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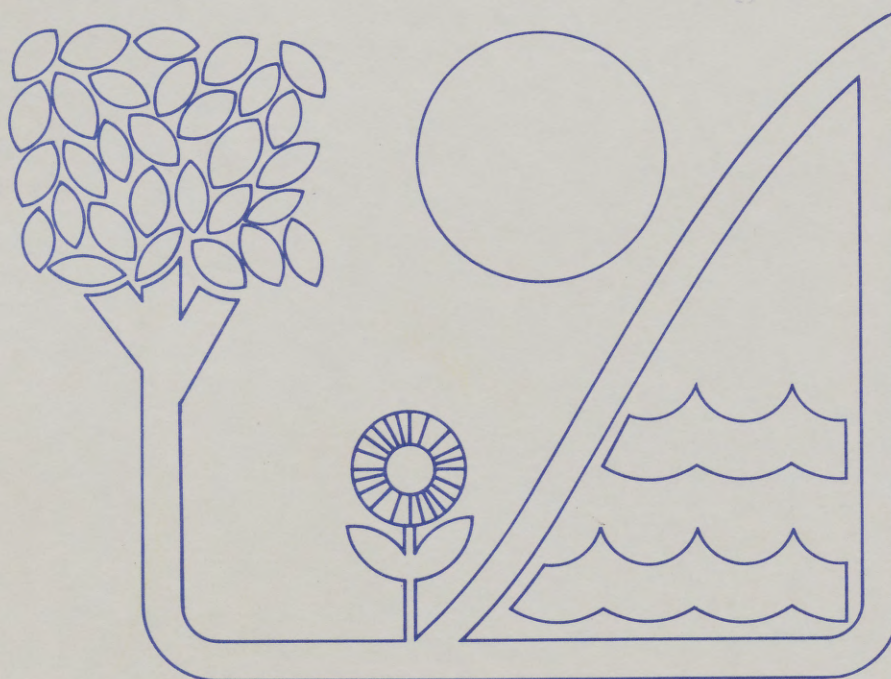
STAFF REPORT



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1980 PESTICIDE USE ON SOYBEANS
IN THE NORTH CENTRAL STATES

by

Michael Hanthorn, Craig Osteen,
Robert McDowell, and Larry Roberson

February 1982

ERS Staff Report No. AGES820209

Natural Resource Economics Division
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1980 PESTICIDE USE ON SOYBEANS IN THE NORTH CENTRAL STATES. By Michael Hanthorn, Craig Osteen, Robert McDowell, and Larry Roberson; Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C. 20250; February 1982.

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ABSTRACT

Farmers reported that 77.8 million pounds (a.i.) of pesticides were applied to soybeans in the North Central States during 1980. This consisted of 77.1 million pounds (a.i.) of herbicides and 700,000 pounds (a.i.) of insecticides. Pesticide acre-treatments totaled 58.1 million and consisted of 44.8 million with single material herbicides, 12.6 million with herbicide mixes, and 700,000 with insecticides. The primary herbicides were alachlor, bentazon, metribuzin, and trifluralin. The major insecticide was carbaryl. Herbicides were applied primarily to control cocklebur, foxtail, and velvetleaf infestations. Most insecticides were applied for armyworm, bean leaf beetle, corn earworm, grasshopper, and Mexican bean beetle control. Coefficients of variation were computed for acres of soybeans treated with specific pesticide materials.

Key words: Pesticides, herbicides, insecticides, active ingredient, acres treated, acre-treatments, application rates, primary target pests, soybeans, and North Central States.

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AUTHORS

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PREFACE

This report presents data for pesticides applied to soybeans in the North Central States during 1980. Pesticide use data for the major producing States not included in the North Central States and for all major producing regions are available in the following ERS Staff Reports:

- "1980 Pesticide Use on Soybeans in the Mississippi Valley"
- "1980 Pesticide Use on Soybeans in the Southeast"
- "1980 Pesticide Use on Soybeans in the Major Producing States".

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INTRODUCTION

This report presents pesticide use data for soybeans grown in the North Central States during 1980. The data include usage patterns and quantities of specific herbicides and insecticides applied to soybeans. This information should be useful to policymakers, academic institutions, government agencies, and private and commercial entities in evaluating the impacts of regulatory actions on specific pesticides, conducting economic analyses of pesticide use, developing more effective pest management programs, and conducting pesticide market analyses.

METHODOLOGY AND TERMINOLOGY

The Economics and Statistics Service collected pesticide use data as part of the 1980 Soybean Objective Yield Survey. A total of 1,915 farmers were personally interviewed by enumerators in the 17 major soybean producing States. In the North Central States, 1,045 farmers were interviewed and the sample size by State was as follows: Illinois, 190; Indiana, 130; Iowa, 170; Kansas, 60; Minnesota, 120; Missouri, 160; Nebraska, 75; and Ohio, 140.

Sample fields for each State were randomly selected from farmers who reported through the June Enumerative Survey that they had planted or intended to plant soybeans in 1980. Each soybean acre in a State had an equal probability of being selected. Consequently, the probability of a field being chosen was directly correlated to its size.

Several terms pertinent to this report are defined as follows. An "active ingredient" (a.i.) is that portion of a pesticide material that provides the control activity. "Acres treated" are the number of acres receiving one or more applications of a specific pesticide during the growing season. Acres treated with different pesticide materials cannot be summed because more than one

material may have been applied on a given acre during the growing season. Therefore, the addition of these numbers would result in multiple counting. "Acre-treatments" are the number of acres treated with a pesticide material multiplied by the number of applications made during the growing season. Acre-treatments are summed for each material at the State and regional level. "Pesticide mixes" are two or more pesticide materials that are premixed during formulation or tank-mixed at the time of application.

Pesticide application rates vary as a result of weather conditions, soil type, weed spectrum, and insect species. Also, the method of application influences the amount of a material used per acre. Herbicide and foliar insecticide application rates are generally expressed as broadcast rates. The amount of a material applied on an acre in either a band, in-furrow, or spot application is generally one-fourth to one-third the amount applied in a broadcast application. The application rate listed for each material in this report is an aggregation of band, broadcast, in-furrow, and spot applications.

RELIABILITY OF ESTIMATES

Estimates based upon sample surveys have varying degrees of statistical reliability. Confidence in data depends upon sample size, sampling methods, and the variability of the responses. To provide the user of the data with some indication of the reliability of the estimates, coefficients of variation (CV's) are presented in Appendix Table 1. The CV is a measure of relative variation (expressed in percentage terms) and can be used to indicate the degree of confidence a user can place in the estimate. The smaller the CV, the more reliable the estimate.

