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Pesticide Usage Survey of Agricultural, Governmental, and Industrial Sectors in the United States, 1974

PESTICIDE USAGE SURVEY OF AGRICULTURAL, GOVERNMENTAL, AND INDUSTRIAL SECTORS IN THE UNITED STATES, 1974

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INTRODUCTION AND BACKGROUND

Parties with vested interests in the production, sales, use, and regulation of pesticides have long sought pesticide use information for competitive and enforcement reasons.

Immediately apparent are four other reasons for the need for an inventory of the pesticides which are disbursed to our environment. (1) The most cogent of these is to modify the stereotyped image of pesticides, per se, as being an evil biocide--pesticides, which are an important factor in food and fibre production, are a conglomerate of chemical classes and varying acute and chronic toxicities. It would not be unreasonable to assume that certain of these chemicals are more harmful to the ecosystem than others. (2) From an economic viewpoint, an inventory of use would assist in the evaluation of the impact of continuance or discontinuance of certain pesticides and would provide baselines so that secular trends of use be identified. (3) From an epidemiologic viewpoint, specific use data may serve as the denominator for the incidence of acute poisoning and other diseases. (4) Additionally, determination of usage patterns may assist in the identification of potential areas of concern (for example, in cotton where experienced workers are employed or in vegetable crops where migrant workers are engaged).

The reader is encouraged to accept the data as a beginning in the acquisition of more precise national information. The basis of the agricultural pesticide estimation process reported herein was that the leading pesticides on the seven leading crops in each state were

identified and quantified by established guidelines which called for the most knowledgeable persons available to estimate their use, thus, the knowledgeable concept method used in the agricultural section of this survey.

The most recent and extensive survey of pesticide usage is found in the Midwest Research Institute's "Production, Distribution, Use, and Environmental Impact of Selected Pesticides," published in 1974.[1] This summary, which reports usage for 1972, presents data in the four elements of usage (agriculture, government, industry, and home and garden) and focuses upon 25 leading compounds. The Economic Research Services of the United States Department of Agriculture periodocally surveys pesticide usage; the latest report published in 1974, Farmers' Use of Pesticides in 1971.[2] This survey presents the agricultural element of usage and derives estimates through expansion of use patterns found in a sample survey of farmers. The Agricultural Stabilization and Conservation Service, also part of the USDA, has published on an annual basis since 1953 The Pesticide Review. This publication makes available data concerning the trends, production, and trade of pesticides but provides scant information on specific compounds. The latest publication in this series is The Pesticide Review 1974, published in September 1975, and provides sales and trade data for 1973 and some data for 1974.[3] There have also been a limited number of statewide surveys by local agricultural extension personnel; Kansas, 1974[4] and Arizona, 1974.[5] Pennsylvania surveyed its agricultural pesticide usage for 1973,[6] but as with Kansas and Arizona, these were special studies and not performed on an annual basis. The Epidemiologic Studies Program of the Environmental Protection Agency (EPA) have published information on a limited number of compounds since 1967,[7]

but these data are representative of small geographic areas. The state of California has made the greatest contribution of pesticide usage monitoring since the institution of a mandatory usage reporting system in 1970. Annual reports are published by the first quarter of the following year. The Pesticide Use Report by Commodity 1974[8] and the Pesticide Use Report 1974,[9] prepared by the California Department of Food and Agriculture, provides complete usage information for agriculture, government, and industry. Although some usage data on the state level are available as indicated, local or urban pesticide usage data are more elusive. This point was reported by the Consad Research Corporation in their report to the Environmental Protection Agency, "A Study of the National Scope of Urban Pesticide Runoff," published November 1974. The authors stated that after ". . . a comprehensive literature search, including computerized data bases . . . ; and a survey of state agricultural extension services, little hard data on urban pesticide usage were obtained."[10]

The preceding paragraphs have presented current published research efforts toward pesticide usage estimates. Private market research agencies, in recent years and today, carry out usage surveys for pesticide manufacturers; but since their reporting is on a confidential basis, the data are unavailable to concerned government agencies and the public. Reports of this type may contain valuable and timely information since the reports are frequent and usually generated within a year of pesticide application. The need for definitive and timely pesticide usage reports is quite clear and was recently expressed by the Executive Committee of the National Academy of Sciences in Volume I of their Contemporary Pest Control Practices and Prospects, 1975.[11] This publication recommended the collaboration of the USDA and EPA in a joint effort to improve methodologies

and frequency of pesticide usage surveys and that these surveys should include non-agricultural use.

METHODS AND PROCEDURES

A distinct survey method was used for each component of pesticide usage, i.e., agriculture, industry, and government. The agricultural survey protocol called for pesticide usage estimates to be made by each state's Pesticide Coordinator, who was thought to be the most knowledgeable contact for his respective state. When contacted, the coordinator was asked to estimate usage on his state's seven leading crops taking into consideration number of applications per chemical per crop, acreage treated, and application rate. Forty-four state Pesticide Coordinators or Chemical Specialists cooperated with the survey. Additionally, agricultural usage estimates for three states were derived from state regulatory agency data. In two states, estimates were made by survey personnel and in one state, estimates were made by a consulting firm.

Industrial pesticide usage was considered by public utilities and pest control operations. Public utilities, which included railroads, electric, gas, telephone, and water companies, were surveyed in all states and in each instance, response rates exceeded 85%. The survey of pest control firms required individualized techniques and a variety of approaches because of the diversity of operations. National, regional, and local pest control concerns, as well as national distributors of pest control chemicals, were contacted. Estimates from these sources reflect a consolidation of all source data and were carefully audited to eliminate double reporting.

The survey of governmental usage included state divisions of public health, transportation, park and forest operations and all federal agencies. Of all state agencies contacted, only two failed to respond. Thirty-four state health departments, 47 state highway departments, and 46 park and forest agencies reported pesticide usage for 1974. Federal respondents included military installations; the Department of Agriculture's Soil Conservation, Animal and Plant Health Inspection, and National Forest Services; Corps of Engineers; the Postal Service; and the Department of the Interior.

