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RESTRICTING THE USE OF 2, 4, 5-T: COSTS TO DOMESTIC USERS

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ABSTRACT

About 3.4 million acres of farmland and 4.5 million acres of nonfarmland were treated with an estimated 8.9 million pounds of the phenoxy herbicide 2, 4, 5-T in 1969. If 2, 4, 5-T were restricted, the economic costs to domestic users would have been $52 million in 1969, providing all other herbicides could still be used. However, costs would have increased to $172 million if other phenoxy herbicides were also prohibited. Additional costs to replace 2, 4, 5-T, if other phenoxys could have been used as alternatives, were estimated at $32 million for farmers and $20 million for other domestic users (public utility companies, Government agencies, homeowners, recreation, and timber industries). Without other phenoxys, additional costs would have increased to $44 million for farmers and to $128 million for nonfarm users. For farmers, the major land areas affected would be pasture and rangeland; for nonfarm users, rights-of-way maintenance would be most affected.

Keywords: Phenoxy herbicide, 2, 4, 5-T, economics, farm use, weed control.

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PREFACE

The use of 2, 4, 5-T is currently under investigation by a number of Federal agencies, including the U.S. Department of Agriculture. This investigation was prompted by reports of possible health and environmental hazards. However, this study deals solely with the economic factors involved in the possible transition from 2, 4, 5-T to other methods of brush and weed control.

This report differs in several respects from a related publication "Restricting the Use of Phenoxy Herbicides--Costs to Farmers," U.S. Dept. Agr., Agr. Econ. Rpt. No. 194, November 1970. It considers only one herbicide, 2, 4, 5-T, in greater detail. Moreover, the effects of restricting 2, 4, 5-T are evaluated for all domestic users, for nonfarmers as well as farmers. The costs of restricting its use are estimated for two different sets of assumptions. Under one set of assumptions, all other registered herbicides, including phenoxys, could be used. Under the other set, all other herbicides, except phenoxys, could be used.

An important assumption of the analysis was that the current level of farm production would be maintained and that weeds and brush on noncropland (both farm and nonfarm) would be controlled at present levels. Alternatives include mechanical and other cultural practices as well as other herbicides. On crops where current yields could not be maintained without the use of 2, 4, 5-T, additional land would be brought into production. The additional land would be available from that currently diverted under various Government programs. It was assumed that through adjustments in the provisions of various Government programs, payments to farmers would remain the same.

Data on farm use of 2, 4, 5-T used in the cost calculations are from a nationwide ERS Pesticide Uses Survey for 1964. These are the most recent data for farm use that represent 1969 practices. Although the total farm use of herbicides has increased since 1964, the 1969 use of 2, 4, 5-T was generally similar to 1964. All quantities of herbicides are expressed in pounds of active chemical ingredients. The data presented are quantities farmers indicated they had used in 1964 and do not necessarily mean that such uses are currently registered.

The report was prepared jointly by the Economic Research Service (ERS) and the Agricultural Research Service (ARS), U.S. Department of Agriculture. It was developed under the direction of Velmar W. Davis, Farm Production Economics Division, ERS, and William B. Ennis, Crops Research Division, ARS.

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Use of trade names in this report is for identification only and does not constitute endorsement of these products or imply discrimination against other similar products. Chemical names and other designations of pesticides are shown in table 8.

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SUMMARY

If 2, 4, 5-T, a phenoxy herbicide used to control brush, woody plants, and herbaceous broadleaf weeds were not available for use, costs to domestic users would have increased about $52 million in 1969 providing all other chemical herbicides remained available. If no phenoxy herbicides including 2, 4, 5-T were available for use, costs to domestic users would have increased to about $172 million. These costs are based on estimated use, prices, and alternatives in 1969.

Costs of producing livestock, particularly feeder cattle, would increase without 2, 4, 5-T since rangeland and pasture yields would be greatly affected. Many individual ranchers would have no satisfactory alternative herbicide for controlling brush.

Additional cropland would have to be brought into production to maintain output of crops where yields declined. Regardless of alternative measures taken, the costs of producing some crops, particularly rice and sugarcane, would rise.

For nonfarm uses, the largest additional costs would be to control weeds and brush on rights-of-way. Costs would also increase substantially for treating private nonfarm forest and Federal Government lands.

These evaluations of the economic consequences of restricting 2, 4, 5-T assume levels of weed and brush control on farms, herbicide application rates, and farm production in 1964 were generally similar to those in 1969. It is estimated that some 3.4 million acres of farmland along with the 4.5 million acres of nonfarmland treated with 2, 4, 5-T in 1969 received 8.9 million pounds of 2, 4, 5-T.

Conditions in 1970 were generally similar to those in 1969 except that the registration of 2, 4, 5-T was suspended for all uses on lakes, ponds, or ditch banks. Also, the registration of liquid formulations was suspended for use around the home, recreation areas, and similar sites. These changes would have accounted for less than $2 million of the $52 million of added costs in 1969 if all other chemical herbicides remained available. If 2, 4, 5-T had been restricted and no other phenoxy herbicides could have been used, it would have accounted for about $6 million of the $172 million in 1969.

RESTRICTING THE USE OF 2, 4, 5-T: COSTS TO DOMESTIC USERS

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INTRODUCTION

Until recently, the control of weeds and brush in pastures, fence rows, roadbeds, ditches, barnyards, and other nontilled areas was a major labor-intensive job on most farms. On cropland, many annual and perennial broadleaf plants were also difficult to keep in check. Utility companies had to hire large crews of workers to maintain rights-of-way. Government agencies devoted substantial labor and equipment to maintain and improve productivity of vast areas of Western rangeland and timberland. State and local governments and quasi-public bodies (e.g., irrigation districts) also had difficulty controlling weeds with mechanical and hand practices.

