ECONOMIC IMPACT OF DISCONTINUING FARM USE OF LINDANE AND BHC

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ABSTRACT

A ban on farm use of lindane and benzene hexachloride (BHC) would have cost U.S. farmers an additional $10.4 million in 1972, mainly for treating livestock.

Added costs (based on 1972 acreage) for using alternative insecticides in crop production would have ranged from 2 cents an acre for strawberries to a high of $209 for flowers. In addition, costs for some farmers in value of reduced yields would have ranged from $114 an acre for strawberries to $390 an acre for flowers. Where livestock were treated production costs would have been about 12 cents more per hog, 24 cents more per sheep, and 34 cents more per head of beef cattle.

Total U.S. farm consumption of lindane and BHC would have decreased about 643,000 pounds, if discontinued on farms in 1972. However, use of alternative insecticides would have increased about 5.6 million pounds--5.2 million pounds for treating livestock.

Key words: Insecticides, Lindane, BHC, Economic Impact, Livestock, Crops.

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SUMMARY

If U.S. farmers had to replace lindane and BHC with nonorganochlorine insecticides in 1972, their costs would have been $10.4 million higher. Included are $10 million for alternative insecticides and $400,000 in the value of yield losses because effective alternatives are unavailable. Costs are based on estimates of 1972 crop acreages and livestock numbers treated with lindane and BHC.

Livestock producers would have sustained most of the added costs for alternative insecticides--about 93 percent or $9.3 million. Almost two-thirds of the added livestock producers' costs, $6 million, would have been for treating beef cattle and a third, $3.1 million, for treating hogs. For livestock treated, costs would have averaged about 12 cents more per hog, 24 cents more per sheep, and 34 cents more per head for beef cattle.

Added costs and yield losses for treating crops, seeds, and shrubs and trees in nurseries with alternatives to lindane would have amounted to $1,124,900--$728,400 for alternative insecticides and $396,500 for the value of yield losses in 1972. The largest share of the added cost for using alternative insecticides would have been related to production of apples and other deciduous fruit in the Northeast and Lake States regions--about $3.40 a treated acre.

Strawberry producers in the Northeast and Lake States regions would have had higher costs of 2 cents an acre for alternative insecticides. But in the Pacific region, where there are no effective alternative insecticides to lindane, strawberry producers would have averaged losses in yield valued at $114 an acre on infested acreage--about 5 percent of the crop value.

Highest added costs for discontinuing lindane use in 1972 would have been $600 an acre for some flower growers. Yield losses would have accounted for two-thirds of the higher costs, and use of alternative insecticides would have accounted for the rest.

About 5.6 million pounds of alternative insecticides would have been needed to replace the estimated 643,000 pounds of lindane and BHC used by farmers in 1972. More than 90 percent of the alternative insecticides would have been used to treat livestock.

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INTRODUCTION

Lindane and benzene hexachloride (BHC) provide protection against a broad spectrum of pests which infest crops, livestock, seeds, and buildings. Lindane (a derivative of BHC) has replaced BHC for most uses. 1/ BHC use in food production has declined because some of its isomers impart an unpleasant taste to milk and produce. Lindane, relatively unique, can kill pests in three ways: as a contact poison, a stomach poison, or fumigant.

Data for 1966 farm use of both lindane and BHC are shown, but estimates for farm use and costs of materials relate primarily to lindane, which is more commonly used. Data for 1972 farm use of lindane and BHC are based on livestock and crops treated in 1966.

The U.S. Department of Agriculture continually reviews farm needs of pesticides. If chemicals are needed, USDA recommends patterns of use, methods of application, and formulations which will most effectively limit the impact of the chemical to the target organisms. Information is provided in this report to reevaluate farm needs of lindane and BHC. After identifying farm uses, estimates are made of insect control costs if farm use of lindane and BHC were discontinued.

FARM USES OF LINDANE AND BHC

In 1966, farm use of lindane and BHC was about 814,400 pounds, according to the latest date available--a decline of 42 percent from 1964 when about 1.4 million pounds were used. 2/ These data exclude use in treating lawns and gardens, forests, homes, or pets. 3/ Largest farm uses of lindane and BHC in 1966 were on cotton, beef cattle, and hogs.