Quality Control

Twenty-nine pesticides were chosen for validation; ten by random selection and the remainder because of their current toxicological importance and widespread use. Manufacturers cooperated by supplying, in confidence, their own estimates of use for 23 of them. The mean ratio of survey estimates to manufacturer estimates was .83, with 95% confidence limits of .69 - .98.

Agriculture

Quality control of agricultural data encompassed four procedures: (1) checking estimator's acreage base for all crops against reported acreage of USDA's Statistical Reporting Service, (2) having crop specialists review the consistency of reported use with current practices in six randomly selected states and 22 crops, (3) mechanical verification of submitted data with computer output, and (4) auditing the reliability of data from six randomly pre-survey selected states and four chemicals

per state. These quality control procedures suggested minimum variances:

(1) Of 196 acreage comparisons, 1% were in error and required a change in estimates.

(2) Of 20 crops reviewed, one required a change in estimate.

(3) The mechanical audit found no coding, keypunching, or retrieval errors.

(4) The reliability (reproducibility) of the estimation process was 83%. There were two variances - one of a 5.4% and one of an 8.6% magnitude. One of these variances was attributable to improper labeling and would extrapolate to an overall estimate error of about 1%.

Industry - PCO

A preliminary validation of PCO data was made using extrapolations of usage and market data from a national pest control firm. These findings are presented in the "Discussion" section.

Industrial Utility and Government

Upon completion of survey activities, each surveyor was contacted for an audit to verify that all appropriate utilities and government agencies were surveyed.

Additionally, a stratified random sample of five states was selected along with two government and four utility respondents' reports (randomly selected) from each state. The procedure was to contact at least one respondent from government and two from industry from each state to obtain verification of their originally submitted data. Those respondents who could locate the data in their files responded identically

to their submitted estimates. However, of seventeen agencies contacted, five responded.

RESULTS

Nine hundred and three million pounds of all type pesticides were reported used by the survey methods employed in this study of pesticide usage in the United States in 1974. Almost 94% of the total was in agriculture with about 3½% in government and 2½% in industry (Figure 1). The greatest use of pesticides occurred in the EPA Regions IV and VI, which encompass the Southeast and mid-south states. Low use areas were in the Northeast EPA Regions I and II. These nationwide use figures by EPA region and sector are shown in Table 1.

Tables 2-11 present similar data for each EPA region and individual state and shows that the greatest usage of all type pesticides occurred in California, 90 million pounds; Texas, 89; Iowa, 59; Illinois, 49; Florida, 47; Mississippi, 42; and Arkansas, 41. Those states having the lowest amounts in all sectors were Alaska, New Hampshire, Rhode Island, Vermont, Nevada, and Utah; each area having reported less than one million pounds. Agricultural applications generally were responsible for the high or low rankings. Governmental use was greatest in Florida and Texas and lowest in Alaska and New Hampshire. The greatest industrial uses of pesticides were in the Southeastern states and lowest in the mid and west northern tier of states. Figure 2 displays proportional usage in agriculture, government, and industry for each region. As may be seen from the tabular data, the proportion attrituable to industry may be