The development and adoption of herbicidal chemicals in the mid-1940's, particularly the phenoxy compounds, answered many of these important weed and brush control problems. All of the phenoxy herbicides are effective for control of some weeds and woody species. But 2, 4, 5-T provides the more effective control of many species of brush, other woody plants, and herbaceous broadleaf weeds.

Despite the benefits from the use of 2, 4, 5-T, consideration was given to prohibiting its use in late 1969. In April 1970, the registration of 2, 4, 5-T was suspended for all uses on lakes, ponds, or ditchbanks. Also, liquid formulations of 2, 4, 5-T were suspended for use around the home, recreation areas, and similar sites.

The present report evaluates costs to all U.S. users--farmers, utility companies, and others--of restricting the use of 2, 4, 5-T. First, the extent of use of 2, 4, 5-T is estimated by various categories of use for 1969. This is followed by a brief discussion of the alternatives, chemical and nonchemical, that could be used to control brush and weeds. The report concludes with an

estimate of the economic effect of totally restricting the domestic use of 2, 4, 5-T. The evaluation of restricting domestic use of 2, 4, 5-T is based on the assumption that farm production of each commodity would be maintained, and that weeds and brush on farms would be controlled at 1964 levels--generally similar to 1969. The farm costs are based on 1964 because it is the most recent year of available data for which the use of 2, 4, 5-T is representative of 1969 practices. Nonfarm costs and practices are based directly on 1969 information and conditions.

DOMESTIC USE OF 2, 4, 5-T

Since its registration in the mid-1940's, the use of 2, 4, 5-T increased rapidly. It is an effective herbicide and relatively low-cost in relation to other control methods. Production and estimated domestic use of 2, 4, 5-T acids, esters, and salts in the United States (production less exports) showed a general upward trend through 1968 (table 1). They were down sharply in 1969, but were generally similar to 1964. Increases from 1965 to 1968 do not reflect changing domestic use but rather military purchases for use abroad. The 1969 data reflect the transition from domestic shortages of the late 1960's to the present adequate supplies.

Farm Use

The major farm use of 2, 4, 5-T is for controlling brush on rangeland, pasture, and noncropland such as fence rows, ditches, and roadbanks. In 1969, it was estimated that more than 2.4 million acres of pasture, rangeland, and hayland were treated with 2, 4, 5-T (table 2). It was also used to control certain weeds in cereal crops and sugarcane that are not controlled effectively with 2, 4-D (table 3).1/ In addition, 2, 4, 5-T was used in lieu of 2, 4-D in many situations, particularly in rice, because it presents less drift hazard to cotton and soybeans. About a million acres of farmland not used for hay, pasture, or rangeland were also treated.

The largest acreages treated with 2, 4, 5-T were in the Southern Plains (table 4). Applications were on rangeland for control of mesquite, other woody plants, and herbaceous plants. Relatively large amounts of the 2, 4, 5-T applied to grazing lands and crops were used in the Southern Plains, Northern Plains, and the rice area of the Delta region in 1964.

Nonfarm Use

In addition to the farm use of 2, 4, 5-T, about 4.5 million acres of nonfarmland were treated in 1969, some of which were publicly owned grazing land and forests (table 2). The largest acreages in the nonfarm category treated with 2, 4, 5-T in 1969 were rights-of-way. They can often be treated with alternative materials. Much of Government use as well as private nonfarm forest use was for timber management. The selectivity of 2, 4, 5-T makes it desirable for this purpose. Turf treatment with 2, 4, 5-T is important for controlling undesirable

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1/ *The registration of 2,4,5-T for use on food crops and in aquatic areas was withdrawn in April 1970.*

broadleaf weeds, while permitting abundant growth of desirable grasses. Treatment of aquatic plants with 2, 4, 5-T is believed to be less hazardous to aquatic animals than treatment with some other herbicides. However, in April 1970 the registration of 2, 4, 5-T for use in aquatic areas was withdrawn. "Other uses" include State and local government applications as well as applications on industrial and other nonfarm sites.

ALTERNATIVES

There are several chemical and nonchemical alternatives for 2, 4, 5-T, but all increase the cost of weed and brush control on grazing lands, in crops and in noncrop areas. Some alternative chemicals (2, 4-D, MCPA, dichlorprop, silvex) are relatives of 2, 4, 5-T. Other partial alternatives for some uses include picloram and dicamba, and some inorganic compounds as well as other organic materials. However, some of these alternatives are not registered for the same uses, and do not control the same large number of woody plants and herbaceous weeds as 2, 4, 5-T. Some of the alternative herbicides (e.g., 2, 4-D) constitute a greater drift hazard for susceptible crops like cotton. Also, dicamba and picloram persist in soil longer than 2, 4, 5-T.

For many years, 2, 4, 5-T has been the most effective registered herbicide for controlling brush on grazing lands. Even so, it does not give complete control. Because of this and because of the vast area of brush-infested rangeland, major herbicide companies have attempted to develop more effective herbicides. In the last 20 years, however, only a few herbicides have been registered for use on grazing lands, and none have been as effective as 2, 4, 5-T.

Except for certain other phenoxy compounds, the use of substitutes for 2, 4, 5-T in 1964 to treat growing crops was not important (table 5). Alternative herbicides not registered in 1969 were not considered in this report.

The major nonchemical alternative methods of maintaining farm production and of controlling brush on nonfarmland involve increased cultural practices and mechanical brush removal. Moreover, to maintain total production of some crops, additional acres of farmland currently diverted under Government production control programs could be brought back into cultivation. Use of additional acres is particularly applicable for small grains, rice, and sugarcane. In this report, additional cropland is assumed to be available where needed from diverted acreage programs.

