorine insecticides are more toxic than aldrin, and therefore may be a greater hazard to farm operators and workers handling these materials. Organophosphorus and carbamate insecticides are less persistent than the organochlorines, but for this study it was assumed that one application of a nonorganochlorine insecticide replaces one application of aldrin on corn. It is recognized that the persistence of aldrin may provide multi-year insect control, compared to the nonorganochlorines, but no data were available from the survey to determine if farmers applied aldrin each year to a field or only alternate years. On the other hand, the persistence of the organochlorine insecticides may have an adverse effect in that they build up in the soil causing plants to accumulate residues.

Although farmers decreased the use of aldrin between 1966 and 1971, the corn acreage treated with any insecticide increased slightly from 33 percent in 1966 to 35 percent in 1971 (table 5) The acreage treated with Bux, carbofuran, and phorate (phosphate and carbamate materials) increased from 0.3 percent of the planted acreage in 1966 to 15.5 percent in 1971. The acreage treated with heptachlor (an organochlorine similar to aldrin) and diazinon decreased during the period.

Table 5--Acres of corn treated with selected insecticides and percentage distribution, United States, 1966 and 1971

Insecticide	Acres treated 1/		Percent of acres treated 1/	
	1966	1971	1966	1971
	1,000 acres		Percent	
Aldrin	13,386	7,540	20.2	10.2
Bux	59	4,425	0.1	6.0
Carbofuran 2/	--	3,677	--	5.0
Phorate	161	3,353	.2	4.5
Heptachlor	2,026	1,901	3.1	2.6
Diazinon	4,011	1,850	6.0	2.5
Others	4,640	5,806	7.1	7.8
Any insecticide	22,080	25,623	33.3	34.6

1/ Detail does not sum to total because the same acreage was treated with more than one insecticide.

2/ Carbofuran was registered for use on corn in 1969.

Sources: Theodore Eichers and others. Quantities of Pesticides Used by Farmers in 1966. U.S. Dept. Agr., Econ. Res. Serv., Agr. Econ. Rpt. No. 179, Apr. 1970; and 1971 Farm Production Expenditure Survey, U.S. Dept. Agr., Econ. Res. Serv. and Statis. Rptg. Serv., unpublished.

The selection of alternative insecticides to replace aldrin was based on insect control recommendations and discussions with entomologists in the Corn Belt. It was assumed that aldrin was applied in a band or in-furrow at planting time for corn rootworm (and a less extent wireworm) control and as a broadcast-preplant application for wireworm and cutworm control (appendix table 1).

Bux, carbofuran, and phorate banded at planting were assumed to be the most likely materials farmers would use to replace aldrin for corn rootworm control. This is based on State recommendations and the actual materials reported used by farmers in 1971 (table 5) which shows the use of these three increasing while aldrin use declined.

Phorate applied in a band at planting was assumed to be the alternative to aldrin for wireworm control in all States, except Ohio and Missouri. It was selected because it is recommended in several States as a partial control for wireworms on dairy farms and it is the only alternative material applied in a band that has label registration for possible reduction of wireworm infestations (not for controlling them). Diazinon applied preplant-broadcast-incorporated was assumed to be the alternative used in Ohio and Missouri.

There is limited information on the effectiveness of alternative insecticides for controlling cutworms. It was assumed that a postemergent carbaryl bait would be used in all States, except Ohio and Missouri. The bait is applied broadcast after cutworm activity is observed in the field. It was assumed that Ohio farmers would use a carbaryl spray and Missouri farmers a toxaphene spray. These materials are sprayed at the base of the corn plant and incorporated into the soil by cultivation.

The change in corn yields from soil insect damage with and without alternative insecticides is shown in table 6. These estimates were based on discussions with entomologists from the Corn Belt States. They are estimates of what damage might occur with a moderate to heavy insect infestation. It was assumed that corn yield would not change if alternative insecticides were used to replace aldrin for corn rootworm control. There is some indication, from Illinois data, that yields may increase if nonorganochlorine insecticides are substituted for aldrin in corn rootworm control. 1/

For wireworm and cutworm control it was assumed that the alternative insecticides were not as effective as aldrin. The percentage change in yields for wireworm and cutworm damage takes into account the fact that not all the acreage treated with aldrin (table 4) for control of these insects is infested. In developing the loss estimates, the damage incurred on the infested acreage was prorated to represent the acreage treated with aldrin. For example, if 80 percent damage occurred but on only 10 percent of the acreage, the loss for all acres treated with aldrin was estimated at 8 percent (80 percent x 10 percent).