Figure 1

USA 1974 PESTICIDE USAGE IN AGRICULTURE, GOVERNMENT, AND INDUSTRIAL SECTORS

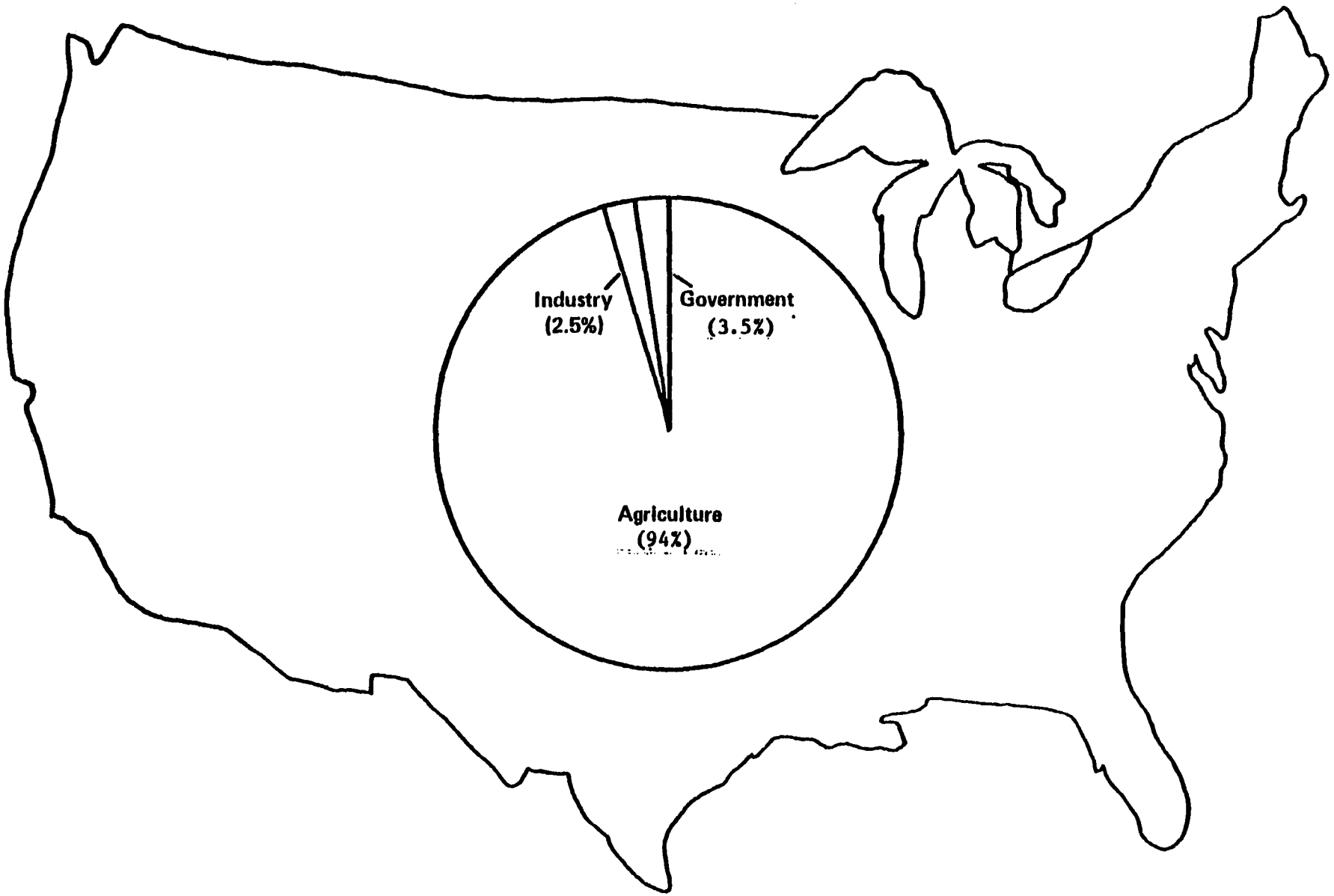


Table 1

ESTIMATED PESTICIDE USAGE[1] FOR U.S.A. AND EPA REGIONS BY TYPE OF USE, 1974

EPA REGION	Agriculture	Government	Industry[2]	Total
I	6.1	.7	1.1	7.9
II	12.7	1.8	1.6	16.1
III	19.5	1.4	2.8	23.7
IV	213.8	14.1	9.4	237.3
V	140.1	2.1	2.1	144.3
VI	159.1	5.8	1.7	166.6
VII	127.5	.8	1.2	129.5
VIII	37.9	.9	.7	39.5
IX	104.5	2.5	2.2	109.2
X	26.0	2.7	.4	29.1
U.S. Total	847.2	32.8	23.2	903.2

[1] in million pounds of active ingredient

[2] Totals reported

Table 2.

ESTIMATED PESTICIDE USAGE[1] FOR REGION I AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry[2]	Total
REGION I				
Connecticut	1,111	13	315	1,439
Maine	2,669	491	47	3,207
Massachusetts	1,455	80	568	2,103
New Hampshire	167	8	30	205
Rhode Island	328	82	71	481
Vermont	331	14	40	385
TOTAL	6,061	688	1,071	7,820

[1] in thousand pounds active ingredient

[2] Reported

Table 3

ESTIMATED PESTICIDE USAGE[1] FOR REGION II AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry[2]	Total
REGION II				
New Jersey	2,435	870	678	3,983
New York	10,288	940	896	12,124
TOTAL	12,723	1,810	1,574	16,107

[1] in thousand pounds active ingredient

[2] Reported

Table 4

ESTIMATED PESTICIDE USAGE[1] FOR REGION III AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry	Total
REGION III				
Delaware	1,158	77	108	1,343
Maryland	3,022	352	871	4,245
Pennsylvania	7,589	302	866	8,757
Virginia	6,800	668	741	8,209
West Virginia	899	26	247	1,172
TOTAL	19,468	1,425	2,833	23,726

[1] in thousand pounds active ingredient

Table 5

ESTIMATED PESTICIDE USAGE[1] FOR REGION IV AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry	Total
REGION IV				
Alabama	18,742	179	885	19,806
Florida	34,216	11,236	2,018	47,470
Georgia	31,427	110	1,634	33,171
Kentucky	9,002	239	642	9,883
Mississippi	40,650	477	494	41,621
North Carolina	35,097	632	1,421	37,150
South Carolina	27,944	673	1,618	30,235
Tennessee	16,708	540	666	17,914
TOTAL	213,786	14,086	9,378	237,250

[1] in thousand pounds active ingredient

Table 6

ESTIMATED PESTICIDE USAGE[1] FOR REGION V AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry	Total
REGION V				
Illinois	48,537	241	617	49,395
Indiana	24,315	446	547	25,308
Michigan	16,581	698	462	17,741
Minnesota	25,750	314	46	26,110
Ohio	13,936	261	348	14,545
Wisconsin	10,991	149	112	11,252
TOTAL	140,110	2,109	2,132	144,351

[1] in thousand pounds active ingredient

Table 7

ESTIMATED PESTICIDE USAGE[1] FOR REGION VI AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry	Total
REGION VI				
Arkansas	39,687	1,045	349	41,081
Louisiana	25,250	336	365	25,951
New Mexico	2,429	375	45	2,849
Oklahoma	7,260	125	293	7,678
Texas	84,488	3,896	650	89,034
TOTAL	159,114	5,777	1,702	166,593

[1] in thousand pounds active ingredient

Table 8

ESTIMATED PESTICIDE USAGE[1] FOR REGION VII AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry	Total
REGION VII				
Iowa	58,393	211	120	58,724
Kansas	21,569	204	217	21,990
Missouri	19,161	155	693	20,009
Nebraska	28,355	222	151	28,728
TOTAL	127,478	792	1,181	129,451

[1] in thousand pounds active ingredient

Table 9

ESTIMATED PESTICIDE USAGE[1] FOR REGION VIII AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry	Total
REGION VII				
Colorado	12,171	280	116	12,567
Montana	2,566	53	9	2,628
North Dakota	7,986	83	107	8,176
South Dakota	9,144	105	139	9,388
Utah	564	280	51	895
Wyoming	5,429	133	252	5,814
TOTAL	37,860	934	674	39,468

[1] in thousand pounds active ingredient

Table 10

ESTIMATED PESTICIDE USAGE[1] FOR REGION IX AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry	Total
REGION IX				
Arizona	11,194	236	222	11,652
California	86,031	1,914	1,626	89,571
Hawaii	6,747	346	339	7,432
Nevada	498	36	53	587
TOTAL	104,470	2,532	2,240	109,242