In simplest terms, it can be said there is 95 percent confidence that the sample represents the true population and that the true value for the

population lies within an interval defined as ± 2 CV's times the estimated value. For example, with a CV of 10 percent and an estimate of 40, the interval would be 32 to 48. However, there is also a 5 percent chance that the true value does not fall within the interval as defined above because the sample is not representative of the population.

CV's were calculated only for acres treated with specific pesticides. The estimates of acres treated are expected to have greater variation than other data reported. Consequently, for most other information included in this report, the level of reliability should be equal to or greater than that reported for acres treated.

NORTH CENTRAL STATES

Description

The North Central States include Illinois, Indiana, Iowa, Kansas, Minnesota, Missouri, Nebraska, and Ohio (Figure 1). This region is the major soybean producing area in the United States. In 1980, approximately 57 percent of the U.S. soybean acreage (39.7 million acres) was planted in the North Central States, from which 71 percent of the national crop (1.3 billion bushels) was produced (Table 1). The farm value of soybeans grown in this region during 1980 amounted to \$9.8 billion.

Trends in Pesticide Use

The number of acres planted to soybeans and treated with pesticides increased substantially in the North Central States between 1972 and 1980. Acres planted increased one-third from 29.4 to 39.7 million, while acres treated with herbicides and insecticides increased 15.9 million and 688,000, respectively (Table 2). Virtually all farmers reported using herbicides on soybeans in 1980, which represents a 72 percent increase in planted acres treated with herbicides

Figure 1. States included in the 1980 Soybean Pesticide Use Survey

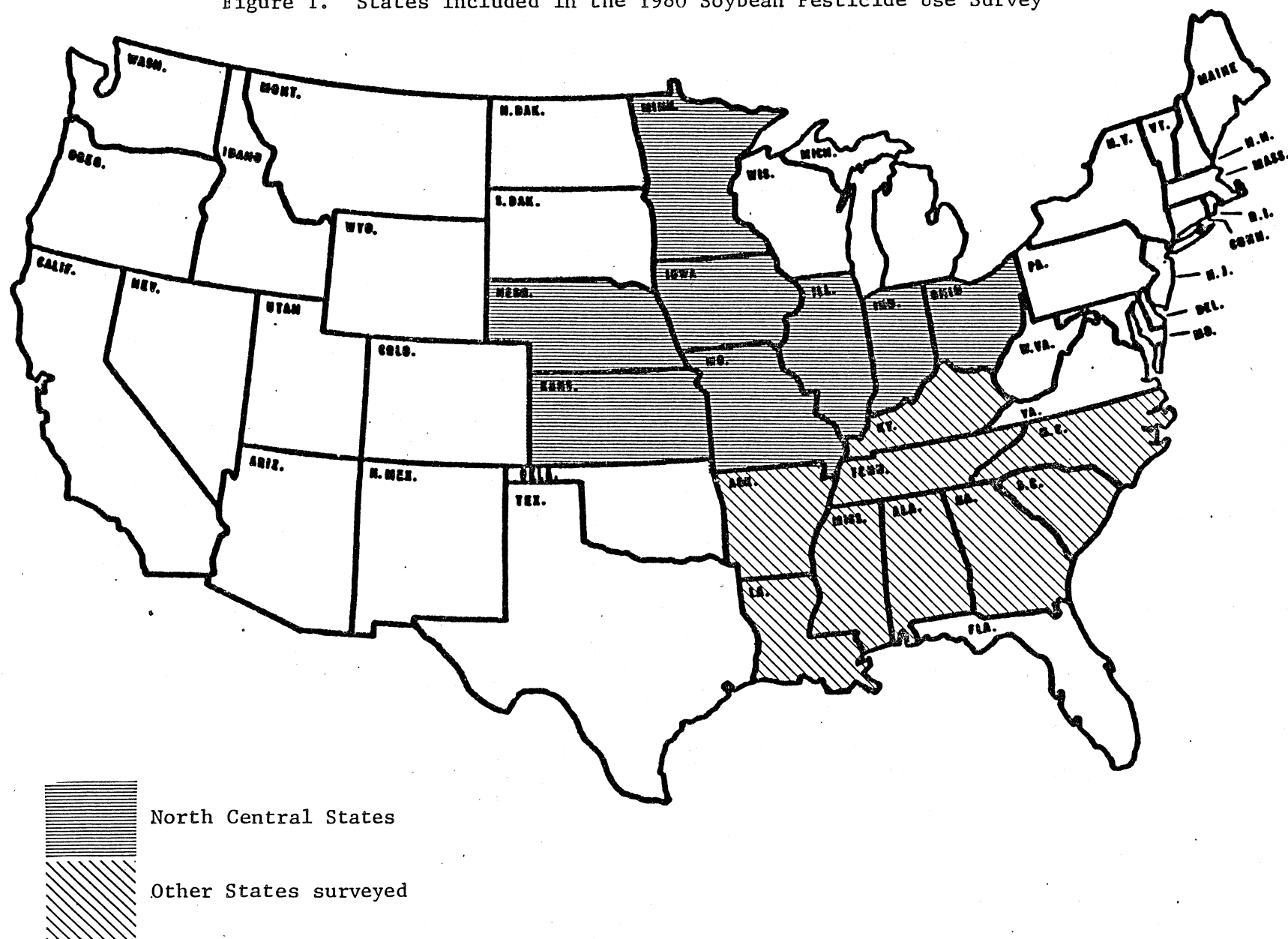


Table 1. Soybean acreage planted and harvested, production, and value in the North Central States, 1980

States	: Total acres a/	: Total	: Total
	: Planted : Harvested	: production a/	: value b/
	----- <u>Million</u> -----	<u>Million</u> <u>bushels</u>	<u>Million</u> <u>dollars</u>
Illinois	9.3 9.2	310	2,386
Indiana	4.4 4.4	158	1,214
Iowa	8.3 8.3	323	2,403
Kansas	1.6 1.4	24	182
Minnesota	4.8 4.8	152	1,081
Missouri	5.7 5.5	138	1,058
Nebraska	1.8 1.8	53	390
Ohio	3.8 3.8	135	1,036
Region	39.7 39.2	1,293	9,750
U.S. total	70.1 67.9	1,817	13,825
Percent of U.S. total	57 58	71	71

a/ "Crop Production-1980 Annual Summary", USDA, ESS, Crop Reporting Board, CrPr 2-1(81), January 14, 1981.

b/ "Field Crops-Production, Disposition, Value 1979-80", USDA, ESS, Crop Reporting Board, CrPr 1(81), April 1981.