Using the procedure described above, the estimated reduction in corn yield ranged from zero to 8 percent for wireworm control with alternative insecticides (table 6). For cutworm control, the estimated reduction in yield ranged from

1/ Kuhlman, D.E. and Petty, H.B. "Summary of Corn Rootworm Insecticide Demonstrations, 1968-1972", Twenty-Fifth Illinois Custom Spray Operators Training School, Urbana, Illinois, January 24 and 25, 1973.

Table 6--Change in corn yields from soil insect damage with and without alternative insecticides to replace aldrin, States and regions, 1971

State and region	Average yield per acre, 1970-72 1/	Change in per acre yields 2/				
		With alternative insecticides			Without alternative insecticides 3/	
		Corn rootworm	Wireworm	Cutworm	Wireworm	Cutworm
	Bushels	Percent				
Ohio	88	0	0	-5	-10	-10
Indiana	92	0	0	-10	-10	-25
Illinois	96	0	0	-10	-10	-25
Iowa	101	0	-8	-10	-12	-25
Missouri	79	0	-8	-15	-12	-30
Lake States and Northern Plains	77	0	-8	-10	-12	-25
Other States	68	0	0	0	0	0

1/ Crop Production Annual Summary 1972. U.S. Dept. Agr., Statis. Rptg. Serv., CrPr 2-1 (72), Jan. 1973.

2/ Based on discussions with entomologists from the Corn Belt States. The figures represent the estimated loss on all the acres treated with aldrin and not the amount of damage where the infestation occurred. For example, if the level of damage in the infested area was 80 percent but only occurred on 10 percent of the acreage the loss for all acres treated was estimated at 8 percent.

3/ Changes in yield are not included for corn rootworm damage because it was assumed that alternative insecticides would be used.

5 percent in Ohio to 15 percent in Missouri. With the use of the carbaryl bait or spray or toxaphene spray as a postemergent application, cutworm damage will be incurred before the insecticide is applied. Also, there will be additional damage before the cutworm population is reduced by the insecticide. Farmers would need to be especially vigilant and check fields frequently when using these postemergent materials or considerable damage could occur before the insecticide is applied. In addition, with the carbaryl bait, soil surface temperature and moisture need to be favorable so that the cutworms are feeding at or very near the soil surface. Thus, the losses for individual farmers would be highly variable the first few years until they gained experience in applying these materials to control cutworms.

On the acreage treated with aldrin for wireworms, it was estimated that yield losses would average from 10 to 12 percent without alternative insecticides. The reduction in yield was estimated at 10 percent in Ohio and 25 to 30 percent in the other Corn Belt States without alternative insecticides to replace aldrin for cutworms in 1971 (table 6).

ECONOMIC ANALYSIS OF DISCONTINUING ALDRIN USE IN CORN PRODUCTION

The economic impact of replacing aldrin with nonorganochlorine insecticides is analyzed for two general conditions.

1. Corn acreage was held constant and corn price was allowed to rise--because of reduced output.

2. Additional land was brought into production to maintain corn output--corn price held constant.

For each condition above, two assumptions were made regarding alternative insecticides to replace aldrin.

1. Alternative insecticides would be used to control corn rootworms, wireworms, and cutworms.

2. No insecticides would be used to control wireworms and cutworms but alternative insecticides would be used to control corn rootworms.

No Additional Land Brought Into Production

With Alternative Insecticides for All Soil Insect Control--The added cost for alternative insecticides to replace aldrin would have been $12.3 million in 1971 (table 7). Of this total, $6.9 million was for corn rootworm and $4.1 million for cutworm control. The cost of alternative insecticides for wireworm control was estimated at another $1.3 million. Illinois and Iowa would have had the largest expenditures to replace aldrin for soil insect control in 1971 at $3.5 million and $2.9 million, respectively.