1/ BHC is composed of various isomers. Of 5 isomers identified in technical BHC, only the gamma isomer is effective against pests. Lindane contains at least 99 percent gamma isomer of BHC.

2/ Theodore Eichers and others. Quantities of Pesticides Used by Farmers in 1964. U.S. Dept. Agr., Econ. Res. Serv., Agr. Econ. Rpt. 131, Jan. 1968.

3/ In 1970, about 2,100 pounds of lindane were used by the U.S. Forest Service. D. Lee Fowler and John N. Mahan. The Pesticide Review 1971. U.S. Dept. Agr., Agr. Stab. and Conserv. Serv., Mar. 1972.

Regionally, use of lindane and BHC in 1966 varied widely. 4/ The Southeast and Delta regions accounted for about 60 percent of the use on crops--43 percent in the Southeast and 17 percent in the Delta region. The Northeast, Lake States, and Southern Plains regions each accounted for about 10 percent of the crop use. The Corn Belt and Northern Plains regions accounted for 62 percent of the use on livestock--42 percent in the Corn Belt and 20 percent in the Northern Plains.

Crops

Cotton producers were the largest single users of lindane and BHC in 1966 (table 1). They used about 260,500 pounds of these materials as a foliar treatment on 357,700 acres of cotton. But these insecticides are no longer registered for such use on cotton. Lindane is still registered for treating cotton seed, but farmers did not report such use in 1966. 5/

About 61,400 pounds of lindane and BHC were used by apple producers in 1966, primarily for aphid control, in the Northeast and Lake States regions. Other deciduous fruits--peaches and pears--accounted for 47,300 pounds, mostly in the Mountain region.

Peanut producers in the Southeast used 18,500 pounds of lindane (in a sulfur-based mixture) as a foliar treatment in 1966. However, lindane is no longer registered for such use on peanuts.

Vegetable producers used 16,600 pounds of lindane in 1966 as a foliar treatment primarily to control cucumber beetles, squash vine borers, and pickleworms on cucumbers, squash, and watermelons. An additional 1,100 pounds of lindane were used in vegetable transplant water. In 1972, lindane was registered and recommended as a foliar treatment on cucumbers and squash, but not on watermelons. Lindane is still registered but not recommended for use in transplant water because the cabbage maggot has become resistant to lindane. 6/ Although lindane had been reported used in vegetable transplant water in 1966, it was not reported used for that purpose in 1971. 7/

Tobacco producers, mostly in North Carolina, used 1,700 pounds of lindane in field transplant water and 200 pounds in tobacco seedbeds in 1966. But wireworms began developing resistance to lindane in the mid-1960's and

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4/ Based on data from the 1966 Pesticide and General Farm Survey, U.S. Dept. Agr., Econ. Res. Serv., Farm Prod. Econ. Div., unpublished.

5/ Throughout this report "registered" refers to crop and livestock uses for which an insecticide product has label clearance as published in Summary of Registered Agr. Pesticide Chemical Uses, vol. III, 3rd ed., amended, U.S. Dept. Agr., Agr. Res. Serv., Oct. 1968. "Recommended" refers to insecticide use practices for crops and livestock published by Agricultural Colleges and USDA.

6/ Based on discussions with extension entomologists, New York State Agr. Exp. Sta., Geneva, N.Y., Nov. 1972.

7/ Based on data from 1971 Farm Production Expenditure Survey, U.S. Dept. Agr., Statis. Rptg. Serv., unpublished.