Table 2. Soybean acreage planted and treated for weed and insect control in the North Central States, 1972 and 1980

States	Planted		Treated acres				Percent of planted acres treated			
	acres		Herbicides		Insecticides		Herbicides		Insecticides	
	1972 a/	1980 b/	1972 c/	1980 d/	1972 c/	1980 d/	1972:	1980:	1972:	1980
	-----Million-----				---Thousand---		-----Percent-----			
Illinois	7.6	9.3	5.7	9.2	-	-	75	99	-	-
Indiana	3.7	4.4	3.0	4.3	-	116	80	97	-	3
Iowa	6.0	8.3	5.1	8.1	-	-	83	97	-	-
Kansas	.9	1.6	.3	1.4	-	79	37	92	-	5
Minnesota	3.3	4.8	2.6	4.6	-	-	81	96	-	-
Missouri	4.1	5.7	2.9	5.3	-	44	72	93	-	1
Nebraska	.7	1.8	.4	1.6	-	93	57	86	-	5
Ohio	3.1	3.8	2.2	3.6	-	356	70	95	-	9
Region	29.4	39.7	22.2	38.1	-	688	76	96	-	2

- None reported.

a/ "Agricultural Statistics, 1974", U.S. Department of Agriculture.

b/ "Crop Production-1980 Annual Summary", USDA, ESS, Crop Reporting Board, CrPr 2-1(81), January 14, 1981.

c/ Herman W. Delvo, "1972 Soybean Objective Yield Survey", USDA, ERS, Farm Production Economics Division, 1972, (unpublished).

d/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

since 1972. No insecticide use was reported in the 1972 Soybean Objective Yield Survey for this region; however, 2 percent of the planted acres were treated with insecticides in 1980.

Pesticide Use

The major soybean weed and insect pests, as reported by farmers in the North Central States, are listed in Tables 3 and 4. Although several pests may have been present at any given time and caused varying degrees of damage, farmers were asked to report what they perceived to be the primary target pest for each pesticide material applied to soybeans. In 1980, foxtail was the primary target pest for 40 percent of the herbicide acre-treatments, cocklebur for 19 percent, and velvetleaf for 10 percent (Table 3). About 45 percent of the insecticide acre-treatments were made to control Mexican bean beetle infestations and 35 percent were made for armyworm, bean leaf beetle, and corn earworm control (Table 4).

About 77.8 million pounds (a.i.) of pesticides were applied to soybeans in 1980, consisting of 50.5 million pounds of single material herbicides, 26.6 million pounds of herbicide mixes, and 700,000 pounds of insecticides (Table 5). Application rates for herbicides, applied alone and in mixes, were 1.1 and 2.1 pounds (a.i.) per acre-treatment, respectively. Insecticide application rates averaged 1 pound (a.i.) per acre-treatment.

Farmers made 58.1 million pesticide acre-treatments, comprised of 44.8 million with single material herbicides, 12.6 million with herbicide mixes, and 700,000 with insecticides.

Trifluralin acre-treatments totaled 13.5 million, or 30 percent of those made with single material herbicides. Alachlor, bentazon, and metribuzin accounted for 19.3 million acre-treatments, or 43 percent of the same total. Forty percent (5 million) of the herbicide mix acre-treatments were made with

Table 3. Percentage of soybean herbicide acre-treatments by primary weeds controlled as reported by farmers in the North Central States, 1980 a/

Weeds	: Illi- : nois	: Ind- : iana	: Kan- : Iowa	: Minn- : sas	: Mis- : esota	: Ne- : souri	: : braska	: : Ohio	: : Region
	----- Percent -----								
<u>Grasses</u>									
Barnyardgrass	1	-	-	-	2	-	-	1	1
Broadleaf									
signalgrass	1	2	-	2	1	1	3	1	1
Crabgrass	-	1	-	19	-	3	1	1	1
Foxtail	42	38	45	13	46	36	35	37	40
Johnsongrass	4	3	1	2	1	1	-	3	2
Panicum	1	1	-	-	-	-	-	4	1
Shattercane	-	1	-	6	-	3	10	-	1
Other	2	4	1	7	10	3	7	2	4
<u>Broadleaves</u>									
Canada thistle	1	1	1	-	6	-	-	1	1
Cocklebur	21	15	14	24	16	32	9	15	19
Morningglory	2	1	-	6	-	3	-	2	1
Pigweed	3	3	3	11	6	6	6	3	4
Ragweed	3	4	1	-	2	1	-	16	3
Smartweed	2	3	8	-	-	-	3	5	3
Velvetleaf	9	5	21	6	6	8	18	5	10
Other	7	18	4	4	4	3	8	2	7
Nutsedge	1	-	1	-	-	-	-	2	1

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Table 4. Percentage of soybean insecticide acre-treatments by primary insects controlled as reported by farmers in the North Central States, 1980 a/ b/

Insects	:	:	:	:	:	:
	: Indiana	: Kansas	: Missouri	: Nebraska	: Ohio	: Region
	<u>Percent</u>					
Armyworm	50	-	50	-	-	13
Bean leaf beetle	-	-	-	86	11	10
Corn earworm	-	100	-	-	-	12
Grasshopper	-	-	50	14	-	8
Mexican bean beetle	-	-	-	-	79	45
Other	50	-	-	-	10	12

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Insecticide use was not reported in Illinois, Iowa, or Minnesota.