No production loss was estimated for corn rootworms because the alternative insecticides were assumed to be as effective as aldrin. But for wireworm and cutworm control, alternative insecticides were assumed to be less effective and production losses would result. It was estimated that corn production would be reduced 21.1 million bushels on the acreage treated with aldrin if alternative insecticides were used (table 8). Of the total, 18.5 million bushels resulted from cutworm damage and 2.6 million bushels from wireworm damage. Illinois would have had the largest loss in production--about 6.9 million bushels. The lowest production loss would have been in Indiana at 0.6 million bushels.

The reduction in production of 21.1 million bushels would affect the market price of corn. In order to estimate the change in price, it is necessary to know the price elasticity of demand for corn and the percentage change in corn production. A price elasticity of 0.5 and an average U.S. corn production of 5.1 billion bushels is used. 2/

To compute the percentage change in corn price the following formula is used:

2/ Western Extension Marketing Committee Task Force. A Handbook on the Elasticity of Demand for Agricultural Products in the United States. Western Extension Marketing Committee Pub. No. 4, Jul. 1967 and Crop Production Annual Summary 1972. U.S. Dept. Agr., Statis. Rptg. Serv., CrPr 2-1 (72), Jan. 1973.

Table 7--Added cost of alternative insecticides to replace aldrin on corn, 1971

Type of insect control	Estimated acres treated with aldrin 1/	Added cost per acre for alternative insecticides 2/	Added cost for alternative insecticides
	1,000 acres	Dollars	1,000 dollars
Corn rootworm:			
Ohio	479	1.45	695
Indiana	432	1.45	626
Illinois	1,378	1.45	1,998
Iowa	1,383	1.45	2,005
Missouri	655	1.45	950
Lake States and Northern Plains	336	1.45	487
Other States	77	1.45	112
United States	4,740	--	6,873
Wireworm:			
Ohio	67	8.40	563
Indiana	251	-.40	-100
Illinois	496	-.40	-198
Iowa	170	-.40	-68
Missouri	138	8.40	1,159
Lake States and Northern Plains	50	-.40	-20
United States	1,172	--	1,336
Cutworm:			
Ohio	278	0.95	264
Indiana	70	2.40	168
Illinois	716	2.40	1,718
Iowa	400	2.40	960
Missouri	373	1.50	560
Lake States and Northern Plains	174	2.40	418
United States	2,011	--	4,088
Grand total	--	--	12,297

-- = not applicable
1/ From table 4.
2/ From appendix table 1.

Table 8--Change in corn production from wireworm and cutworm damage with and without alternative insecticides, States and regions, 1971 1/

State and region	Reduction in corn production with alternative insecticides for aldrin			Reduction in corn production without alternative insecticides for aldrin		
	Wireworm	Cutworm	Total	Wireworm	Cutworm	Total
	1,000 bushels					
Ohio	--	1,223	1,223	590	2,446	3,036
Indiana	--	644	644	2,309	1,610	3,919
Illinois	--	6,874	6,874	4,762	17,184	21,946
Iowa	1,377	4,040	5,417	2,057	10,080	12,137
Missouri	869	4,401	5,270	1,311	8,952	10,263
Lake States and Northern Plains	310	1,340	1,650	460	3,341	3,801
United States	2,556	18,522	21,078	11,489	43,613	55,102

1/ From appendix tables 2 and 3.

1. Price elasticity = $\frac{\text{Percentage change in quantity}}{\text{Percentage change in price}}$

The reduction of 21.1 million bushels is about 0.4 percent of the average annual production of 5.1 billion bushels. By substituting the price elasticity and percentage change in quantity into the formula, the following is obtained:

2. $0.5 = \frac{0.4}{\text{Percentage change in price}}$

3. Percentage change in corn price = 0.8 percent.

To obtain the price change per bushel of corn, the percentage change in price is multiplied by the average corn price of $1.23 a bushel (1970-72 average). Therefore, the price increase for a bushel of corn with alternative insecticides to replace aldrin was estimated to be 1 cent ($1.23 x 0.8% - .01).

The economic impact on farmers who used alternative insecticides to replace aldrin for soil insect control in corn production in 1971 would have been a reduction in income of about $31.5 million (table 9). These farmers would have had added costs of $12.3 million for alternative insecticides and production losses valued at $25.9 million. However, these costs would have been partially offset by the gain of $6.7 million from the price increase of 1 cent a bushel on the production from those acres previously treated with aldrin.