Table 1--Farm use of lindane and benzene hexachloride (BHC), 1966 1/

Type of use	Lindane		BHC		Total	
	Quantity	Acres	Quantity	Acres	Quantity	Acres
	1,000 pounds	1,000 acres	1,000 pounds	1,000 acres	1,000 pounds	1,000 acres
Crops:						
Cotton	163.4	297.8	97.1	59.9	260.5	357.7
Peanuts	18.5	20.8	--	--	18.5	20.8
Tobacco	1.7	18.9	--	--	1.7	18.9
Alfalfa	2/	6.0	--	--	2/	6.0
Vegetables	16.6	46.8	--	--	16.6	46.8
Apples	60.7	91.4	0.7	0.8	61.4	92.2
Other deciduous fruits	44.2	28.9	3.1	7.0	47.3	35.9
Strawberries	6.2	5.2	--	--	6.2	5.2
Nursery and greenhouse	1.2	--	--	--	1.2	--
Total	312.5	515.8	100.9	67.7	413.4	583.5
Seed treatment:						
Corn	20.3	--	--	--	20.3	--
Small grains	5.3	--	--	--	5.3	--
Other crops	.5	--	--	--	.5	--
Total	26.1	--	--	--	26.1	--
Seedbeds and transplants:						
Vegetables	1.1	--	--	--	1.1	--
Tobacco	.2	--	--	--	.2	--
Total	1.3	--	--	--	1.3	--
Crop storage buildings	.2	--	--	--	.2	--
Livestock and buildings:						
Beef cattle	130.1	--	50.9	--	181.0	--
Dairy cattle	24.4	--	.1	--	24.5	--
Hogs	124.5	--	26.4	--	150.9	--
Sheep	7.2	--	.6	--	7.8	--
Poultry	8.7	--	.5	--	9.2	--
Other livestock	2/	--	--	--	2/	--
Total	294.9	--	78.5	--	373.4	--
Total all farm uses	635.0	515.8	179.4	67.7	814.4	583.5

-- not applicable

1/ Data for lindane are revisions of those shown in Theodore Eichers and others, Quantities of Pesticides Used by Farmers, 1966, U.S. Dept. of Agr., Econ. Res. Serv., Agr. Econ. Rpt. 179, Apr. 1970. BHC data are based on unpublished data from the ERS Pesticide and General Farm Survey, 1966.

2/ Less than 50 pounds.

diazinon has replaced it in most transplant water recommendations. 8/ In addition, lindane was not reported used in 1971 in States where it had been in 1966. 9/

Strawberry producers used 6,200 pounds of lindane in 1966 to control root weevil in Oregon and spittlebug in Michigan. Neither State recommended its use on strawberries in 1972, but it is registered, and farmers may have used it as a foliar or soil treatment. Aldrin and dieldrin are recommended for root weevil and dieldrin for spittlebug control. No effective nonorganochlorine insecticides are available for root weevil control, but carbaryl is effective against spittlebug. 10/

About 1,200 pounds of lindane were used in nurseries and greenhouses in 1966, primarily for aphid control on flowers, shrubs, and evergreens. Also, lindane might have been used to control pine root collar weevil in Christmas tree plantings. Although currently registered for use on these crops, lindane is either being restricted or not recommended for such use by many States. 11/ Lindane is also used for nonagricultural purposes such as controlling borers, in ornamental plants in and around the home, and to control a variety of forest insects, but the extent of such use is not considered in this report.

A small amount of lindane was used in a mixture with methoxychlor on alfalfa in 1966. Lindane was not registered in 1972 for use on alfalfa as a foliar treatment.

Farmers in the Corn Belt, Lake States, and Northern Plains used 20,300 pounds of lindane to treat corn seed in 1966. An additional 5,300 pounds were used to treat wheat, barley, and oat seed, mostly in the Lake States and Northern and Southern Plains. In 1966, 500 pounds of lindane was used as a seed treatment for dry beans and sunflowers. It is also registered for treating vegetable seeds, but farmers did not report using lindane for this purpose in 1966, although they may have purchased commercially treated seed.

Farmers used 200 pounds of lindane in 1966 to treat empty crop storage buildings.

8/ Based on discussions with extension entomologists, N.C. State Univ., Raleigh, N.C., Nov. 1972.

9/ Based on data from 1971 Farm Production Expenditure Survey, U.S. Dept. Agr., Statis. Rptg. Serv., unpublished.

10/ Based on discussions with extension entomologists, Oreg. State Univ., Corvallis, Oreg. and Mich. State Univ., East Lansing, Mich., Nov. 1972.

11/ For example, Pennsylvania does not recommend the use of lindane, although extension entomologists state it is the only effective material for pine root collar weevil control. New York State requires a permit to use lindane in nurseries and for treating shade trees, primarily for borer control.

Livestock

Beef cattle and hog producers accounted for about 89 percent of the lindane and BHC used on livestock in 1966, mostly in the Corn Belt and Northern Plains to control lice and mites.

About 24,500 pounds of lindane and BHC were used on dairy cattle in 1966, mainly in the Northeast. Small amounts of lindane and BHC were used on sheep and poultry. Lindane and BHC are no longer registered for use on dairy cattle and poultry or in dairy barns and poultry houses.