Table 5. Usage patterns and quantities of specific pesticides applied to soybeans in the North Central States, 1980 a/

	: Acres <u>b/</u>	: Acre- <u>c/</u>	:Pounds of active ingredient	
Pesticides	: treated	: treatments	: Total	: Per treatment
----- <u>Million</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	7.9	7.9	16.8	2.1
Bentazon	6.1	6.1	5.6	.9
Chloramben	3.1	3.1	4.8	1.5
Glyphosate	1.6	1.8	1.7	.9
Linuron	2.6	2.7	1.7	.6
Metribuzin	5.3	5.3	2.5	.5
Trifluralin	13.2	13.5	11.8	.9
Other	-	4.4	5.6	1.3
Total	-	44.8	50.5	1.1
<u>Tank-mix materials</u>				
Alachlor + chloramben	.4	.4	1.0+ .6	2.4+1.5
Alachlor + linuron	1.8	1.8	3.4+1.2	1.9+ .7
Alachlor + metribuzin	2.1	2.2	4.8+1.2	2.2+ .6
Dinoseb + naptalam	.4	.4	.3+ .6	.7+1.3
Metribuzin + trifluralin	4.9	5.0	2.3+4.7	.5+ .9
Other	-	2.8	6.5	2.3
Total	-	12.6	26.6	2.1
Total herbicides	-	57.4	77.1	1.3
INSECTICIDES				
Carbaryl	.4	.4	.4	1.1
Other	-	.3	.3	1.0
Total	-	.7	.7	1.0
TOTAL PESTICIDES	-	58.1	77.8	1.3

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

metribuzin plus trifluralin. Alachlor plus linuron comprised 1.8 million (14 percent) of the herbicide mix acre-treatments and alachlor plus metribuzin acre-treatments totaled 2.2 million (17 percent).

Two-thirds of the alachlor acre-treatments and 71 percent of the trifluralin acre-treatments were made for foxtail control (Appendix Table 2). About 55 percent of the bentazon acre-treatments were made to control cocklebur infestations and 17 percent were made to control velvetleaf infestations (Appendix Table 3). One-third of the metribuzin acre-treatments were made to control cocklebur infestations and another third were made for foxtail and velvetleaf control.

Carbaryl accounted for 400,000 (57 percent) of the insecticide acre-treatments (Table 5). Two-thirds of the carbaryl acre-treatments were made to suppress Mexican bean beetle infestations and one-fourth were made for armyworm and bean leaf beetle control (Appendix Table 4).

ILLINOIS

In 1980, Illinois farmers planted 9.3 million acres of soybeans and treated 9.2 million with herbicides (Table 2). Insecticide use on soybeans was not reported in Illinois for the 1980 growing season. Approximately 18.5 million pounds (a.i.) of herbicides were applied to soybeans, of which 13.7 million pounds were single material herbicides and 4.8 million pounds were herbicide mixes (Table 6). Application rates for herbicides, applied alone and in mixes, averaged 1.1 and 2.1 pounds (a.i.) per acre-treatment.

Total herbicide acre-treatments were estimated to be 14.2 million, comprised of 11.9 million with single material herbicides and 2.3 million with herbicide mixes. About 3.7 million (31 percent) of the single material herbicide acre-treatments were trifluralin. Also, alachlor, bentazon, chloramben, and metribuzin

Table 6. Usage patterns and quantities of specific pesticides applied to soybeans in Illinois, 1980 a/

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- Million -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	2.0	2.0	4.5	2.2
Bentazon	1.3	1.3	1.3	1.0
Chloramben	1.2	1.2	2.1	1.7
Metribuzin	1.8	1.8	0.8	.4
Trifluralin	3.6	3.7	3.2	.9
Other	-	1.9	1.8	.6
Total	-	11.9	13.7	1.1
<u>Tank-mix materials</u>				
Alachlor + linuron	.2	.2	.5+ .1	2.1+ .6
Alachlor + metribuzin	.3	.3	.7+ .1	2.4+ .5
Dinoseb + naptalam	.2	.2	.1+ .3	.8+1.6
Metribuzin + trifluralin	1.1	1.1	.5+1.3	.5+1.2
Other	-	.5	1.2	2.4
Total	-	2.3	4.8	2.1
TOTAL PESTICIDES	-	14.2	18.5	1.2

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

acre-treatments totaled 6.3 million (53 percent). Metribuzin plus trifluralin acre-treatments totaled 1.1 million (48 percent) of the herbicide mix acre-treatments. Alachlor plus linuron accounted for 225,000 (10 percent) of the herbicide mix acre-treatments and alachlor plus metribuzin acre-treatments totaled 282,000 (12 percent). Dinoseb plus naptalam acre-treatments totaled 169,000 (7 percent).

About 56 percent of the alachlor and 68 percent of the trifluralin acre-treatments were made to control foxtail infestations (Appendix Table 2). Approximately 38 percent of the bentazon acre-treatments were made for cocklebur control and 16 percent were made for velvetleaf control (Appendix Table 3). Metribuzin acre-treatments totaled 36 percent for cocklebur control, 24 percent for foxtail control, and 12 percent for velvetleaf control.

INDIANA

About 4.4 million acres of soybeans were planted in Indiana during 1980, of which 4.3 million were treated with herbicides and 116,000 were treated with insecticides (Table 2). A total of 10.2 million pounds (a.i.) of pesticides were applied to soybeans, which consisted of 6.1 million pounds of single material herbicides, 4 million pounds of herbicide mixes, and 164,000 pounds of insecticides (Table 7). Herbicide application rates averaged 1.1 pounds (a.i.) per acre-treatment for single materials and 2.8 pounds (a.i.) per acre-treatment for mixes. The average application rate for insecticides was 1.4 pounds (a.i.) per acre-treatment.

Pesticide acre-treatments totaled 7.3 million and were comprised of 5.7 million with single material herbicides, 1.4 million with herbicide mixes, and 117,000 with insecticides.

Of the single material herbicide acre-treatments, 1.4 million (24 percent)

Table 7. Usage patterns and quantities of specific pesticides applied to soybeans in Indiana, 1980 a/

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- <u>Thousand</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	1,368	1,407	2,603	1.9
Bentazon	438	438	340	.8
Linuron	706	745	421	.6
Metribuzin	1,090	1,129	494	.4
Trifluralin	973	1,051	1,143	1.1
Other	-	973	1,105	1.1
Total	-	5,743	6,106	1.1
<u>Tank-mix materials</u>				
Alachlor + dinoseb	195	195	427+257	2.2+1.3
+ naptalam			491	+2.5
Alachlor + linuron	414	414	769+209	1.9+ .5
Alachlor + metribuzin	153	153	343+77	2.2+ .5
Dinoseb + naptalam	117	117	71+135	.6+1.2
Metribuzin + trifluralin	156	156	59+123	.4+ .8
Other	-	387	996	2.6
Total	-	1,422	3,957	2.8
Total herbicides	-	7,165	10,063	1.4
INSECTICIDES				
Total <u>d/</u>	-	117	164	1.4
TOTAL PESTICIDES	-	7,282	10,226	1.4

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Specific materials not listed because of a limited number of observations.

were alachlor, 1.1 million (20 percent) were metribuzin, and 1.1 million (18 percent) were trifluralin. Unlike herbicide use in most of the North Central States, alachlor rather than trifluralin was the primary herbicide applied to soybeans in Indiana. Alachlor plus linuron acre-treatments accounted for 414,000 (29 percent) of the herbicide mix acre-treatments and alachlor plus metribuzin acre-treatments totaled 153,000 (11 percent). Also, alachlor plus dinoseb plus naptalam acre-treatments amounted to 195,000 (14 percent) and metribuzin plus trifluralin acre-treatments totaled 156,000 (11 percent).