[1] in thousand pounds active ingredient

Table 11

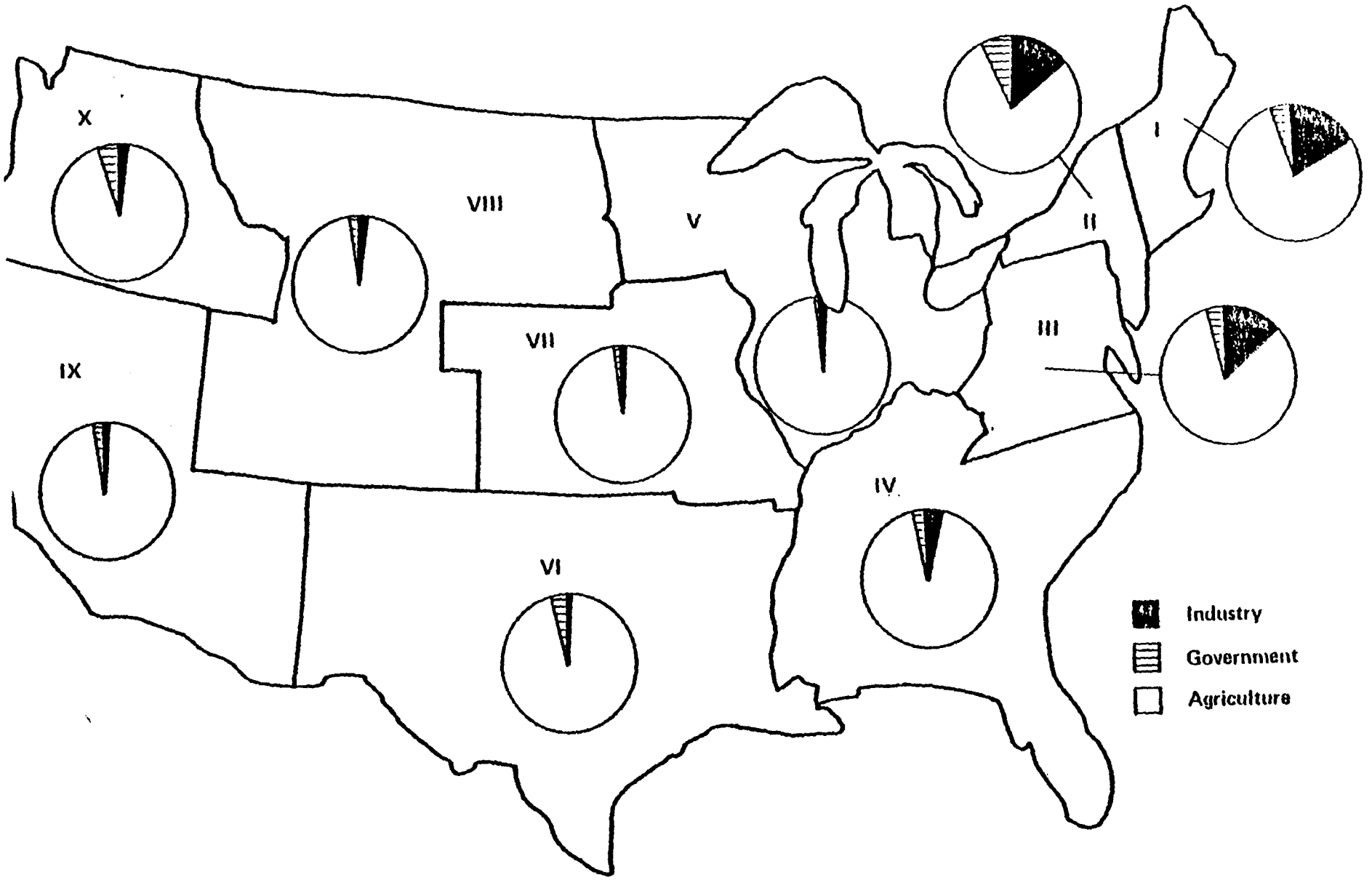
ESTIMATED PESTICIDE USAGE[1] FOR REGION X AND STATES BY TYPE OF USE, 1974

	Agriculture	Government	Industry	Total
REGION X				
Alaska	11	12	60	83
Idaho	7,758	609	7	8,374
Oregon	7,167	735	74	7,976
Washington	11,072	1,305	294	12,671
TOTAL	26,008	2,661	435	29,104

[1] in thousand pounds active ingredient

Figure 2

PESTICIDE USAGE IN U.S.A. BY EPA REGION, 1974



increased because agricultural or governmental usage was low or because industrial figures were actually higher than in other areas.

As shown in Figure 3 and Table 12, chlorinated hydrocarbons accounted for nearly one-fourth (24%) of the use of all classes of pesticides, followed by carbamates and amides (18%), and organophosphates (16%). Arsenic-type materials only made up about 2% of national usage reported in this survey while 40% was attributable to other metals and miscellaneous classes of chemicals.

Fifty-one percent of all chlorinated hydrocarbons were used in Regions IV and VI, as well as two-thirds of all organophosphate pesticides and over 90% of arsenic-bearing products. Thus, these Southeastern and mid-south regions can be characterized as having used 45%, nearly half, of all pesticides used in the U. S.; one-fourth of all carbamates and amides; one-half of the chlorinated hydrocarbons; two-thirds of the organophosphates; and nearly all of the arsenicals.

Estimated usage by type of pesticides and by EPA region is exhibited in Figure 4 and shows that herbicides dominated with 45% of usage, followed by insecticides, 30%; fungicides, 11%; and nematocides and other products having 14% of the market. Table 13 presents these data by region. The mid-western states in EPA Regions V and VII used 211 million pounds or 52% of all herbicides. The southern states, comprising Regions IV and VI, however, used 180 million pounds (66%) of insecticides.