The economic impact on the corn producing sector (that is, all farmers raising corn) would have been an increase in net income of $12.5 million in 1971. This results because the price increase from $1.23 to $1.24 a bushel adds $24.8 million to the total value of U.S. corn production which more than offsets the added cost of alternative insecticides--$12.3 million.

Table 9--Losses to corn farmers treating with aldrin and gains to all corn farmers with and without alternative insecticides to replace aldrin, 1971

Item	Units	With alternatives to treat all soil insects 1/	Without alternatives to treat wireworms and cutworms 2/
Average U.S. corn production 1970-72 3/	1,000 bu.	5,088,926	5,088,926
Reduction in corn output without aldrin 4/	do.	21,078	55,102
Corn production without aldrin	do.	5,067,848	5,033,824
Increase in U.S. price per bushel because of lower production 5/	cents	1	3
Economics of aldrin restriction for control of soil insects on acreage treated in 1971:			
Added cost of alternative insecticides 6/	$1,000	-12,297	-6,873
Reduction in income:			
Loss in corn production	1,000 bu.	21,078	55,102
Price of corn (1970-72) 5/	dollars	1.23	1.23
Value of corn production losses	$1,000	-25,926	-67,775
Increase in income:			
Total production on acres treated with aldrin 7/	1,000 bu.	673,186	639,162
Increase in price per bushel 5/	cents	1	3
Value of gain from price change	$1,000	6,732	20,175
Loss on corn acreage treated with aldrin in 1971 8/	do.	-31,491	-54,473
Impact on corn producing sector:			
Increase in value of average corn production 9/	$1,000	24,752	83,240
Added cost of alternative insecticides	do.	-12,297	-6,873
Gain on all corn acreage 10/	do.	12,455	76,367

1/ It was assumed farmers would use alternative insecticides for all uses of aldrin--primarily for corn rootworm, wireworm, and cutworm control.

2/ It was assumed that farmers would continue to use alternative insecticides for corn rootworm control (table 6).

3/ Crop Production Annual Summary 1972. U.S. Dept. Agr., Statis. Rptg. Serv., CrPr 2-1 (72), Jan. 1973.

4/ Lower production is limited to acreage treated for wireworm and cutworm control (table 8).

5/ Based on an average corn price of $1.23 per bushel (1970-72) and a 0.8 percent (1 cent) increase in price with alternative insecticides and a 2.2 percent (3 cent) increase without alternative insecticides.

6/ From table 7.

7/ Based on State acreages treated with aldrin for soil insect control (table 4) times the average yield per acre 1970-72 (table 6) minus the reduction in corn production (table 8).

8/ Added cost of alternative insecticides plus value of production losses minus value of gain from higher corn price.

9/ Corn production without aldrin (line 3) times the change in corn price because of lower production (line 4) less the loss in corn production (line 2) times $1.23 a bushel. This is an increased cost to consumers.

10/ Increase in value of corn production less added cost of alternative insecticides. This is an increase in net income for corn producers.

This increase in income to the corn producing sector also means that if alternative insecticides were used to replace aldrin and no additional land is brought into production, the added cost to consumers would be $24.8 million.

Without Alternative Insecticides for Wireworm and Cutworm Control--It was assumed that alternative insecticides would be used for corn rootworm but not for wireworm and cutworm control. The added cost for alternative insecticides to replace aldrin for corn rootworm control would have been $6.9 million in 1971 (table 7).

It was estimated that total corn production would be reduced about 55.1 million bushels--11.5 million bushels from wireworms and 43.6 million bushels from cutworms--if no alternative insecticides had been used to replace aldrin in 1971 (table 8). Illinois would have had the largest reduction in production--21.9 million bushels--followed by Iowa at 12.1 million bushels. Reduction in corn output would have ranged from 3.0 to 10.3 million bushels in the other Corn Belt States. The reduction in production of 55.1 million bushels is about 1.1 percent of the 1970-72 average U.S. corn production of 5.1 billion bushels. The effect (using the price elasticity formula) would be to raise corn price 2.2 percent or 3 cents a bushel ($1.23 x 2.2% = .03).