On pasture and rangeland, periodic bulldozing, seeding, and reseeding coupled with annual mowing gives reasonably effective control for brush and weeds. For rights-of-way, hand cutting is the only effective nonchemical alternative, but is much more expensive. For weeds in aquatic areas, no mechanical controls are completely satisfactory, but drag-line cleaning is a partial alternative.

In this analysis, the herbicide substitutes were generally 2, 4-D, silvex, dicamba, and picloram. There are many other herbicides that might be included for specified uses, but they are generally more costly and less effective.

COSTS OF RESTRICTING 2, 4, 5-T

The costs of restricting domestic use of 2, 4, 5-T in 1969 were estimated on the assumption that farm production and weed infestation were at 1964 levels and that weeds and brush on nonfarmland would be controlled.

In the short run, these additional costs would be borne by farmers, governmental units, and the recreational, industrial, and timber industries. Over time, some of these costs would be transferred to consumers.

Costs were estimated separately using two different assumptions: (1) all other effective registered herbicides could be used as substitutes, and (2) only nonphenoxy herbicides could be used as substitutes.

Under the first assumption, only 2, 4, 5-T was restricted for domestic use. Although 2, 4, 5-T is the most effective all around brush killer, and the best choice for control of some weeds in crops, some species of weeds and brush can be controlled by closely related materials such as 2, 4-D, silvex, dichlorprop, and MCPA. These registered herbicides could have been used as substitutes on about 5.5 million acres of a total of 7.9 million acres treated with 2, 4, 5-T (table 6).

The additional costs of these chemicals and the changes in mechanical and cultural practices are estimated at $52 million. About two-thirds of the costs would be borne by farmers, primarily livestock ranchers. Without 2, 4, 5-T, a major problem would exist on rangeland where some brush species could not be controlled with silvex, 2, 4-D, or other phenoxy herbicides. Mixed stands of brush as in mesquite are a prime example. Most of this land would have to receive cultural treatment even if other phenoxys were available. For uses other than on grazing land, several herbicides are registered which will cover many of the needs at a cost usually somewhat higher than for 2, 4, 5-T.

On the average, costs of additional cultural practices for farmers and nonfarmers would have been about $16 an acre on over 39 percent of the acres treated with 2, 4, 5-T.

Under the second assumption, no other phenoxy herbicides could be used as substitutes for 2, 4, 5-T. Alternative herbicides such as dicamba, atrazine, and picloram could have been used on about 3.5 million acres of a total of 7.9 million acres. However to maintain production on farms and to control weeds and brush on nonfarmland, more mechanical and cultural practices as well as additional cropland would be substituted for 2, 4, 5-T.

It is estimated that additional costs would have risen to $172 million, or over three times the expenditures if 2, 4, 5-T had been available (table 7). Nonfarm users' costs would have increased $128 million and farmers would have paid an additional $44 million to maintain the same control. Costs of additional cultural practices would have been about $22 an acre for about 73 percent of all acres treated in 1969 with phenoxys.

Under both assumptions, costs in 1970 would have been generally similar to 1969. But they would have been lower because of actions taken by the Pesticide Regulation Division to suspend registration of all uses of 2, 4, 5-T on lakes, ponds, or ditch banks; and liquid formulations for use around the home, recreation areas, and similar sites. Under the first assumption, where other phenoxy herbicides could be substituted for most of the 2, 4, 5-T, the suspended uses in 1970 would have accounted for less than $2 million of the $52 million for 1969. Under the second assumption, where more alternatives were non-chemical substitutes for 2, 4, 5-T, the suspended uses in 1970 would have accounted for about $6 million of the $172 million for 1969.

Table 1.--Production, exports, and production less exports of 2,4,5-T acid, esters and salts, United States, 1958-69

Year	Production 1/	Exports 2/	Production less exports 3/
	Million pounds		
1958	5.2	2.1	3.1
1959	8.0	1.8	6.2
1960	7.9	2.7	5.2
1961	7.8	2.8	5.0
1962	10.5	3.2	7.3
1963	10.0	4.6	5.4
1964	13.0	4.1	8.9
1965	13.5	2.2	11.3
1966	18.1	1.7	16.4
1967	27.2	1.4	25.8
1968	42.5	1.1	41.4
1969 4/	11.6	2.3	9.3

1/ Includes production from both 2,4,5-T acid and other precursors. Prior to 1966 most of the esters and salts were produced from 2,4,5-T acid, but thereafter increasing proportions of the esters and salts were prepared by processes not involving 2,4,5-T acid as a distinct intermediate.

2/ Estimate based on exports of both 2,4-D and 2,4,5-T acid basis. Assumed esters and salts weighed 25 percent more than the acids from which they were made (average of the extent to which production of 2,4,5-T acid, esters and salts was greater than the acid for the years 1958 thru 1964). Exports of 2,4,5-T were estimated at 25 percent of combined exports of 2,4-D and 2,4,5-T (average proportion that production of 2,4,5-T esters and salts was of the combined production of 2,4-D and 2,4,5-T for 1967 thru 1969).

3/ Prior to 1966 and again in 1969 these data are reasonably good indicators of the level of domestic use of 2,4,5-T even though they do not allow for changes in stocks between years. From 1966 to 1969 they are not good indicators of domestic use because military purchases for use abroad are included; they were not considered exports. The 1969 data reflect the transition from domestic shortages of the late 1960's to present adequate supplies.

4/ Preliminary.

Source: The Pesticide Reviews, 1970 and earlier, U.S. Dept. Agr., Stabil. and Conserv. Serv.