About 69 percent of the alachlor acre-treatments and 56 percent of the trifluralin acre-treatments were made to control foxtail infestations (Appendix Table 2). Cocklebur control accounted for 36 percent of the bentazon acre-treatments and 24 percent of the metribuzin acre-treatments (Appendix Table 3). Also, metribuzin acre-treatments totaled 21 percent for foxtail, 10 percent for pigweed, and 10 percent for ragweed control.

Insecticide acre-treatments totaled 117,000 (Table 7). Armyworm was the primary target pest for one-half of the insecticide acre-treatments (Table 4).

IOWA

During the 1980 growing season, 8.3 million acres of soybeans were planted in Iowa, of which 8.1 million were treated with herbicides (Table 2). Soybean insecticide use was not reported in Iowa for the 1980 growing season. A total of 14.9 million pounds (a.i.) of herbicides were applied to soybeans, consisting of 8.6 million pounds of single material herbicides and 6.3 million pounds of herbicide mixes (Table 8). Single material herbicide applications averaged 1 pound (a.i.) per acre-treatment and herbicide mix applications averaged 1.9 pounds (a.i.) per acre-treatment.

Herbicide acre-treatments totaled 11.8 million and consisted of 8.4 million with single material herbicides and 3.3 million with herbicide mixes.

Table 8. Usage patterns and quantities of specific pesticides applied to soybeans in Iowa, 1980 a/

Pesticides	: Acres b/	: Acre- c/	:Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- <u>Thousand</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	576	576	1,272	2.2
Bentazon	1,238	1,240	1,196	-1.0
Chloramben	601	601	911	1.5
Glyphosate	800	921	800	.9
Metribuzin	541	541	272	.5
Trifluralin	3,621	3,681	3,040	.8
Other	-	850	1,082	1.3
Total	-	8,410	8,573	1.0
<u>Tank-mix materials</u>				
Alachlor + metribuzin	458	458	1,467+343	3.2+ .7
Metribuzin + trifluralin	2,105	2,105	864+1,697	.4+ .8
Other	-	782	1,940	2.5
Total	-	3,345	6,311	1.9
TOTAL PESTICIDES	-	11,755	14,884	1.3

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

About 3.7 million (44 percent) of the single material herbicide acre-treatments were trifluralin, while bentazon and glyphosate acre-treatments totaled 1.2 million (15 percent) and 921,000 (11 percent), respectively. Nearly two-thirds (2.1 million) of the herbicide mix acre-treatments were made with metribuzin plus trifluralin. Alachlor plus metribuzin acre-treatments totaled 458,000 (14 percent) of the same set of acre-treatments.

All of the alachlor and 95 percent of the trifluralin acre-treatments were made for foxtail control (Appendix Table 2). About 39 percent of the bentazon acre-treatments and 56 percent of the metribuzin acre-treatments were made to control velvetleaf infestations (Appendix Table 3). Also, 45 percent of the bentazon acre-treatments and 22 percent of the metribuzin acre-treatments were applied to control cocklebur infestations.

KANSAS

Farmers planted 1.6 million acres of soybeans in Kansas during the 1980 growing season and treated 1.4 million acres with herbicides and 79,000 acres with insecticides (Table 2). Approximately 2.8 million pounds (a.i.) of pesticides were applied to soybeans, of which 1.9 million were single material herbicides, 827,000 were herbicide mixes, and 73,000 were insecticides (Table 9). Herbicide application rates averaged 1.1 pounds (a.i.) per acre-treatment for single materials and 2.3 pounds (a.i.) per acre-treatment for mixes. Insecticide rates averaged 0.9 pound (a.i.) per acre-treatment.

Of the 2.2 million pesticide acre-treatments, 1.8 million were single material herbicides, 353,000 were herbicide mixes, and 80,000 were insecticides.

One-fourth (430,000) of the single material herbicide acre-treatments were trifluralin. Also, alachlor, linuron, and metribuzin acre-treatments totaled 822,000, or 47 percent of the same amount. Over three-fourths (274,000)

Table 9. Usage patterns and quantities of specific pesticides applied to soybeans in Kansas, 1980 a/

Pesticides	: Acres <u>b/</u> : : treated	Acre- <u>c/</u> : : treatments	:Pounds of active ingredient : Total : Per treatment	
----- <u>Thousand</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	305	305	557	1.8
Linuron	199	199	115	.6
Metribuzin	318	318	154	.5
Pendimethalin	119	119	119	1.0
Trifluralin	430	430	445	1.0
Other	-	380	553	1.5
Total	-	1,751	1,943	1.1
<u>Tank-mix materials</u>				
Alachlor + metribuzin	274	274	535+113	2.0+ .4
Other	40	79	179	2.3
Total	-	353	827	2.3
Total herbicides	-	2,104	2,770	1.3
INSECTICIDES				
Total <u>d/</u>	-	80	73	.9
TOTAL PESTICIDES	-	2,184	2,843	1.3

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Specific materials not listed because of a limited number of observations.

of the herbicide mix acre-treatments were made with alachlor plus metribuzin.

Weed problems in Kansas were different than those in the other North Central States. Crabgrass control accounted for a greater proportion and foxtail control a smaller proportion of the herbicide acre-treatments (Table 3). Approximately three-fourths of the alachlor acre-treatments were made to control cocklebur, crabgrass, and foxtail infestations (Appendix Tables 2 and 3). All of the bentazon acre-treatments were made for cocklebur control. Cocklebur and pigweed control accounted for 46 and 25 percent, respectively, of the metribuzin acre-treatments. Approximately two-thirds of the trifluralin acre-treatments were made to control crabgrass and shattercane infestations, while one-fifth were made for pigweed control.

Insecticide acre-treatments totaled 80,000 and were made to suppress corn earworm infestations (Tables 9 and 4).