ECONOMICS OF DISCONTINUING FARM USE OF LINDANE AND BHC

If farm use of lindane and BHC were discontinued, farmers would have higher costs for substitute insect control in the production of both crops and livestock. For most crops, except flowers and strawberries, and for all livestock, it was assumed that there would be no yield losses.

This analysis was developed under the following general assumptions: (1) Only agricultural uses of lindane and BHC were considered; (2) Only nonorganochlorines were considered as alternative insecticides; and (3) Only control of insects causing economic losses was considered.

Organophosphorus and carbamate insecticides (nonorganochlorines) are generally less persistent than the organochlorines such as lindane and BHC. But many nonorganochlorine insecticides are more toxic than lindane and BHC. Therefore, farm operators and workers face a greater hazard handling the nonorganochlorine altervatives. In addition, more of the beneficial insects may be killed than with lindane and BHC.

Many of the 1966 uses of lindane and BHC reported earlier have been replaced by organophosphorus or carbamate materials. But cancellation of DDT for most agricultural uses makes lindane and BHC more important. They are two of the best alternative pesticides for some DDT uses and provide an important backup for several other organochlorine insecticides which are being considered for cancellation. For some uses, alternative insecticides are available, but they generally cost more and do not provide equal control. Lindane and BHC remain the most effective materials for controlling garden symphylan and fuller rose beetle on flowers.

Estimated values of yield reductions and costs of substitutes are for 1972. To estimate the use of lindane and BHC in 1972, crop acreage and the number of head of livestock treated in 1966 were used as a base. 12/ Where lindane or BHC is currently recommended by Agricultural Colleges or USDA, it was assumed that the 1972 crop acreage and livestock numbers treated were the same as reported in 1966. Crops and livestock treated with lindane or

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12/ The 1966 Pesticide and General Farm Survey, conducted by the Econ. Res. Serv., is the latest available comprehensive survey on the extent of U.S. farm pesticide use.

BHC in 1966 were not included in the analysis if these insecticides were no longer registered or recommended as a control practice in 1972.

To facilitate presentation costs of alternative insecticides and losses in crop yields are discussed first followed by costs of alternative insecticides used in livestock production. Finally, the total added costs and value of yield losses will be combined.

Crops

Cost of Substitute Materials

The use of alternative insecticides to replace lindane and BHC on crops would have added $498,000 to farmers' production costs in 1972 (table 2). Of this, about 87 percent would have been for apple and other deciduous fruit production.

Apple producers' costs would have increased $313,500. Growers of other deciduous fruits, mainly peaches and pears, would have had added production costs of $122,100 in 1972. Several effective aphid control materials are now available, and many producers may have already shifted to these insecticides. For example, demeton is an effective substitute but costs $3.40 more an acre than lindane.

Vegetable producers would have had added costs of $51,500 for alternative insecticides to replace lindane on about 47,000 acres in 1972. Carbaryl could be substituted for lindane at an added cost of $1.10 per acre.

It was estimated that lindane was used on about 52 acres of flowers in 1972. A combination of malathion and carbaryl could be used to replace lindane for the control of aphids, white flies, and pickleworms. These substitute insecticides would have increased flowers producers' costs about $10,900 or more than $200 an acre.

Of the 5,200 acres of strawberries treated with lindane in 1972, an estimated 1,900 acres in the Northeast and Lake States were treated for spittlebug control. Carbaryl, an effective substitute, would have cost 2 cents more an acre than lindane. This substitution would have increased growers' costs only $38 in these regions in 1972. The balance of the strawberry acreage (3,300 acres) treated with lindane is in the Pacific region, and is discussed in the next section.

Value of Yield Losses

Alternative insecticides are not totally effective substitutes for lindane on flowers in nurseries and greenhouses. And, none of the substitutes effectively control root weevil in strawberry production. Thus in 1972, value of yield losses for flowers and strawberries would have totaled about $396,500 (table 3).