Table 2.--Estimated acres treated, quantities and percentage of 2,4,5-T used, by type of use, United States, 1969

Use category	Land treated	Quantities of active ingredients in 2,4,5-T applied	Proportion of total quantity applied
	1,000 acres	1,000 pounds	Percent
Farm use: 1/			
Hay, pasture, and rangeland	2,441	581	7
Other crops	2/671	398	4
Other farm use	3/339	676	8
Total farm use	3,451	1,655	19
Nonfarm use:			
Federal Government 4/	296	656	7
Lawn and turf 5/	1,200	600	7
Rights-of-way 6/	2,175	4,368	49
Private nonfarm forests 7/	430	888	10
Aquatic areas 8/	81	162	2
Other uses 9/	306	583	6
Total nonfarm use	4,488	7,257	81
Total all uses	7,939	10/8,912	100

1/ Based on Quantities of Pesticides Used by Farmers in 1964, U.S. Dept. Agr., Agr. Econ. Rpt. No. 131, Jan. 1968. Farm data exclude Alaska and Hawaii. In some farm uses, all acres in a field were reported treated while only spots actually received 2,4,5-T, thus making the rate per acre seem low. It is believed that farm use in 1969 was generally similar to 1964.

2/ Sum of acres of all crops, except hay, pasture, and rangeland treated.

3/ The acreage of noncropland was estimated by allocating the quantity of 2,4,5-T used for such purposes at the rate of 2 pounds per acre.

4/ Based on 1969 usage of the Departments of Agriculture, Interior, and Defense; and 1951-69 average usage by the Tennessee Valley Authority.

5/ Based on estimated 500,000 acres of turf and 700,000 acres of lawns treated. Estimates based on Extent and Cost of Weed Control With Herbicides and an Evaluation of Important Weeds, U.S. Dept. Agr., Agr. Res. Serv., ARS 34-102; and on unpublished data.

6/ Based on sources cited in footnote 5 with rate of application same as for federally treated rights-of-way. Does not include rights-of-way treated by Federal agencies.

7/ Estimated at 4 times the acreage treated and quantities of pesticides applied to public forests in 1969.

8/ Based on sources cited in footnote 5 and rates used on federally treated waterways.

9/ Includes governments other than Federal, and any other usage.

10/ Production less exports in 1964 from table 1. It is assumed that total domestic disappearance in 1969 was similar to 1964.

Table 3.--Farm use of 2,4,5-T on crops, by category of use, United States, 1964 1/

Use category	Active ingredients 2/	Acres treated 2/	Percentage of planted acres treated with 2,4,5-T 3/
	1,000 pounds	1,000 acres	Percent
Hay, pasture and rangeland	581	2,441	0.4
Corn	72	255	.4
Wheat	16	55	4/
Sorghum	5	48	.3
Other grains 5/	264	196	.4
Other crops	41	117	.1
All crop uses	979	3,112	.3

1/ Does not include Alaska and Hawaii. Use in 1964 generally reflects practices in 1969.
2/ Revised estimates based on Quantities of Pesticides Used by Farmers in 1964, U.S. Dept. Agr., Agr. Econ. Rpt. No. 131, Jan. 1968.
3/ Acres treated as a percentage of acres grown as reported in Statis. Bul No. 384 and Agricultural Statistics 1968.
4/ Less than 0.1 percent.
5/ Includes rice and other small grains except wheat.

Table 4.--Farm use of 2,4,5-T, by farm production regions, United States, 1964 1/

Region	Active ingredients 2/	Acres treated 2/	Percentage of planted acres treated with 2,4,5-T 3/
	1,000 pounds	1,000 acres	Percent
Northeast	8	11	4/
Appalachian	52	176	0.5
Southeast	16	37	.1
Delta	258	167	.6
Corn Belt	80	235	.3
Lake States	8	13	6/
Northern Plains	123	326	.2
Southern Plains	400	2,081	1.3
Mountain	22	35	4/
Pacific	12	32	4/
All regions			
--excluding noncrop use	979	3,112	.3
--including noncrop use	1,655	5/	5/

1/ Does not include Alaska and Hawaii. Use in 1964 generally reflects practices in 1969.
2/ Revised estimates based on Quantities of Pesticides Used by Farmers in 1964, U.S. Dept. Agr., Agr. Econ. Rpt. No. 131, Jan. 1968.
3/ Acres treated as a percentage of acres grown as reported in Statis. Bul. No. 384 and Agricultural Statistics 1968.
4/ Less than 0.05 percent of crop acres treated.
5/ Acreage data not available for noncrop usage.

Table 5.--Farm acreages treated with 2,4,5-T, and selected similarly acting herbicides, United States, 1964 1/

Crop category	2,4,5-T 2/	2,4-D	Other phenoxy 3/	Dicamba	Picloram
	1,000 acres				
Hay, pasture, and rangeland	2,441	5,415	133	---	---
Corn	255	21,816	665	---	---
Wheat	55	16,540	529	103	---
Sorghum	48	3,056	16	---	---
Other grains 4/	196	7,496	2,056	---	---
Other crops	117	1,977	1,421	21	---
All crops	3,112	56,300	4,820	124	---

1/ Does not include Alaska and Hawaii. Based on ERS Pesticide and General Farm Survey 1966.
2/ Use in 1966 was unusually small and not representative of current practices because of shortages due to military purchases.
3/ Includes all phenoxy and related herbicides other than 2,4-D and 2,4,5-T -- erbon, fenac, 2,4-DEP, MCPA, MCPB, mecoprop, sesone, silvex, dichlorprop, and 2,4-DB.
4/ Includes rice and other small grains except wheat.