Crop utilization of pesticides, shown in Table 14, indicates that corn, cotton, fruit, soybeans, and vegetable crops used 81% (683 million pounds) of all agricultural pesticides reported by this survey. Three of these crops, corn, cotton, and soybeans, accounted for 506 million

Figure 3

ESTIMATED PESTICIDE USAGE IN U.S.A. BY CLASS OF COMPOUND, 1974

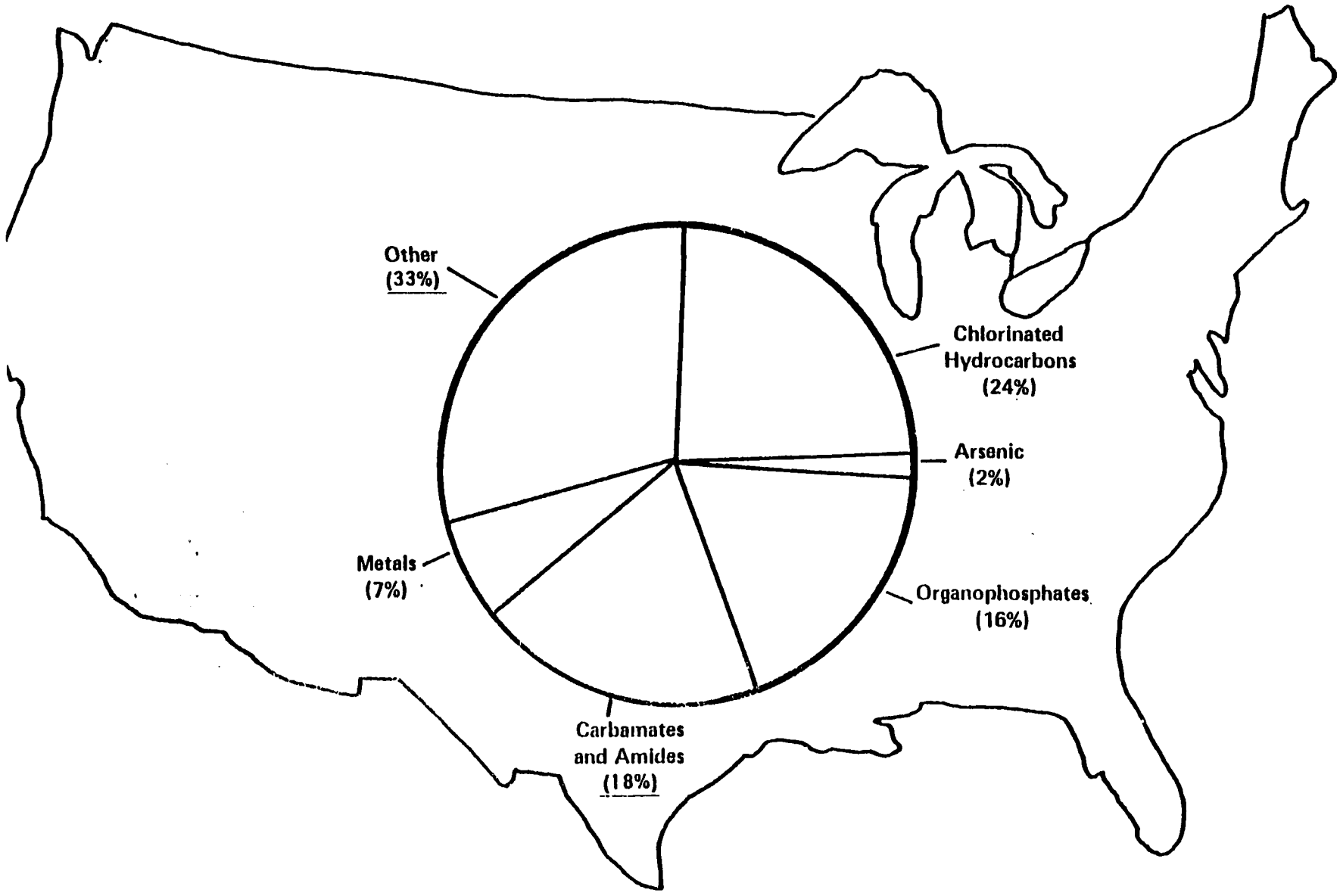


Table 12

ESTIMATED PESTICIDE USAGE* FOR U.S.A. AND EPA REGIONS BY CLASS OF COMPOUND, 1974

EPA Region	Chlorinated Hydrocarbons	Carbamates and Amides	Organo-Phosphates	Arsenic	Other Metals	Other	Total
I	1.4	2.5	.9	-	.1	3.0	7.9
II	2.9	4.4	3.8	0	.4	4.6	16.1
III	5.2	6.7	3.3	-	.2	8.3	23.7
IV	57.4	34.9	38.6	9.7	13.4	83.3	237.3
V	39.3	49.3	6.5	.1	1.8	47.3	144.3
VI	52.6	10.4	58.1	6.3	3.1	36.1	166.6
VII	25.6	44.9	12.6	.2	.1	46.1	129.5
VIII	11.9	5.7	4.9	-	.5	16.5	39.5
IX	9.6	3.9	10.2	.7	44.7	40.1	109.2
X	9.0	3.1	6.1	-	.8	10.1	29.1
U.S. TOTAL	214.9	165.8	145.0	17.0	65.1	295.4	903.2

*in million pounds active ingredient; 0 = none reported; - = estimate less than .1 million pounds