The 3,300 acres of strawberries on which lindane was used as a soil treatment in the Pacific region would have had a yield loss of 5 percent in

Table 2--Added cost of alternative insecticides to replace lindane on crops, 1972 1/

Crop	Cost per acre 2/		Added cost per acre for alternative insecticide materials	Estimated acres treated with lindane and BHC 3/	Total added cost of using alternative insecticides 4/
	Lindane	Alternative insecticide treatment			
	Dollars	Dollars	Dollars	1,000 acres	1,000 dollars
Vegetables	1.60	2.70	1.10	46.8	51.5
Apples	10.70	14.10	3.40	92.2	313.5
Other deciduous fruits	10.70	14.10	3.40	35.9	122.1
Strawberries 5/	2.68	2.70	.02	5/1.9	6/
Flowers 7/	92.02	301.00	208.98	7/	10.9
Total				176.8	498.0

1/ Includes only those crops treated with lindane or BHC in 1966 for which these materials are still registered or recommended in 1972. Therefore, cotton, peanuts, tobacco, alfalfa, and vegetable transplants are not included. It was assumed that only lindane was used on these crops in 1972 because it has been replacing BHC and only a small quantity of BHC was used on these crops in 1966.

2/ Derivation of these costs is shown in appendix table 1. Includes only cost of insecticide materials. Similar application costs were assumed for lindane and alternative insecticides. Data on yield losses are shown in table 3.

3/ Estimated acres treated in 1972 were the same as in 1966 (table 1).

4/ Added cost of alternative insecticide times acreage treated with lindane.

5/ Of the 5,200 acres of strawberries treated with lindane in the United States, a substitute could be used on 1,900 acres in the Northeast and the Lake States. The yield loss on the remaining 3,300 acres in the Pacific region is shown in table 3.

6/ Less than $50.

7/ An estimated 52 acres of flowers were treated with lindane in 1972 (900 pounds ÷ 17.2 pounds per acre per season). Of the 1,200 pounds of lindane used in nurseries and greenhouses, 900 pounds were used on flowers (table 1). Lindane use is recommended at the rate of 0.1 pounds per 1,000 square feet or 4.3 pounds an acre. It was assumed that lindane was applied 4 times per season for a total of 17.2 pounds per acre per season (4.3 pounds X 4 times).

Table 3--Value of production losses if alternative insecticides replaced lindane on selected crops, 1972 1/

Crop	Value of production per acre 2/	Loss in value of production per acre	Estimated acreage treated with lindane or BHC 3/	Total value of production losses
	Dollars	Dollars	Acres	1,000 dollars
Flowers	3,000	4/390	52	20.3
Strawberries	2,275	5/114	3,300	376.2
Total	--	118	3,352	396.5

-- not applicable.

1/ Crops shown in table 2 where yield losses were incurred even though an alternative insecticide was used.

2/ Average value of production for flowers is based on discussions with horticultural marketing specialists, Mkt. Econ. Div., Econ. Res. Serv., U.S. Dept. of Agr. Average value of production per acre for strawberries was calculated from information in Vegetables--Fresh Market, 1971 Annual Summary, U.S. Dept. of Agr., Stat. Rptg. Serv., Vg2-2(71).

3/ See footnotes 5 and 7 in table 2.

4/ A yield reduction of 13 percent an acre was assumed. Based on information contained in Losses in Agriculture, Agr. Handbook 291, U.S. Dept. of Agr., Agr. Res. Serv., Aug. 1965.

5/ Based on discussions with extension entomologists, Ore. State Univ., Corvallis, Ore. In the Pacific region aldrin and dieldrin are recommended as a soil treatment for control of root weevil. Although not recommended, lindane is registered for such use and was reported used on 3,300 acres. No organochlorine insecticides could be used as a substitute for lindane. Thus, it was assumed that a 5 percent yield loss would be incurred if lindane use was discontinued but these losses might increase as the materials already applied to the soils lose their effectiveness.

1972. Estimated value of production losses would have been about $114 an acre or a reduction in strawberry producers' income of $376,200 in 1972.

The nonorganochlorine insecticides used to replace lindane in flower production are not as effective in controlling fuller rose beetle and garden symphylan. In 1972, the average value of flower production was about $3,000 an acre. It was estimated that production would have been reduced 13 percent if lindane were not available--a loss of some $20,300 on 52 acres of flowers.

Seeds, Shrubs and Trees, and Crop Storage Buildings

Lindane is used as a corn seed treatment to control seed corn maggot, seed corn beetle, and wireworms. Substitution of diazinon for lindane as a seed corn treatment would have increased growers' costs in 1972 by $176,900 (table 4). This amounted to 82 cents a bushel for corn treated with diazinon or about 20 cents an acre where lindane-treated seed was used in 1972. An additional 5,800 pounds of lindane used as a seed treatment on these crops would have cost producers about $51,300 more in 1972.