MINNESOTA

Approximately 4.8 million acres of soybeans were planted in Minnesota during 1980 (Table 2). Herbicide treated acres totaled 4.6 million, while no insecticide use was reported. Of the 9.6 million pounds (a.i.) of herbicides applied to soybeans, 8.1 million were single materials and 1.5 million were mixes (Table 10). The average application rate was 1.2 pounds (a.i.) per acre-treatment for single material herbicides and 1.7 pounds (a.i.) per acre-treatment for herbicide mixes.

A total of 7.3 million herbicide acre-treatments were made on soybeans, consisting of 6.6 million with single material herbicides and 900,000 with herbicide mixes. Trifluralin acre-treatments amounted to 2.3 million, or 35 percent of those made with single material herbicides, while alachlor and bentazon acre-treatments totaled 1.1 million (17 percent) and 1.2 million (18

Table 10. Usage patterns and quantities of specific pesticides applied to soybeans in Minnesota, 1980 a/

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- <u>Million</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	1.1	1.1	2.9	2.6
Bentazon	1.1	1.2	1.1	1.0
Chloramben	.5	.5	.7	1.3
Metribuzin	.6	.6	.3	.6
Trifluralin	2.2	2.3	2.0	.9
Other	-	.9	1.1	1.2
Total	-	6.6	8.1	1.2
<u>Tank-mix materials</u>				
Alachlor + linuron	.1	.1	.2+ .1	1.5+ .9
Alachlor + metribuzin	.2	.2	.3+ .1	2.0+ .8
Metribuzin + trifluralin	.4	.4	.2+ .3	.6+ .8
Other	-	.2	.3	3.0
Total	-	.9	1.5	1.7
TOTAL PESTICIDES	-	7.3	9.6	1.3

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

percent), respectively. Metribuzin plus trifluralin acre-treatments comprised 354,000 (39 percent) of the herbicide mix acre-treatments. Also, acre-treatments of alachlor plus linuron totaled 100,000 (11 percent) and alachlor plus metribuzin acre-treatments totaled 152,000 (17 percent).

About 82 percent of the alachlor and 74 percent of the trifluralin acre-treatments were made to control foxtail infestations (Appendix Table 2). Bentazon acre-treatments for cocklebur and Canada thistle control totaled 62 and 25 percent, respectively (Appendix Table 3). Cocklebur and velvetleaf control accounted for 36 and 18 percent of the metribuzin acre-treatments, respectively.

MISSOURI

Farmers planted 5.7 million acres of soybeans in Missouri during 1980 and treated 5.3 million with herbicides and 44,000 with insecticides (Table 2). Total pesticides applied to soybeans amounted to 10.1 million pounds (a.i.), comprised of 4.5 million pounds of single material herbicides, 5.4 million pounds of herbicide mixes, and 150,000 pounds of insecticides (Table 11). Single and combined material herbicides were applied at an average rate of 1 and 2.1 pounds (a.i.) per acre-treatment, respectively. Insecticide application rates averaged 1.6 pounds (a.i.) per acre-treatment.

Approximately 7.2 million pesticide acre-treatments were made in 1980. This total included 4.5 million single material herbicide acre-treatments, 2.6 million herbicide mix acre-treatments, and 92,000 insecticide acre-treatments.

Over two-thirds (3.1 million) of the single material herbicide acre-treatments were made with bentazon and trifluralin. Also, alachlor acre-treatments totaled 829,000 (18 percent). Metribuzin plus trifluralin comprised 778,000 (30 percent) of the herbicide mix acre-treatments, while alachlor plus linuron acre-treatments

Table 11. Usage patterns and quantities of specific pesticides applied to soybeans in Missouri, 1980 a/

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- <u>Thousand</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	829	829	1,669	2.0
Bentazon	1,403	1,403	1,024	.7
Trifluralin	1,681	1,681	1,347	.8
Other	-	613	494	.8
Total	-	4,526	4,534	1.0
<u>Tank-mix materials</u>				
Alachlor + linuron	593	593	980+349	1.7+ .6
Alachlor + metribuzin	366	389	731+183	1.9+ .5
Metribuzin + trifluralin	732	778	453+739	.6+1.0
Other	-	864	1,952	2.3
Total	-	2,624	5,387	2.1
Total herbicides	-	7,150	9,921	1.4
INSECTICIDES				
Total <u>d/</u>	-	92	150	1.6
TOTAL PESTICIDES	-	7,242	10,071	1.4

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Specific materials not listed because of a limited number of observations.

totaled 593,000 (23 percent). Two-thirds of the alachlor acre-treatments and 63 percent of the trifluralin acre-treatments were made to control foxtail infestations (Appendix Table 2). About 85 percent of the bentazon acre-treatments and one-third of the metribuzin acre-treatments were made to suppress cocklebur infestations (Appendix Table 3). Also, one-third of the metribuzin acre-treatments were made for velvetleaf control.

Insecticide acre-treatments totaled 92,000 (Table 11). Armyworm was the primary target pest for one-half of the insecticide acre-treatments and grasshopper for the other half (Table 4).

NEBRASKA

During the 1980 growing season, 1.8 million acres of soybeans were planted in Nebraska, of which 1.6 million were treated with herbicides and 93,000 were treated with insecticides (Table 2). About 2.5 million pounds (a.i.) of pesticides were applied to soybeans, consisting of 1.4 million pounds of single material herbicides, 1.1 million pounds of herbicide mixes, and 15,000 pounds of insecticides (Table 12). Application rates for herbicides, applied alone and in mixes, were 1 and 1.7 pounds (a.i.) per acre-treatment, respectively. Insecticides were applied at an average rate of 0.4 pound (a.i.) per acre-treatment.

Farmers made 2.2 million pesticide acre-treatments, comprised of 1.5 million with single material herbicides, 647,000 with herbicide mixes, and 36,000 with insecticides.