The economic impact on the corn producing sector would have been an increase in net income of $76.4 million in 1971 if no alternative insecticides had been used to replace aldrin for wireworm and cutworm control--alternatives used for corn rootworms (table 9). The price increase from $1.23 to $1.26 a bushel would have added $83.2 million to the value of U.S. corn production in 1971. Of this amount $20.2 million would have accrued to those farmers who had used aldrin and $63.0 million to those farmers who did not use aldrin. It must be remembered that this increase in corn producers' gross income is also a cost to consumers.

The $20.2 million in added gross income to farmers who used aldrin was more than offset by increased costs of $74.7 million--$6.9 million for alternative insecticides for corn rootworms and production losses valued at $67.8 million from wireworms and cutworms. Thus, the net result of aldrin restriction for those farmers using aldrin in 1971 would have been added costs of $54.5 million.

Additional Land Brought Into Production

If additional land had been brought into production to maintain corn output through a change in the 1971 Federal Government set-aside program, the cost of replacing aldrin with or without alternative insecticides would be borne by corn producers. The 1971 farm program required a 20-percent set-aside of the feed grain base which idled 18.2 million acres of cropland. No voluntary diversion provision under which farmers received a payment for idling additional cropland was available. Thus, the changing of the set-aside requirement to bring more land into production would not have affected farm program payments. Farmers would have added costs for alternative insect control practices and for bringing additional land into production. It was assumed that the land brought into production would be of lower productivity and that there would be a need to control wireworms because the crop cover--grass or weeds on idle land--is conducive for population increases.

The price of corn is assumed to remain constant because the output from the additional land offsets the loss in production on the acreage damaged by wireworms and cutworms. Therefore, there would be no added cost to consumers for replacing aldrin in corn production.

In interpreting the results, it is important to keep in mind that only a small part of the additional acreage brought into production would be on farms where aldrin was used in 1971. The reason for this is that the areas that generally have the most cutworm problems are low areas in flood plains of rivers and streams. These soils are fertile and farmers probably use most of it for intensive corn production. Therefore, the additional acreage would be spread among all corn producers throughout the United States.

With Alternative Insecticides for All Soil Insect Control--The added cost to the corn producing sector for maintaining corn output with alternative insecticides to control soil insects would have been $25.9 million in 1971 (table 10). Added costs would have been $12.3 million for alternative insecticides to replace aldrin plus $13.6 million for variable production costs on the additional 293,000 acres needed to maintain output.

Table 10--Cost of maintaining corn production by bringing in additional acres to offset production losses incurred with and without alternative insecticides to replace aldrin, 1971

Item	With alternatives to treat all soil insects	Without alternatives to treat wireworms and cutworms
	1,000 dollars	
Added cost of alternative insecticides on land currently in corn production..	1/ 12,297	2/ 6,873
Variable production costs on additional acres needed to maintain corn output at 1970-72 average 3/.....	13,624	34,199
Less value of aldrin not used.....	--	4/ 9,549
Cost on all corn acreage.....	25,921	31,532

1/ It was assumed farmers would use alternative insecticides for all uses of aldrin--primarily for corn rootworm, wireworm, and cutworm control (table 7).

2/ It was assumed that farmers would continue to use alternative insecticides for corn rootworm control (table 7).

3/ Cost of bringing additional land into production as shown in appendix table 4.

4/ Estimated acres treated with aldrin for wireworm and cutworm control (table 4) times the cost per acre for aldrin (appendix table 1).

Without Alternative Insecticides for Wireworm and Cutworm Control--If no alternative insecticides were used to replace aldrin to control wireworms and cutworms (but used for corn rootworm control), corn farmers would have had added costs of $31.5 million in 1971 (table 10). The added cost for corn rootworm control would have been $6.9 million. To maintain corn output, 819,000 acres of additional land would be needed. The variable production costs for bringing the land into corn production would have been $34.2 million. Farmers would have saved $9.5 million on aldrin not purchased for wireworm and cutworm control.

RESEARCH NEEDS

The economic impact of aldrin restriction on individual farmers may influence the type of farm organization. Because of the potential loss from insect damage, the cash-grain farmer may find it necessary to shift from intensive continuous corn production to a corn-soybean rotation or to crops such as small grains and forage. On the other hand, farmers with crop-livestock operations utilizing home grown corn may find it necessary to curtail their livestock enterprises or purchase additional corn from other farmers or commercial sources, increasing their cost of production.