Substitute insecticides could be used to replace lindane without appreciably affecting producers' costs for treating shrubs and trees in nurseries and empty crop storage buildings. Separate applications of carbaryl and diazinon could be used for aphid control on shrubs and trees in nurseries at an added cost of $2,400 annually. Malathion could be used in place of lindane to treat empty crop storage buildings at no additional cost to producers.

Livestock

Livestock producers would have had added costs of about $9.3 million in 1972 for alternative insecticides if farm use of lindane and BHC had been canceled (table 5). Although several alternative insecticides will control pests on livestock, their application rates are generally higher. But the number of applications per year on livestock is generally the same for lindane or BHC and the alternative insecticides. In this report malathion is the alternative to lindane and BHC because it effectively controls lice and mites without need of a waiting period before livestock slaughter. 13/ Use of other alternatives would have added about the same to costs as malathion.

Beef cattle producers would have had about $6 million higher costs for alternative insecticides than for lindane in 1972 to control lice, ticks, and ear ticks. Where these pests were a problem, costs would have averaged 34 cents a head more than if lindane or BHC were used (table 6).

Hog producers would have had added costs of about $3 million for alternative insecticides. Such additional costs--primarily for controlling lice and mites--would have averaged 12 cents a hog more than lindane or BHC.

13/ Based on selected State recommendations and discussions with extension entomologists, Colo. State Univ., Fort Collins, Colo., Nov. 1972.

Table 4--Added cost of alternative insecticides to replace lindane for treating seeds, shrubs and trees in nurseries, and crop storage buildings, 1972

Item	Lindane			Alternative insecticide				Total added cost of using alternative insecticides
	Quantity of active ingredient used 1/	Cost per pound of active ingredient 2/	Total cost	Insecticide	Quantity of active ingredient used 3/	Cost per pound of active ingredient 2/	Total cost	
	1,000 pounds	Dollars	1,000 dollars		1,000 pounds	Dollars	1,000 dollars	1,000 dollars
Seed treatment: 4/								
Corn	20.3	6.50	132.0	Diazinon	27.1	11.40	308.9	176.9
Small grains	5.3	6.50	34.4	Diazinon	7.1	11.40	80.9	46.5
Other crops	.5	6.50	3.2	Diazinon	.7	11.40	8.0	4.8
Total			169.6				397.8	228.2
Shrubs and trees in nurseries 5/	.3	5.35	1.6	Carbaryl and Diazinon	1.2 .5	1.35 4.85	1.6 2.4	
Total			1.6				4.0	2.4
Crop storage buildings	.2	5.35	1.1	Malathion	.4	2.15	.9	-.2
Total	--	--	172.3		--	--	402.7	230.4

-- not applicable

1/ From table 1. Does not include lindane used for seedbeds and transplants because use for these purposes is no longer recommended.

2/ Recent retail prices published by pesticide suppliers. The higher prices for lindane and diazinon used in seed treatment are due to the limited market for these formulations.

3/ Based on insecticide use recommendations for selected States.

4/ Lindane was assumed to be used at the rate of 1.5 oz. per bushel and diazinon at 2.0 oz. per bushel.

5/ Of the 1,200 pounds of lindane used in nurseries and greenhouses, 300 pounds was for treating shrubs and trees. Separate applications of carbaryl and diazinon would be needed to control those insects presently controlled with lindane. No estimate of additional application costs was made because such data are not available.

Table 5--Added cost of alternative insecticide to replace lindane and BHC on livestock, 1972 1/

Livestock	Lindane and BHC			Malathion 2/			Total added cost of using alternative insecticide
	Quantity of active ingredient used 3/	Cost per pound of active ingredient 4/	Total cost	Quantity of active ingredient used 5/	Cost per pound of active ingredient 4/	Total cost	
	1,000 pounds	Dollars	1,000 dollars	1,000 pounds	Dollars	1,000 dollars	1,000 dollars
Beef cattle	181.0	5.35	968.4	3,258.0	2.15	7,004.7	6,036.3
Hogs	150.9	5.35	807.3	1,810.8	2.15	3,893.2	3,085.9
Sheep	7.8	5.35	41.7	93.6	2.15	201.2	159.5
Total	339.7	--	1,817.4	5,162.4	--	11,099.1	9,281.7

1/ Includes only those livestock classes treated with lindane or BHC in 1966 with registration or recommendation for such treatment continuing into 1972. Thus, use on dairy cattle and poultry is not included. For this report it was assumed that all lindane and BHC used in livestock production in 1972 was for treating animals only even though some may have been used on livestock buildings. It was also assumed that the lindane and BHC used in 1972 was to treat lice and mites.