Figure 4

ESTIMATED PESTICIDE USAGE IN U.S.A. BY TYPE OF COMPOUND, 1974

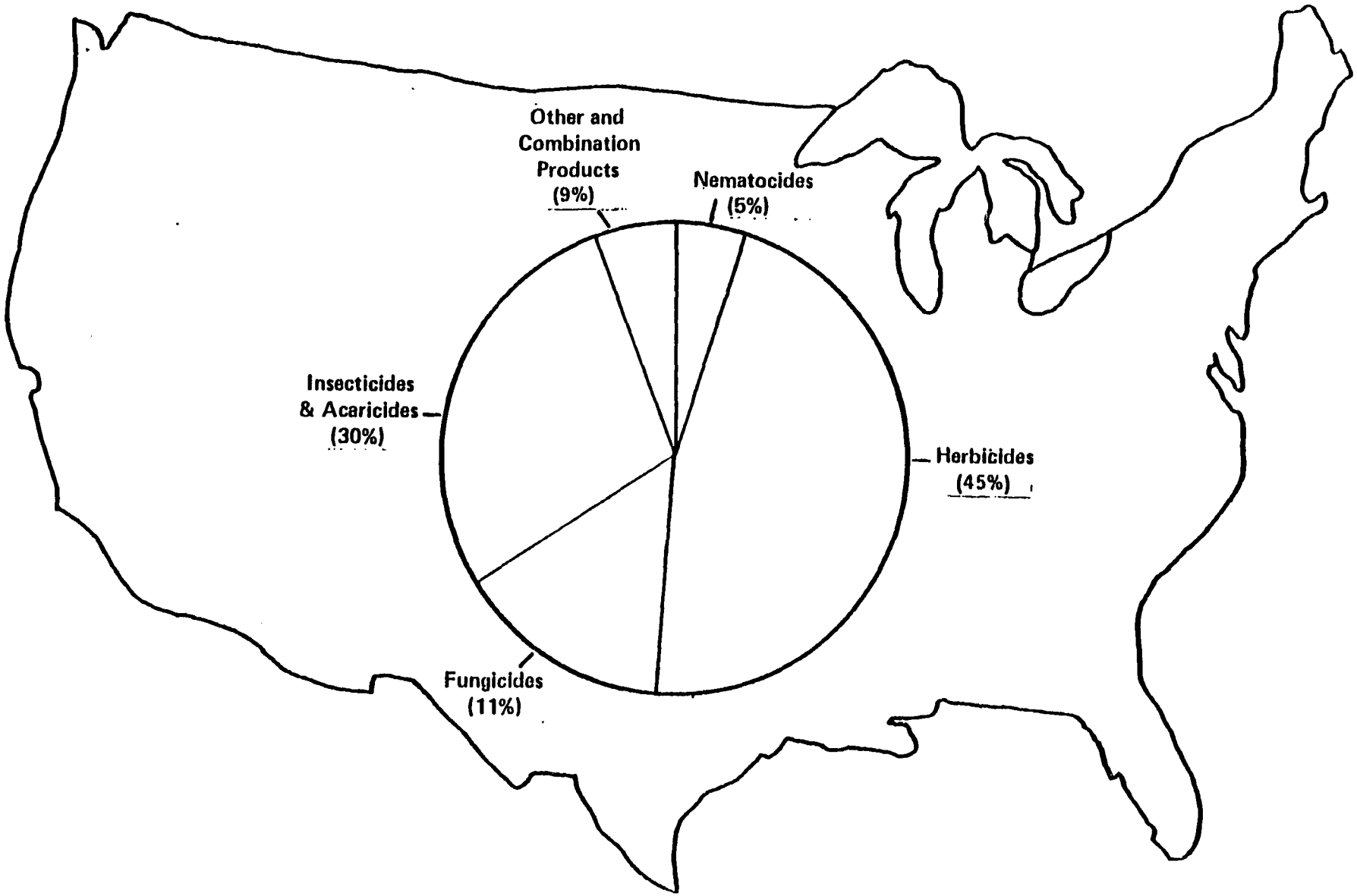


Table 13

ESTIMATED PESTICIDE USAGE[1] IN U.S.A. BY EPA REGION AND TYPE OF COMPOUND, 1974

EPA Region	Nematocides	Herbicides	Fungicides	Insecticides and Acaricides	Other and Combination Products	Total
I	19	1,823	1,941	2,143	1,894	7,820
II	763	3,651	3,765	6,495	1,433	16,107
III	257	11,952	3,233	5,457	2,827	23,726
IV	22,168	75,504	24,369	86,907	28,302	237,250
V	27	114,618	6,602	18,851	4,253	144,351
VI	211	62,277	5,981	93,023	5,101	166,593
VII	3,672	96,539	755	22,940	5,545	129,451
VIII	9,697	18,032	2,592	8,325	822	39,468
IX	7,287	14,206	45,490	18,071	24,188	109,242
X	4,022	9,206	4,178	8,268	3,430	29,104
U.S. TOTAL	48,123	407,808	98,906	270,480	77,795	903,112

[1] In thousand pounds active ingredient

Table 14

ESTIMATED PESTICIDE USAGE[1] FOR U.S.A. BY MAJOR CROP AND CLASS OF COMPOUND, 1974

Crop	Chlorinated Hydrocarbons	Carbamates and Amides	Organo-Phosphates	Arsenic	Other Metals	Other	Total
Field Crops							
Corn	38,909	76,346	13,010	0	7	79,140	207,412
Cotton	68,275	7,319	79,475	15,401	3,198	30,308	203,976
Hay and Small Grain	19,984	2,784	3,273	0	253	4,020	30,314
Sorghum	6,465	1,326	5,640	0	-	17,509	30,940
Soybeans	15,224	37,228	2,989	0	119	39,034	94,594
Sugar Beets	585	2,478	558	0	2,930	14,546	21,097
Tobacco	531	6,215	4,025	0	-	20,763	31,534
Misc. Field Crops (alfalfa, flax, rice, sunflower, sugar cane)	16,338	3,393	5,267	22	287	7,059	32,366
Fruit and Nut	13,112	11,213	12,499	96	53,434	36,712	127,066
Livestock and Mink	2,660	14	4,075	0	0	66	6,815
Ornamental and Misc.	6,111	1,299	1,328	263	77	2,212	11,290
Vegetables	8,078	14,341	7,049	0	2,820	17,379	49,667
TOTAL	196,272	163,956	139,188	15,782	63,125	268,748	847,071

[1] in thousand pounds active ingredient; 0 = none reported; - = estimate less than .1 thousand pounds

pounds or 60% of all agricultural pesticides in 1974. Viewed by class of chemical, these three crops used 62% of the chlorinated hydrocarbons, 74% of the carbamates, 68% of the organophosphates, 97% of the arsenicals, and 45% of the other pesticide classes.