Table 6.--Economic effects of restricting 2,4,5-T, if other phenoxy herbicides and all other registered herbicides could have been used, United States, 1969 1/

Use category	Estimated acres treated with 2,4,5-T	Acres that could be treated with alternative	Acres requiring additional cultural practices	Cost of 2,4,5-T and application	Cost of alternative herbicides and application	Cost of additional cultural practices	Net increased cost of using alternatives 2/
	1,000 acres			1,000 dollars			
Farm use:							
Hay, pasture, and rangeland 3/	2,441	488	1,953	4,052	1,781	32,443	30,172
Other crops 4/	671	654	660	1,764	1,130	1,720	1,086
Other farm use 5/	339	225	114	2,204	2,115	766	677
Total farm use	3,451	1,367	2,727	8,020	5,026	34,929	31,935
Nonfarm use:							
Federal Government 6/	296	281	15	3,287	3,765	735	1,213
Lawn and turf 7/	1,200	1,200	60	2,850	3,720	240	1,110
Rights-of-way 8/9/	2,175	1,958	217	33,772	36,028	9,548	11,804
Private nonfarm forests 8/10/	430	387	43	3,738	4,411	3,363	4,036
Aquatic areas 8/11/	81	73	8	608	760	240	392
Other uses 12/	306	291	15	2,219	3,026	375	1,182
Total nonfarm use	4,488	4,190	358	46,474	51,710	14,501	19,737
Total all uses	7,939	5,557	3,085	54,494	56,736	49,430	51,672

1/ Based on estimated use in 1964 as shown in table 2 and on substitute herbicides available in 1969. Additional explanation of the derivation of the data is shown in appendix tables 1-9.

2/ Cost of alternative herbicides and application plus cost of additional cultural practices less cost of 2,4,5-T and application.

3/ The alternative herbicide was 0.5 pounds silvex and 1 pound 2,4-D on 20 percent of the acres treated. Cultural treatments on the other 1,953,000 acres include renovating a third of the acres at $15.66 an acre; then bulldozing 72 percent of the remaining two-thirds at $23.16 an acre, and mowing the other 28 percent at $1.50 an acre.

4/ Most acres of individual crops treated with 2,4,5-T in 1964 could have been treated with 2,4-D. Rates of 2,4-D use on crops were assumed to be the 1966 average rate of all phenoxy usage for that crop except for other grains where 2,4-D was used at the same rate as 2,4,5-T. Supplemental hand or mechanical control was used on some of the corn, sorghum, and noncropland. Additional acres of wheat, other small grains, and other crops were grown to maintain production in spite of yield losses. In rice production, additional fertilizer and a change in the crop rotation were required to maintain production and offset loss in quality.

5/ Silvex and 2,4-D were applied on the noncropland. Substitute practices also included some mowing and hand cutting.

6/ Based on 1969 use by the Departments of Agriculture, Interior, and Defense; and TVA. Two pounds each of 2,4-D and silvex were substituted for 2,4,5-T on 95 percent of all acres treated in 1964. Remaining acres required additional cultural, mechanical, and manual controls averaging $49 per treated acre.

7/ All acres could have been treated with 0.5 pounds each of 2,4-D and silvex, but $4 of manual work was also required on 5 percent of all acres.

8/ Two pounds each of 2,4-D and silvex were used as substitutes for 2,4,5-T on 90 percent of all acres.

9/ Ten percent of the acres required hand cutting at $44 per acre.

10/ Ten percent of the acres were mowed, hand cut, or undesirable species girdled at a cost of $78.21 per acre.

11/ The remainder required cleaning with a drag line at $30 per acre for treated acres.

12/ Two pounds each of 2,4-D and silvex were used to replace 2,4,5-T on 95 percent of these acres. The remaining acres required mechanical control by hand or with machines at $25 per acre on which used.

Table 7.--Economic effects of restricting 2,4,5-T, if no other phenoxy herbicides could have been used but all other registered herbicides could have been used, United States, 1969 1/

Use category	Estimated acres treated with 2,4,5-T	Acres that could be treated with alternative	Acres requiring additional cultural practices	Cost of 2,4,5-T and application	Cost of alternative herbicides and application	Cost of additional cultural practices	Net increased cost of using alternatives 2/
	1,000 acres			1,000 dollars			
Farm use:							
Hay, pasture, and rangeland 3/	2,441	---	2,441	4,052	---	40,551	36,499
Other crops 4/	671	428	479	1,764	1,801	3,301	3,338
Other farm use 5/	339	200	139	2,204	4,585	1,866	4,247
Total farm use	3,451	628	3,059	8,020	6,386	45,718	44,084
Nonfarm use:							
Federal Government 6/	296	83	213	3,287	3,901	10,863	11,477
Lawn and turf 7/	1,200	1,200	1,200	2,850	2,310	4,800	4,260
Rights-of-way 8/	2,175	1,631	544	33,772	84,812	23,936	74,976
Private nonfarm forests 9/	430	---	430	3,738	---	33,630	29,892
Aquatic areas 10/	81	---	81	608	---	2,430	1,822
Other uses 11/	306	---	306	2,219	---	7,650	5,431
Total nonfarm use	4,488	2,914	2,774	46,474	91,023	83,309	127,858
Total all uses	7,939	3,542	5,833	54,494	97,409	129,027	171,942

1/ Based on estimated use in 1964 as shown in table 2 and on substitute herbicides available in 1969. Additional explanation of the derivation of the data is shown in appendix tables 1-9.

2/ Cost of alternative herbicides and application plus cost of additional cultural practices less cost of 2,4,5-T and application.

3/ Cultural treatments include renovating a third of the acres at $15.66 an acre; then bulldozing 72 percent of the remaining two-thirds at $23.16 an acre, and mowing the other 28 percent at $1.50 an acre.

4/ Weeds on some acres of most crops treated with 2,4,5-T in 1964 could have been controlled with nonphenoxy herbicides. Important chemical substitutes used include dicamba, and atrazine and oil. Supplemental hand or mechanical control was also required on some corn, sorghum, small grains, and noncropland. Additional acres of wheat, other small grains, and other crops were grown to maintain production in spite of yield losses. In rice production additional fertilizer and a change in the crop rotation were required to maintain production and offset loss in quality.