2/ Malathion is a suitable alternative to lindane. Although other alternative insecticides would have similar costs, malathion use permits cattle to be slaughtered without a waiting period, compared with a 30-day or more period for lindane.

3/ Assumes quantities used in 1972 are the same as in 1966 (table 1).

4/ Recent retail prices published by pesticide suppliers.

5/ Based on 1972 State insecticide use recommendations: Recommended solution of lindane or BHC for treating beef cattle is 1 quart of a 12-percent emulsifiable concentrate (E.C.) per 100 gallons of water, and for hogs and sheep it is 1.5 quarts of a 12-percent E.C. per 100 gallons of water. Malathion is recommended at 4 quarts of a 57-percent E.C. per 100 gallons of water for beef cattle, hogs, and sheep.

Table 6--Cost per animal for treating with alternative insecticides to replace lindane and BHC on livestock, 1972

Livestock	Quantity of lindane and BHC 1/		Estimated number of animals treated 4/	Added cost of using alternative insecticides	
	Total 2/	Per animal 3/		Total 2/	Per animal 5/
	1,000 pounds	Pounds	1,000	1,000 dollars	Dollars
Beef cattle	181.0	0.0103	17,572.8	6,036.3	0.34
Hogs	150.9	.0058	26,017.2	3,085.9	.12
Sheep	7.8	~~.0016~~ .0116	~~487.5~~ 672.4	159.5	.24
Total	339.7	--	--	9,281.7	--

-- Not applicable.

1/ Active ingredient.
2/ From table 5.
3/ Based on 1972 State insecticide use recommendations. Concentration of lindane in 100 gallons of water is shown in table 5, footnote 5. It was assumed that 4 applications were made to each class of livestock. The assumed quantity of spray solution applied per head was 4 quarts for beef cattle, 1.5 quarts for hogs, and 3 quarts for sheep.
4/ Total quantity (column 1) divided by quantity per animal (column 2).
5/ Added cost for alternative insecticides divided by the number of animals treated.

Sheep ranchers would have had added costs of about $160,000 in 1972 for alternative insecticides to control fleeceworm, lice, and ticks on sheep and lambs. Costs would have averaged 24 cents a head more for treating sheep where these pests are a problem.

Total Additional Costs

Added cost for U.S. farmers to replace lindane and BHC with nonorganochlorine insecticides in 1972 would have totaled $10.4 million--$10 million

for substitute insecticides and $400,000 in production losses (table 7). Livestock producers would have had most of the additional costs--$9.3 million for substitute insecticides--mainly for treatment of beef cattle ($6.0 million) and hogs ($3.1 million).

Table 7--Total added cost and value of production losses if alternative insecticides replaced lindane and BHC in crop and livestock production, 1972

Item	Added materials costs	Value of yield losses	Total added costs and yield losses
	1,000 dollars		
Crops 1/	498.0	396.5	894.5
Seed treatment, shrubs and trees in nurseries, and crop storage buildings 2/	230.4	--	230.4
Livestock 3/	9,281.7	--	9,281.7
Total	10,010.1	396.5	10,406.6

-- Not applicable

1/ From tables 2 and 3.
2/ From table 4.
3/ From table 5.

Crop farmers would have added costs of $894,500 in 1972--$498,000 for substitute insecticides and $396,500 in production losses--on apples, other deciduous fruits, strawberries, vegetables, and flowers. Producers of apples and other deciduous fruits would have had added costs of $435,600 for substitute insecticides. Vegetable producers would have had added costs of $51,500 on 46,800 acres in 1972 to replace lindane with nonorganochlorine insecticides.