Table 15 allows an examination of these crops by type of pesticide. Sugar beets, tobacco, vegetables, and fruit and nut crops required the greatest amount (87%) of all nematocides reported in the study, while 74% (288 million pounds) of all herbicides were applied to corn, cotton, and soybeans. Fruits, nuts, and vegetables required 83% of all fungicides, while using only 8% of the insecticides reported. The major insecticide-using crops in 1974 were corn (34 million pounds) and cotton (145 million pounds), accounting for 70% of the total agricultural estimate.

A breakdown by class of compound of governmental estimates (Table 16) shows that chlorinated hydrocarbons comprised the bulk of usage by both federal and state or local governmental agencies. Organophosphate usage ranked second. Similar data for type of pesticide are given in Table 17 and indicate that herbicides and insecticides were the most frequently used of all pesticides. Overall, these tables show pesticide use by state or local governments to be several times that of federal agency use.

The use estimates in Table 18 show that in the industrial sector, PCOs used more chlorinated hydrocarbons than any other type. The chlorinated hydrocarbons, in this instance, were comprised mainly of chlordane, aldrin, dieldrin, and heptachlor. Organophosphates accounted for only 8% of industrial usage, made up mostly of malathion and

Table 15

ESTIMATED PESTICIDE USAGE[1] FOR U.S.A. BY MAJOR CROP AND TYPE OF COMPOUND, 1974

Crop	Nematocides	Herbicides	Fungicides	Insecticides & Acaricides	Other	Total
Field Crops						
Corn	-	161,123	1,700	34,282	10,307	207,412
Cotton	1,993	46,822	5,787	145,311	4,063	203,976
Hay and Small Grain	-	21,977	2,142	5,943	252	30,314
Sorghum	0	23,026	201	7,540	173	30,940
Soybeans	3,046	80,724	1,168	8,662	994	94,594
Sugar Beets	14,078	2,900	2,947	632	540	21,097
Tobacco	11,703	7,522	526	2,511	9,272	31,534
Misc. Field Crops (alfalfa, flax, rice, sunflower sugar cane)	4	20,652	355	7,870	3,485	32,366
Fruit and Nut	6,981	8,815	64,695	20,568	26,007	127,066
Livestock and Mink	0	0	0	6,766	49	6,815
Ornamental and Misc.	1,000	6,184	1,436	2,222	448	11,290
Vegetables	8,528	6,813	15,469	12,289	6,568	49,667
TOTAL	47,333	386,558	96,426	254,596	62,158	847,071

[1] In thousand pounds active ingredient; 0 = none reported; - = estimate less than .1 thousand pounds

Table 16.

ESTIMATED PESTICIDE USAGE[1] FOR U.S.A. BY GOVERNMENT AND CLASS OF COMPOUND, 1974

Government	Chlorinated Hydrocarbons	Carbamates and Amides	Organo-Phosphates	Arsenic	Other Metal	Other	Total
Federal	1,531	382	1,207	55	1,505	2,668	7,348
State and Local	6,971	619	2,739	646	71	14,415	25,461
U.S. TOTAL	8,502	1,001	3,946	701	1,576	17,083	32,809

[1] in thousand pounds active ingredient

Table 17

ESTIMATED PESTICIDE USAGE[1] FOR U.S.A. BY GOVERNMENT AND TYPE OF COMPOUND, 1974

Government	Nematocides	Herbicides	Fungicides	Insecticides and Acaricides	Other and Combination Products	Total
Federal	754	1,334	1,612	2,413	1,235	7,348
State and Local	24	10,175	158	3,561	11,543	25,461
TOTAL	778	11,509	1,770	5,974	12,778	32,809

[1] In thousand pounds active ingredient

Table 18

ESTIMATED PESTICIDE USAGE[1] FOR U.S.A. BY ELEMENTS OF INDUSTRY AND CLASS OF COMPOUND, 1974

Industry	Chlorinated Hydrocarbons	Carbamates and Amides	Organo-Phosphates	Arsenic	Other Metal	Other	Total
Pest Control Operations	8,325	367	1,688	366	244	2,530	13,520
Utilities	1,285	53	29	48	125	2,058	3,598
Other	662	216	70	283	5	4,871	6,107
U.S. TOTAL	10,272	636	1,787	697	374	9,459	23,225

[1] in thousand pounds active ingredient

diazinon. Of all industrial use, PCO reports accounted for almost 60% of the total. This PCO figure may be underestimated and will be considered further under the "Discussion" section of this report.

Insecticides made up 44% of all industrial usage, shown in Table 19; the greatest portion (98%) of this reported by PCOs. Herbicides, which ranked second to insecticides, were mostly used by utilities and railroads (included in "Other"). Fungicides, nematocides, and other type products only made up 15% of all industrial use.

Table 20 contains a listing of pesticide product estimates in agriculture, government, and industry by type of use and genetic name. This table enumerates 238 chemicals plus a consolidated "Others" item listed at the end of each type. The confidence intervals of data in this table probably would be in the magnitude of 100,000 pounds, but figures down to the thousand levels, may assist in ranking use.

The top ranking 25 pesticides have been selected for Table 21 and show the leading products, quality-wise, as judged from the ESP survey estimates. These 25 chemicals account for 75% of all pesticides reported used nationally in 1974 in this study.