The probability and intensity of cutworm damage if aldrin use is restricted may also affect the financial position of farmers. If a farmer has a heavy debt load and his corn crop sustains considerable insect damage the first year after aldrin restriction he may find it difficult to meet his obligations. But if he does not have any severe insect damage for a couple of years he will probably make some adjustments in his operation so that he is in a better position to handle a reduction in income. But these adjustments whether they are increases in cash reserves, grain reserves, or the purchase of insurance increase the cost of operation and reduce the farmers income.

The problems of the individual farmer may also have an impact on the rural community. The secondary impact on the community from a reduction in farmers' income would depend on the intensity of corn production in the area and the potential severity of cutworm damage if aldrin is not used.

These issues concerning the economic impact on individual farmers and rural communities are important but beyond the scope of this study. Therefore, there is a need to identify those areas where cutworms are a problem and initiate studies to determine the economic impact for the area and for individual farmers with cutworm problems.

Appendix table 1--Per acre costs for alternative insecticides to replace aldrin on corn, 1971

Type of insect control	Aldrin			Alternative insecticides				
	Quantity of active ingredient applied per acre 1/	Cost per pound of active ingredient 2/	Cost per acre	Insecticide 3/	Quantity of active ingredient applied per acre 4/	Cost per pound of active ingredient 2/	Cost per acre	Added cost alternative insecticide per acre 5/
	Pounds	---Dollars---			Pounds	---------Dollars--------		
Corn rootworm control:								
All States	1.0	1.50	1.50	Bux	0.8	3.80	3.04	
				Carbofuran	.8	4.00	3.20	
				Phorate	1.0	2.60	2.60	
Average cost			1.50				2.95	1.45
Wireworm control:								
Ohio and Missouri	2.0	1.50	3.00	Diazinon	4.0	2.85	11.40	8.40
Other States	2.0	1.50	3.00	Phorate	1.0	2.60	2.60	-.40
Cutworm control:								
Missouri	2.0	1.50	3.00	Toxaphene spray	3.0	.75	6/ 4.50	1.50
Ohio	2.0	1.50	3.00	Carbaryl spray	2.0	1.35	6/ 3.95	.95
Other States	2.0	1.50	3.00	Carbaryl bait	1.0	5.40	5.40	2.40

1/ Based on insect control recommendations for the Corn Belt States. The rate is for a banded application for corn rootworm control and a broadcast application for wireworm and cutworm control.

2/ Based on recent retail prices published by pesticide suppliers.

3/ If aldrin use is cancelled, there are several nonorganochlorine insecticides that might be used to control soil insects in corn production. The list of alternative insecticides is based on (1) insect control recommendations for the Corn Belt States and (2) information on the more frequently used insecticides for corn rootworm control in these States. Data for the latter are from preliminary tabulations from the 1971 Farm Expenditure Survey, U.S. Dept. Agr., Econ. Res. Serv. and Statis. Rptg. Serv.

4/ The rate per acre is for a banded application for corn rootworm control. For wireworm control, the diazinon rate is for a broadcast-preplant-incorporated application and for phorate a banded application. The rate for toxaphene and carbaryl spray for cutworm control is for a postemergent application directed at the base of the plant. The carbaryl bait is a 5-percent granule applied broadcast-postemergent.

5/ Cost of alternative insecticide minus the cost of aldrin. It was assumed that application costs did not change.

6/ Applied as a basal spray and includes a charge of $1.25 for a cultivation to incorporate the material into the soil.