5/ Picloram was applied on the noncropland. Substitute practices also included some mowing and handweeding.

6/ Based on 1969 use by the Departments of Agriculture, Interior, and Defense; and TVA. Two pounds of picloram with a drift reducing adjuvant were substituted for 2,4,5-T on 75 percent of federally maintained rights-of-way (110,000). All other acres required cultural, mechanical, and manual control averaging $51 per acre.

7/ All acres can be treated with 0.5 pound dicamba but supplemental manual work costing $4 per acre was required on all acres.

8/ Two pounds of picloram with a drift reducing adjuvant were substituted for 2,4,5-T on 75 percent of all acres. The remainder required hand cutting at $44 an acre.

9/ All acres had to be mowed, hand cut, or undesirable species hand girdled at a cost of $78.21 per treated acre.

10/ All acres needed to be mechanically cleaned with a drag line at $30 per acre treated.

11/ All acres required mechanical control by hand or with machines at $25 per acre.

Table 8.--Identification of pesticides mentioned in this report

Common name or other designation	Chemical name
atrazine	2-chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine
2,4-D	(2,4-dichlorophenoxy)acetic acid
2,4-DB	4-(2,4-dichlorophenoxy)butyric acid
2,4-DEP	tris[2-(2,4-dichlorophenoxy)ethyl]phosphite
dicamba	3,6-dichloro-*o*-anisic acid
dichlorprop	2-(2,4-dichlorophenoxy)propionic acid
erbon	2-(2,4,5-trichlorophenoxy)ethyl 2,2-dichloropropionate
fenac	(2,3,6-trichlorophenyl)acetic acid
MCPA	[(4-chloro-*o*-tolyl)oxy]acetic acid
MCPB	4-[4-chloro-*o*-tolyl)oxy]butyric acid
mecoprop	2-[4-chloro-*o*-tolyl)oxy]propionic acid
paraquat	1,1'-dimethyl-4,4'-bipyridinium ion
picloram	4-amino-3,5,6-trichloropicolinic acid
propachlor	2-chloro-*N*-isopropylacetanilide
sesone	2-(2,4-dichlorophenoxy)ethyl sodium sulfate
silvex	2-(2,4,5-trichlorophenoxy)propionic acid
2,4,5-T	(2,4,5-trichlorophenoxy)acetic acid

APPENDIX

Appendix table 1.--Cost of 2,4,5-T and application, all domestic uses, United States, 1969

Use category	Acres treated	Materials			Application		Total cost of material and application
		Pounds per acre	Cost per pound	Total cost	Cost per acre	Total cost	
	1,000 acres	Pounds	Dollars	1,000 dollars	Dollars	1,000 dollars	1,000 dollars
Farm use:							
Hay, pasture, and rangeland	2,441	0.24	2.75	1,611	1.00	2,441	4,052
Other crops	671	1/.59	2.75	1,093	1.00	671	1,764
Other farm use	339	2.00	2.75	1,865	1.00	339	2,204
Total farm use	3,451	.48	2.75	4,569	1.00	3,451	8,020
Nonfarm use:							
Federal Government	296	2.22	2.75	1,807	5.00	1,480	3,287
Lawn and turf	1,200	.50	2.75	1,650	1.00	1,200	2,850
Rights-of-way	2,175	2.01	2.75	12,022	10.00	21,750	33,772
Private nonfarm forests	430	2.07	2.75	2,448	3.00	1,290	3,738
Aquatic areas	81	2.00	2.75	446	2.00	162	608
Other uses	306	1.91	2.75	1,607	2.00	612	2,219
Total nonfarm use	4,488	1.62	2.75	19,980	5.90	26,494	46,474
Total all uses	7,939	1.12	2.75	24,549	3.77	29,945	54,494

1/ Calculated weighted average of individual crops and crop groupings (0.59233).

Appendix table 2.--Cost of alternative herbicides and application for acres that could be treated with an alternative to 2,4,5-T if all other registered herbicides could be used, all domestic uses, United States, 1969

Use category	Material	Acres treated	Materials			Application		Total cost of material and application
			Pounds per acre	Cost per pound	Total cost	Cost per acre	Total cost	
		1,000 acres	Pounds	Dollars	1,000 dollars	Dollars	1,000 dollars	1,000 dollars
Farm use:								
Hay, pasture, and rangeland....	Silvex	488	0.5	3.10	756	---	---	---
	2,4-D	488	1.0	1.10	537	---	---	---
		(488)			1,293	1.00	488	1,781
Other crops.....	2,4-D	654	1/.7	1.10	476	---	---	---
Other farm use.....	Silvex	225	2.0	3.10	1,395	---	---	---
	2,4-D	225	2.0	1.10	495	---	---	---
		(879)			2,366	1.00	879	3,245
Nonfarm use:								
Federal Government.....	Silvex	281	2.0	3.10	1,742	---	---	---
	2,4-D	281	2.0	1.10	618	---	---	---
		(281)			2,360	5.00	1,405	3,765
Lawn and turf.....	Silvex	1,200	.5	3.10	1,860	---	---	---
	2,4-D	1,200	.5	1.10	660	---	---	---
		(1,200)			2,520	1.00	1,200	3,720
Rights-of-way.....	Silvex	1,958	2.0	3.10	12,140	---	---	---
	2,4-D	1,958	2.0	1.10	4,308	---	---	---
		(1,958)			16,448	10.00	19,580	36,028
Private nonfarm forests.....	Silvex	387	2.0	3.10	2,399	---	---	---
	2,4-D	387	2.0	1.10	851	---	---	---
		(387)			3,250	3.00	1,161	4,411
Aquatic acres.....	Silvex	73	2.0	3.10	453	---	---	---
	2,4-D	73	2.0	1.10	161	---	---	---
		(73)			614	2.00	146	760
Other uses.....	Silvex	291	2.0	3.10	1,804	---	---	---
	2,4-D	291	2.0	1.10	640	---	---	---
		(291)			2,444	2.00	582	3,026

1/ Calculated weighted average of individual crops and crop groupings (0.662 pounds per acre).