One-third (496,000) of the single material herbicide acre-treatments were made with trifluralin, while alachlor and metribuzin acre-treatments totaled 310,000 (21 percent) and 248,000 (17 percent), respectively. Metribuzin plus trifluralin comprised 279,000 (43 percent) of the herbicide mix acre-treatments

Table 12. Usage patterns and quantities of specific pesticides applied to soybeans in Nebraska, 1980 a/

Pesticides	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
	: treated	: treatments	: Total	: Per treatment
----- <u>Thousand</u> -----				
HERBICIDES				
<u>Single materials</u>				
Alachlor	310	310	511	1.6
Bentazon	93	93	93	1.0
Glyphosate	93	124	71	.6
Metribuzin	248	248	133	.5
Trifluralin	496	496	439	.9
Other	-	203	173	.9
Total	-	1,474	1,420	1.0
<u>Tank-mix materials</u>				
Alachlor + metribuzin	186	186	254+110	1.4+ .6
Metribuzin + trifluralin	279	279	102+218	.4+ .8
Other	-	182	394	2.2
Total	-	647	1,078	1.7
Total herbicides	-	2,121	2,498	1.2
INSECTICIDES				
Total <u>d/</u>	-	36	15	.4
TOTAL PESTICIDES	-	2,157	2,513	1.2

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

d/ Specific materials not listed because of a limited number of observations.

and alachlor plus metribuzin acre-treatments totaled 186,000 (29 percent).

Shattercane and velvetleaf control accounted for a larger proportion and cocklebur control a smaller proportion of the herbicide acre-treatments in Nebraska than in most of the other North Central States (Table 3). About 70 percent of the alachlor acre-treatments and one-half of the trifluralin acre-treatments were made to control foxtail infestations (Appendix Table 2). Also, one-fourth of the trifluralin acre-treatments were made to control cocklebur and pigweed infestations (Appendix Table 3). Velvetleaf control accounted for two-thirds of the bentazon acre-treatments. One-half of the metribuzin acre-treatments were made for foxtail and shattercane control, while the other half was made to control broadleaf signalgrass, cocklebur, smartweed, and velvetleaf infestations.

Insecticide acre-treatments totaled 36,000 (Table 12). Bean leaf beetle was the primary target pest for 86 percent of the insecticide acre-treatments and grasshopper for 14 percent (Table 4).

OHIO

Ohio farmers planted 3.8 million acres of soybeans in 1980 and treated 3.6 million with herbicides and 350,000 with insecticides (Table 2). Approximately 9.2 million pounds (a.i.) of pesticides were applied to soybeans, of which 6.2 million were single material herbicides, 2.7 million were herbicide mixes, and 320,000 were insecticides (Table 13). Application rates for herbicides, applied alone and in mixes, averaged 1.4 and 2.3 pounds (a.i.) per acre-treatment, respectively. Insecticide rates averaged 0.9 pound (a.i.) per acre-treatment.

Pesticide acre-treatments totaled 6 million and were comprised of 4.4 million with single material herbicides, 1.1 million with herbicide mixes, and 376,000 with insecticides.

Table 13. Usage patterns and quantities of specific pesticides applied to soybeans in Ohio, 1980 a/

	: Acres <u>b/</u>	: Acre- <u>c/</u>	: Pounds of active ingredient	
Pesticides	: treated	: treatments	: Total	: Per treatment
		<u>Thousand</u>		
HERBICIDES				
<u>Single materials</u>				
Alachlor	1,323	1,323	2,825	2.1
Bentazon	416	436	495	1.1
Chloramben	414	414	680	1.6
Linuron	804	804	592	.7
Metolachlor	411	411	978	2.4
Metribuzin	557	557	314	.6
Trifluralin	141	181	171	.9
Other	-	323	192	.6
Total	-	4,449	6,247	1.4
<u>Tank-mix materials</u>				
Alachlor + linuron	277	277	619+249	2.2+ .9
Alachlor + metribuzin	275	275	494+140	1.8+ .5
Metolachlor + metribuzin	119	119	233+50	2.0+ .4
Metribuzin + trifluralin	238	238	110+271	.5+1.1
Other	-	237	492	2.1
Total	-	1,146	2,658	2.3
Total herbicides	-	5,595	8,905	1.6
INSECTICIDES				
Carbaryl	277	277	261	.9
Other	-	99	59	.6
Total	-	376	320	.9
TOTAL PESTICIDES	-	5,971	9,225	1.5

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Data in this column for "other" and "total" were not reported because two or more materials may have been used on the same acre resulting in multiple counting.

c/ Most farmers applied herbicides and insecticides one time during the growing season. The average number of applications per season for each material can be determined by dividing acre-treatments (column 2) by acres treated (column 1).

As in Indiana, alachlor was the primary soybean herbicide used in Ohio during 1980. It accounted for 1.3 million (30 percent) of the single material herbicide acre-treatments. Linuron acre-treatments totaled 804,000 (18 percent). Bentazon, chloramben, metolachlor, and metribuzin acre-treatments accounted for 1.8 million, or 41 percent of these acre-treatments. Alachlor plus linuron constituted 277,000 (24 percent) of the herbicide mix acre-treatments and alachlor plus metribuzin acre-treatments totaled 275,000 (24 percent). Metribuzin plus trifluralin acre-treatments totaled 238,000 (21 percent).

Herbicide use patterns in Ohio were similar to those in the region, except that a higher proportion of herbicide acre-treatments were made to control ragweed infestations in Ohio than in the other States (Table 3). Foxtail control accounted for 63 percent of the alachlor acre-treatments, 18 percent of both the bentazon and metribuzin acre-treatments, and 44 percent of the trifluralin acre-treatments (Appendix Table 2). Also, 44 percent of the trifluralin acre-treatments were made to control broadleaf signalgrass and smartweed infestations (Appendix Tables 2 and 3). About 42 percent of the bentazon acre-treatments were made to control cocklebur infestations and 27 percent were made for ragweed control. Metribuzin acre-treatments totaled 43 and 21 percent, respectively, to control the same pests.

Carbaryl comprised 277,000 (74 percent) of the insecticide acre-treatments (Table 13). Mexican bean beetle control accounted for 86 percent of the carbaryl acre-treatments, while bean leaf beetle control accounted for the remaining 14 percent (Appendix Table 4).

REFERENCES

1. Delvo, Herman W., "1972 Soybean Objective Yield Survey", USDA, ERS, Farm Production Economics Division, 1972, (unpublished).
2. U.S. Department of Agriculture, "Agricultural Statistics, 1974".
3. USDA, ESS, Crop Reporting Board, "Crop Production-1980 Annual Summary", CrPr 2-1(81), January 14, 1981.
4. USDA, ESS, Crop Reporting Board, "Field Crops-Production, Disposition, Value 1979-80", CrPr 1(81), April 1981.