Strawberry producers would have had added costs of $376,238--$376,200 in production losses and $38 for substitute insecticides. Although it was estimated that only 52 acres of flowers were treated with lindane in 1972, growers would

have had added costs of $31,200--$20,300 in production losses and $10,900 for substitute insecticides. Although this added cost is minor for the total industry, it is about $600 an acre (20 percent of the value of an acre of flowers) for growers who use it.

Added costs for replacing lindane with alternative insecticides for seed treatment, primarily corn, would have totaled $228,200 in 1972. In addition, nurserymen would have had added costs of $2,400 for treating shrubs and trees in nurseries with alternative insecticides.

CHANGES IN QUANTITY OF INSECTICIDES USED

Discontinuing farm use of lindane and BHC would have reduced the quantity used in 1972 by 643,000 pounds (table 8). Total additional use of alternative insecticides would have been about 5.6 million pounds.

Livestock producers would have used an additional 5.2 million pounds of malathion in 1972 to replace 339,500 pounds of lindane and BHC. Producers of apples and other deciduous fruits would have used 256,200 pounds of demeton to replace a like amount of lindane and BHC. Vegetable growers would have increased carbaryl use 103,100 pounds. And, for seed treatment, farmers would have substituted about 35,000 pounds of diazinon for about 26,000 pounds of lindane.

Table 8--Changes in quantities of alternative insecticides to replace lindane and BHC in crop and livestock production, 1972

Crops and livestock	Pounds of active ingredients 1/				
	Lindane and BHC	Demeton	Carbaryl	Diazinon	Malathion
	1,000 pounds				
Crops:					
Apples	-184.4	+184.4			
Other deciduous fruit	-71.8	+71.8			
Vegetables	-14.0		+93.6		
Strawberries	2/-5.9		+3.8		
Flowers	-.9		+4.5		+4.5
Seed treatment:					
Corn	-20.3			+27.1	
Small grains	-5.3			+7.1	
Other crops	-.5			+.7	
Shrubs and trees in nurseries	-.3		+1.2	+.5	
Crop storage buildings	-.2				+.4
Livestock:					
Beef cattle	-181.0				+3,258.0
Hogs	-150.7				+1,810.8
Sheep	-7.8				+93.6
Total	-643.1	+256.2	+103.1	+35.4	+5,167.3

1/ For crops, estimated acres treated with lindane and BHC in 1972 (table 2) times the quantity of active ingredients applied per acre (app. table 1). Data for seed treatment, shrubs and trees in nurseries, and crop storage buildings are from table 4 and for livestock table 5.

2/ 1.5 pounds per acre on 3,300 acres in the Pacific region and 0.5 pounds per acre on 1,900 acres in the Lake States and Northeast.

Appendix table 1--Per acre costs for alternative insecticides to replace lindane on crops, 1972 1/

Crop	Lindane			Alternative insecticide			
	Quantity of active ingredient applied per acre 2/	Cost per pound of active ingredient 3/	Cost per acre	Insecticide	Quantity of active ingredient applied per acre 2/	Cost per pound of active ingredient 3/	Cost per acre
	Pounds	Dollars	Dollars		Pounds	Dollars	Dollars
Vegetables	0.3	5.35	1.60	Carbaryl	2.0	1.35	2.70
Apples	2.0	5.35	10.70	Demeton	2.0	7.05	14.10
Other deciduous fruits	2.0	5.35	10.70	Demeton	2.0	7.05	14.10
Strawberries	0.5	5.35	2.68	Carbaryl	2.0	1.35	2.70
Flowers	17.2	5.35	92.02	Malathion and	86.0	2.15	184.90
				Carbaryl	86.0	1.35	116.10
							301.00

1/ Includes only crops treated with lindane or BHC in 1966, for which these materials are still registered and being recommended in 1972. Therefore, cotton, peanuts, tobacco, alfalfa, and vegetable transplants are not included. It was assumed that only lindane was used on these crops in 1972 because it has been replacing BHC and only a small quantity of BHC was used in 1966.

2/ Insecticide application rates for lindane and alternative insecticides are based on 1972 State insecticide use recommendations. The quantity of active ingredient per acre is the total amount used for all applications during the growing season. The number of applications per season varied by crop. It was assumed that two application were made on vegetables, apples, other deciduous fruits, and strawberries. Four applications were made on flowers.

3/ Recent retail prices published by pesticide suppliers.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife -- if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.