Appendix table 3.--Cost of alternative herbicides and application for acres that could be treated with an alternative to 2,4,5-T if no other phenoxy herbicides could have been used but all other registered herbicides could have been used, all domestic users, United States, 1969

Use category	Material	Acres treated	Materials			Application		Total cost of material and application
			Pounds per acre	Cost per pound	Total cost	Cost per acre	Total cost	
		1,000 acres	Pounds	Dollars	1,000 dollars	Dollars	1,000 dollars	1,000 dollars
Farm use:								
Crops other than hay, pasture, and rangeland.....	Dicamba	273	1/0.8	1.85	422	---	---	---
	Other herbicides	2/155	3/	3/	866	---	---	---
		428			1,308	4/1.15	493	1,801
Other farm use.....	Dicamba	100	1.0	1.85	185	---	---	---
	Picloram	100	2.0	20.00	4,000	---	---	---
	Anti-drift	100	2.0	1.00	200	---	---	---
		(200)			4,385	100	200	4,585
Nonfarm use:								
Federal Government.....	Picloram	83	2.0	20.00	3,320	---	---	---
	Anti-drift	83	5/2.0	5/1.00	166	---	---	---
		(83)			3,486	5.00	415	3,901
Lawn and turf.....	Dicamba	1,200	.5	1.85	1,110	1.00	1,200	2,310
Rights-of-way.....	Picloram	1,631	2.0	20.00	65,240	---	---	---
	Anti-drift	1,631	5/2.0	5/1.00	3,262	---	---	---
		(1,631)			68,502	10.00	16,310	84,812

1/ Calculated weighted average of individual crops and crop groupings (0.8356 pounds per acre).

2/ Some acres received two applications. Atrazine and oil was applied postemergence to 130,000 corn acres already treated with a preemergence herbicide.

3/ Rates of application and costs per unit varied by individual crops and crop groupings.

4/ The application cost is $1.00 an acre for all 428,000 acres treated plus $0.50 an acre for 130,000 acres of corn also treated with preemergence herbicides integrated into other tillage operations. The application cost of $1.15 is a weighted average per acre receiving one or more applications of pesticides.

5/ Adjuvant is based on quarts rather than pounds.

Appendix table 4.--Corn: Cost of restricting the use of 2,4,5-T, United States, 1969

Weed control practices	Acres	Costs per acre			Total costs
		Materials	Application	Total	
	1,000 acres	Dollars	Dollars	Dollars	1,000 dollars
1964 use of 2,4,5-T 1/	255	0.78	1.00	1.78	454
Substitute practice 2/					
A. 2,4-D	255	.60	1.00	1.60	408
Cultural practice 3/	255	---	---	1.00	255
Total	---	---	---	---	663
B. Dicamba	125	1.85	1.00	2.85	356
Other herbicides:					
Preemergence 4/	130	4.30	.50	4.80	624
Post emergence 4/	130	1.70	1.00	2.70	351
Additional cultivation	130	---	---	.75	98
Other cultural practices 4/	255	---	---	1.00	255
Total	---	---	---	---	1,684
Additional costs					
Substitute practice: 2/					
A	---	---	---	---	209
B	---	---	---	---	1,230

1/ Based on data from an ERS Pesticide and General Farm Survey.

2/ Practice A assumes other phenoxy and all other registered herbicides could have been used. Practice B assumes no other phenoxy herbicides could have been used but all other registered herbicides could have been used.

3/ Hand weeding.

4/ Practices same as in report "Restricting the Use of Phenoxy Herbicides -- Costs to Farmers --," U.S. Dept. Agr., Agr. Econ. Rpt. No. 194, Nov. 1970.

Appendix table 5.--Sorghum: Cost of restricting the use of 2,4,5-T, United States, 1969

Weed control practices	Acres	Costs per acre			Total costs
		Materials	Application	Total	
	1,000 acres	Dollars	Dollars	Dollars	1,000 dollars
1964 use of 2,4,5-T 1/.....	48	0.29	1.00	1.29	62
Substitute practice 2/					
A. 2,4-D.....	48	.56	1.00	1.56	75
Tillage practice.....	48	---	---	1.00	48
Total.....	---	---	---	---	123
B. Dicamba 3/.....	23	1.85	1.00	2.85	66
Atrazine and oil 3/....	25	4.24	1.00	5.24	131
Tillage practice 4/....	48	---	---	.75	36
Fallow cultural practice 3/.....	5	---	---	2.40	12
Total.....	---	---	---	---	245
Additional costs					
Substitue practice: 2/					
A.....	---	---	---	---	61
B.....	---	---	---	---	183

1/ Based on data from an ERS Pesticide and General Farm Survey.

2/ Practice A assumes other phenoxy and all other registered herbicides could have been used. Practice B assumes no other phenoxy herbicides could have been used but all other registered herbicides could have been used.

3/ Practices same as in report "Restricting the Use of Phenoxy Herbicides -- Costs to Farmers --," U.S. Dept. Agr., Agr. Econ. Rpt. No. 194, Nov. 1970.

4/ Cultivation or hand weeding.

Appendix table 6.--Wheat: Cost of restricting the use of 2,4,5-T, United States, 1969

Weed control practices	Acres	Costs per acre			Total costs
		Materials	Application	Total	
	1,000 acres	Dollars	Dollars	Dollars	1,000 dollars
1964 use of 2,4,5-T 1/	55	0.80	1.00	1.80	99
Substitute practice 2/					
A. 2,4-D	55	.50	1.00	1.50	83
Additional acres 3/	3	---	---	13.50	41
Total	---	---	---	---	124
B. Dicamba 4/	25	1.18	1.00	2.18	55
Additional acres 3/	13	---	---	13.50	176
Cultural practices 4/	18	---	---	2.40	43
Total	---	---	---	---	274
Additional costs					
Substitute practice: 2/					
A	---	---	---	---	25
B	---	---	---	---	175

1/ Based on data from an ERS Pesticide and General Farm Survey.