Appendix Table 1. Coefficients of variation for acres of soybeans treated with specific pesticides in the North Central States, 1980 a/ b/

	:Illi- :nois	:Indi- :ana	: :Iowa	: :Kansas	:Minne- :sota	:Mis- :souri	: Ne- :braska	: :Ohio	: :Region
	-----Percent-----								
HERBICIDES									
<u>Single materials</u>									
Alachlor	15	14	31	32	19	22	29	14	7
Bentazon	19	28	20	72	18	16	57	29	8
Chloramben	20	49	31	<u>c/</u>	30	70	70	29	12
Glyphosate	50	49	26	-	57	48	57	<u>c/</u>	17
Linuron	28	22	<u>c/</u>	42	44	-	-	20	12
Metribuzin	16	16	32	31	29	55	33	24	9
Trifluralin	10	17	10	26	11	14	22	50	5
<u>Tank-mix materials</u>									
Alachlor									
+ chloramben	-	-	57	-	<u>c/</u>	<u>c/</u>	-	<u>c/</u>	36
Alachlor									
+ linuron	50	29	70	<u>c/</u>	70	26	-	37	16
Alachlor									
+ metribuzin	44	49	35	35	57	34	39	37	14
Dinoseb									
+ naptalam	57	57	<u>c/</u>	-	<u>c/</u>	<u>c/</u>	-	-	34
Metribuzin									
+ trifluralin	22	49	15	-	37	23	31	40	9
INSECTICIDES									
Carbaryl	-	<u>c/</u>	-	-	-	<u>c/</u>	-	37	33

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ A coefficient of variation is the standard error of the estimate divided by acres treated times 100. A coefficient of variation describes the relative variation of the estimate. The lower the value of the coefficient, the more reliable the estimate.

c/ Use of this material at the State level was not significant and was reported in the "other" or "total" category.

Appendix Table 2. Percentage of soybean herbicide acre-treatments by primary grasses controlled as reported by farmers in the North Central States, 1980 a/

Herbicides, grasses	:Illi- :nois	:Indi- :ana	: :Iowa	: :Kansas	:Minne- :sota	:Mis- :souri	:Ne- :braska	: :Ohio	: :Region
-----Percent-----									
<u>Alachlor</u>									
Broadleaf									
signalgrass	-	3	-	-	-	6	-	-	1
Crabgrass	-	3	-	26	-	6	10	3	3
Foxtail	56	69	100	26	82	67	70	63	67
Johnsongrass	8	-	-	-	-	-	-	12	4
Quackgrass	3	-	-	-	-	-	-	3	1
Other	5	6	-	13	-	4	10	10	6
<u>Bentazon</u>									
Barnyardgrass	4	-	-	-	-	-	-	-	1
Foxtail	4	-	5	-	-	-	-	18	3
Johnsongrass	9	-	-	-	-	-	-	-	2
Other	4	-	1	-	-	-	-	-	1
<u>Metribuzin</u>									
Barnyardgrass	-	-	-	-	9	-	-	-	1
Broadleaf									
signalgrass	-	3	-	-	-	-	12	-	1
Foxtail	24	21	-	-	-	-	25	18	16
Quackgrass	-	-	-	-	10	-	-	-	1
Shattercane	-	-	-	-	-	-	25	-	1
Other	3	8	-	12	9	-	-	-	4
<u>Trifluralin</u>									
Broadleaf									
signalgrass	2	-	-	-	2	-	6	22	1
Crabgrass	-	-	-	36	-	5	-	-	2
Foxtail	68	56	95	-	74	63	50	44	71
Johnsongrass	5	11	-	-	-	-	-	-	2
Shattercane	-	4	-	28	-	7	13	-	3
Other	2	-	1	-	18	9	-	-	5

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Appendix Table 3. Percentage of herbicide acre-treatments by primary broadleaf weeds controlled as reported by farmers in the North Central States, 1980 ^{a/}

Herbicides, broadleaf weeds	:Illi- :nois	:Indi- :ana	: :Iowa	: :Kansas	:Minne- :sota	:Mis- :souri	:Ne- :braska	: :Ohio	: :Region
	----- Percent -----								
<u>Alachlor</u>									
Cocklebur	14	8	-	22	5	-	-	3	7
Morningglory	-	-	-	13	-	11	-	-	2
Pigweed	3	-	-	-	5	6	-	-	2
Ragweed	3	-	-	-	-	-	-	3	1
Smartweed	3	3	-	-	-	-	10	-	2
Velvetleaf	-	-	-	-	5	-	-	3	1
Other	5	8	-	-	3	-	-	-	3
<u>Bentazon</u>									
Canada thistle	-	9	-	-	25	-	-	13	6
Cocklebur	38	36	45	100	62	85	-	42	55
Morningglory	13	-	-	-	-	-	-	-	3
Pigweed	-	-	-	-	-	3	-	-	1
Ragweed	-	-	-	-	-	-	-	27	2
Smartweed	3	2	10	-	-	-	-	-	3
Velvetleaf	16	9	39	-	9	10	67	-	17
Other	9	44	-	-	4	2	33	-	6
<u>Metribuzin</u>									
Canada thistle	3	-	-	-	-	-	-	-	1
Cocklebur	36	24	22	46	36	32	13	43	32
Morningglory	-	-	-	13	-	-	-	-	1
Pigweed	6	10	11	25	-	-	-	-	7
Ragweed	6	10	-	-	9	-	-	21	7
Smartweed	6	-	-	-	-	4	12	11	4
Velvetleaf	12	3	56	4	18	32	13	7	15
Other	4	21	11	-	9	32	-	-	9
<u>Trifluralin</u>									
Cocklebur	12	7	2	9	-	8	12	-	6
Pigweed	3	-	2	19	4	5	13	-	4
Smartweed	-	4	-	-	-	-	-	22	1
Velvetleaf	6	4	-	-	2	3	6	12	3
Other	2	14	-	8	-	-	-	-	2

- None reported.

^{a/} "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

Appendix Table 4. Percentage of soybean insecticide acre-treatments by primary insects controlled as reported by farmers in the North Central States, 1980 a/ b/

Insecticides, insects	:	Indiana	:	Missouri	:	Ohio	:	Region
----- Percent -----								
<u>Carbaryl</u>								
Armyworm	-		100		-			13
Bean leaf beetle	-		-		14			11
Mexican bean beetle	-		-		86			66
Other	100		-		-			10

- None reported.

a/ "1980 Soybean Pesticide Use Survey", USDA, ESS, Natural Resource Economics Division.

b/ Soybean insecticide use was not reported in Illinois, Iowa, and Minnesota during 1980. Some insecticide use was reported in Kansas and Nebraska, although it did not include carbaryl.