Appendix table 2--Reduction in corn production because of wireworm damage with and without alternative insecticides to replace aldrin, States and regions, 1971

State and region	Estimated acres treated with aldrin 1/	Average yield per acre 1970-72 2/	Reduction in corn production		
			Per acre yield loss 2/		Total
	1,000 acres	Bushels	Percent	Bushels	1,000 bushels
With alternative insecticides:					
Ohio	67	88	0	--	--
Indiana	251	92	0	--	--
Illinois	496	96	0	--	--
Iowa	170	101	8	8.1	1,377
Missouri	138	79	8	6.3	869
Lake States and Northern Plains	50	77	8	6.2	310
United States	1,172	--	--	--	2,556
Without alternative insecticides:					
Ohio	67	88	10	8.8	590
Indiana	251	92	10	9.2	2,309
Illinois	496	96	10	9.6	4,762
Iowa	170	101	12	12.1	2,057
Missouri	138	79	12	9.5	1,311
Lake States and Northern Plains	50	77	12	9.2	460
United States	1,172	--	--	--	11,489

-- = not applicable. 1/ From table 4. 2/ From table 6.

Appendix table 3--Reduction in corn production because of cutworm damage with and without alternative insecticides to replace aldrin, States and regions, 1971

State and region	Estimated acres treated with aldrin 1/	Average yield per acre 1970-72 2/	Reduction in corn production		
			Per acre yield loss 2/		Total
	1,000 acres	Bushels	Percent	Bushels	1,000 bushels
With alternative insecticides:					
Ohio	278	88	5	4.4	1,223
Indiana	70	92	10	9.2	644
Illinois	716	96	10	9.6	6,874
Iowa	400	101	10	10.1	4,040
Missouri	373	79	15	11.8	4,401
Lake States and Northern Plains	174	77	10	7.7	1,340
United States	2,011	--	--	--	18,522
Without alternative insecticides:.					
Ohio	278	88	10	8.8	2,446
Indiana	70	92	25	23.0	1,610
Illinois	716	96	25	24.0	17,184
Iowa	400	101	25	25.2	10,080
Missouri	373	79	30	24.0	8,952
Lake States and Northern Plains	174	77	25	19.2	3,341
United States	2,011	--	--	--	43,613

-- = not applicable. 1/ From table 4. 2/ From table 6.

Appendix table 4--Cost of bringing additional land into production to maintain corn output with and without alternative insecticides to replace aldrin, 1971

State and region	Production loss without aldrin 1/	Average yield per acre 1970-72 2/	Reduction in yield		Average yield per acre on additional land 4/	Additional land needed to replace aldrin 5/	Cost of bringing additional land into production	
			Lower productivity 3/	Wireworm 2/			Per acre 6/	Total
	1,000 bushels	Bushels	----Percent---		Bushels	1,000 acres	Dollars	1,000 dollars
With alternative insecticides:								
Ohio	1,223	88	15	0	74.8	16	50.71	811
Indiana	644	92	15	0	78.2	8	46.02	368
Illinois	6,874	96	15	0	81.6	84	48.93	4,110
Iowa	5,417	101	15	8	77.8	70	44.89	3,142
Missouri	5,270	79	15	8	60.8	87	48.03	4,179
Lake States and Northern Plains	1,650	77	15	8	59.3	28	36.23	1,014
United States	21,078	--	--	--	--	293	--	13,624
Without alternative insecticides:								
Ohio	3,036	88	15	10	66.0	46	39.31	1,808
Indiana	3,919	92	15	10	69.0	57	43.42	2,475
Illinois	21,946	96	15	10	72.0	305	46.33	14,131
Iowa	12,137	101	15	12	73.7	165	42.29	6,978
Missouri	10,263	79	15	12	57.7	178	36.63	6,520
Lake States and Northern Plains	3,801	77	15	12	56.2	68	33.63	2,287
United States	55,102	--	--	--	--	819	--	34,199

-- = not applicable.
1/ From table 8.
2/ From table 6.
3/ P. Weisgerber. Productivity of Diverted Cropland. U.S. Dept. Agr., Econ. Res. Serv., ERS-398, Apr. 1969.
4/ Average yield because of lower productivity and wireworms.
5/ Production loss without aldrin divided by average yield on additional land.
6/ Variable cost for producing corn based on Selected U.S. Crop Budgets, Yields, Inputs, and Variable Costs, Volume II: North Central Region, ERS-458 and Volume III: Great Plains Region, ERS-459, U.S. Dept. Agr., Econ. Res. Serv., Apr. 1971. It was assumed that wireworms would be the major insect problem on the land brought into production. No costs are included for corn rootworm or cutworm control. The cost per acre with alternative insecticides includes the cost of diazinon in Ohio and Missouri and of phorate in the other States for wireworm control.