2/ Practice A assumes other phenoxy and all other registered herbicides could have been used. Practice B assumes no other phenoxy herbicides could have been used but all other registered herbicides could have been used.

3/ Assuming 5 percent yield loss where 2,4-D is used and 30 percent yield loss on land not treatable with 2,4-D or dicamba. Additional acres are sufficient to maintain 1969 production although they also sustain the assumed levels of yield loss.

4/ Practices same as in report "Restricting the Use of Phenoxy Herbicides -- Costs to Farmers --," U.S. Dept. Agr., Agr. Econ. Rpt. No. 194, Nov. 1970.

Appendix table 7.--Other small grains:1/ Cost of restricting the use of 2,4,5-T, United States, 1969

Weed control practices	Acres	Costs per acre			Total costs
		Materials	Application	Total	
	1,000 acres	Dollars	Dollars	Dollars	1,000 dollars
1964 use of 2,4,5-T 2/	196	3.70	1.00	4.70	921
Substitute practice 3/					
A. 2,4-D	196	1.11	1.00	2.11	414
Additional acres 4/	27	---	---	14.52	392
Additional fertilizer 5/	289	---	---	3.23	933
Changing rotation 5/	27	---	---	(9.85)	(266)
Total	---	---	---	---	1,473
B. Dicamba 5/	100	1.18	1.00	2.18	218
Additional acres 4/	34	---	---	18.79	639
Loss in rice quality 5/	27	---	---	14.88	402
Added fertilizer 5/	320	---	---	3.23	1,034
Changing rotation 5/	27	---	---	(9.85)	(266)
Cultural practices 5/	66	---	---	2.40	158
Total	---	---	---	---	2,185
Additional costs					
Substitute practice:3/					
A	---	---	---	---	552
B	---	---	---	---	1,264

1/ Includes rice and other small grains except wheat.

2/ Based on data from an ERS Pesticide and General Farm Survey. Separate data for rice and other small grains are not available for 1964.

3/ Practice A assumes other phenoxy and all other registered herbicides could have been used. Practice B assumes no other phenoxy herbicides could have been used but all other registered herbicides could have been used.

4/ Assuming 5 percent yield loss for rice and 15 percent loss for other grains where phenoxys are used (practice A); and 15 percent loss for rice and 30 percent loss for other grains where phenoxys are not used (practice B). Where production could not be maintained with the cultural practices considered additional acres of crops were grown. Practice A based on growing an additional 26,000 acres of other grains and 1,000 acres of rice at costs of $12.54 and $65.70 per acre respectively. Practice B based on 30,000 additional acres of small grains and 4,000 acres of rice.

5/ Practices same as those reported on rice and other small grain in report "Restricting the Use of Phenoxy Herbicides -- Costs to Farmers--," U.S. Dept. Agr., Agr. Econ. Rpt. No. 194, Nov. 1970.

Appendix table 8.--Other crops: Cost of restricting the use of 2,4,5-T, United States, 1969

Weed control practices	Acres	Costs per acre			Total costs
		Materials	Application	Total	
	1,000 acres	Dollars	Dollars	Dollars	1,000 dollars
1964 use of 2,4,5-T 1/	117	0.96	1.00	1.96	229
Substitute practice 2/					
A. 2,4-D	100	.50	1.00	1.50	150
Additional acres 3/	8	---	---	39.67	317
Total	---	---	---	---	467
B. Additional acres 3/	18	---	---	39.67	714
Total	---	---	---	---	714
Additional costs					
Substitute practice: 2/					
A	---	---	---	---	238
B	---	---	---	---	485

1/ Based on data from an ERS Pesticide and General Farm Survey.

2/ Practice A assumes other phenoxy and all other registered herbicides could have been used. Practice B assumes no other phenoxy herbicides could have been used but all other registered herbicides could have been used.

3/ Includes a 5-percent loss in yield on 2,4-D treated acres, and 15 percent loss on acres not treated with 2,4-D. Additional acres are sufficient to maintain 1969 production even if they also sustain the assumed levels of yield losses.

Appendix table 9.--Noncropland on farms: Cost of restricting the use of 2,4,5-T, United States, 1969

Weed control practices	Acres	Costs per acre			Total costs
		Materials	Application	Total	
	1,000 acres	Dollars	Dollars	Dollars	1,000 dollars
1964 use of 2,4,5-T 1/	339	5.50	1.00	6.50	2,204
Substitute practice 2/					
A. 2,4-D and silvex	225	8.40	1.00	9.40	2,115
Mowing	100	---	---	1.50	150
Hand cutting	14	---	---	44.00	616
Total	---	---	---	---	2,881
B. Dicamba	100	1.85	1.00	2.85	285
Other herbicides 3/	100	42.00	1.00	43.00	4,300
Mowing	100	---	---	1.50	150
Hand cutting	39	---	---	44.00	1,716
Total	---	---	---	---	6,451
Additional costs					
Substitute practice: 2/					
A	---	---	---	---	677
B	---	---	---	---	4,247

1/ Based on data from an ERS Pesticide and General Farm Survey.

2/ Practice A assumes other phenoxy and all other registered herbicides could have been used. Practice B assumes no other phenoxy herbicides could have been used but all other registered herbicides could have been used.

3/ Primarily picloram and Amitrole T. Cost is for 2 pounds picloram with drift reducing adjuvant.

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