DISCUSSION AND RECOMMENDATIONS

The total pesticide usage estimate for 1974 obtained in this ESP survey, v.i.z., 903 million pounds, is in accord with other national estimates,[1,3,11] but the estimate that almost 94% is in agriculture, 3.5% in government, and 2.5% in industry is at considerable variance with other reports. Other estimates have suggested 55% to 60% of all pesticide usage is in agriculture.

Table 19

ESTIMATED PESTICIDE USAGE[1] FOR U.S.A. BY ELEMENTS OF INDUSTRY AND TYPE OF COMPOUND, 1974

Industry	Nematocides	Herbicides	Fungicides	Insecticides and Acaricides	Other and Combination Products	Total
Pest Control Operations	12	1,318	310	10,006	1,874	13,520
Utilities	0	2,429	145	52	972	3,598
Other	0	5,644	255	203	5	6,107
TOTAL	12	9,391	710	10,261	2,851	23,225

[1] in thousand pounds active ingredient; 0 = none reported

Table 20

ESTIMATES OF U.S. PESTICIDE USAGE[1] IN AGRICULTURE, GOVERNMENT AND INDUSTRY BY TYPE OF USE AND GENERIC NAME, 1974

	Agriculture	Government	Industry
Nematocides			
DBCP	9,777	±	12
Dichloropropane/ Dichloropropene	37,544	767	±
Others	12	11	±
Total Nematocides	47,333	778	12
Herbicides			
Acrolein	-	±	30
Alachlor	54,390	35	16
Amitrole	±	130	53
AMS	±	963	257
Atrazine	76,244	200	307
Avadex	437	-	-
Benefin	1,183	17	±
Bensulide	479	±	±
Bentazone	117	-	-
Bentranil	11	-	-
Bromacil	238	230	549
Bromoxynil	614	±	±
Butylate	28,500	±	±
Cacodylic Acid	184	77	30

[1] in thousand pounds active ingredient;
- = less than 1,000 pounds; ± = ≥ 1,000 ≤ 10,000 pounds;
See Appendix C for totals of Agriculture, Government & Industry

	Agriculture	Government	Industry
Calcium Chloride	-	-	760
Calcium Cyanamide	147	-	-
Carbyne	272	-	-
CDAA	51	-	-
CDEC	34	-	±
Chloflurecol	-	±	-
Chloramben	11,828	±	-
Chlorobromuron	257	-	-
Chloropropham	877	-	-
Chlorothalonil	556	-	-
Chloroxuron	421	-	-
Contact	36	-	-
Cyanazine	7,618	±	±
Cycloate	1,318	-	-
Cyprazine	48	-	-
2,4-D	26,662	2,269	1,381
Dacthal	800	25	63
Dalapon	2,072	469	92
2,4-DB	924	±	±
Dicamba	1,139	36	73
Dichlobenil	186	33	±
Dichlorprop	-	-	±
Dinitroamine	719	-	-
Dinitrophenol	-	±	±
Dinoseb	8,579	105	16
Diphenamid	1,264	29	±
Dipropetryn	96	-	-
Diquat	±	24	±
Diuron	5,075	226	381
DSMA/MSMA	15,540	541	427
Endothall	90	21	±

	Agriculture	Government	Industry
EPTC	6,942	±	-
Erbon	-	26	±
Evik	480	-	-
Fatty Alcohols	3,842	-	-
Fenac	321	12	±
Fenuron	-	±	±
Fluometuron	5,087	±	±
Fluorodifen	231	-	-
Folex/Def	5,132	-	-
Glyphosate	-	19	11
Glyphosine	76	-	-
Isocil	54	±	40
Isopropalin	250	-	-
Karbutilate	-	±	92
Linuron	12,878	13	±
Maleic Hydrazide	1,797	101	±
MCPA	2,398	±	-
MCPP	±	±	12
Metribuzin	1,277	±	-
Molinate	1,768	±	-
Monuron	±	67	86
Naptalam	4,940	-	-
Nitralin	408	±	-
Nitrofen	127	-	±
Norflurazon	30	-	-
Paraquat	1,005	29	20
PCP	-	14	383
Pebulate	687	-	-
Phenmedipham	68	-	-
Picloram	126	172	115

	Agriculture	Government	Industry
Profluralin	48	-	-
Prometon	6,970	156	68
Prometryn	1,160	±	±
Pronamide	143	-	-
Propachlor	18,931	±	±
Propanil	9,929	31	-
Propazine	1,556	-	-
Propham	243	-	-
Pyrazon	256	-	-
Siduron	102	-	±
Simazine	4,931	257	117
Sodium Borate	-	422	979
Sodium Chlorate	7,819	321	2,312
2,4,5-T	996	324	662
TBA	-	±	16
TCA	1,838	3,769	61
TCB	-	-	±
Terbacil	396	-	164
Terbutryn	828	±	-
2,4,5-TP	553	82	32
Trifluralin	22,983	11	11
Vernolate	4,708	-	-
Others	3,238	252	126
Total Herbicides	386,558	11,508	9,742

	Agriculture	Government	Industry
Fungicides			
Anilazine	360	±	61
Benomyl	2,467	±	47
Captafol	1,898	-	±
Captan	4,813	13	27
Carboxin	176	-	-
Chloranil	3,695	13	37
Chloroneb	755	±	13
C-3 Hydrocarbons	308	±	-
Copper	4,975	1,548	260
Cycloheximide	-	±	±
DCNA	243	-	-
Dichlone	34	-	-
Dodine	263	±	±
Du-Ter	376	-	-
Fenaminosulf	35	±	-
Ferbam	769	±	12
Folpet	181	-	-
Formaldehyde	-	±	-
Hexachlorobenzene	36	-	-
Maneb/Mancozeb	10,704	20	98
Mercuric Chloride	-	-	±
Metiram	2,455	-	-
PCNB	1,913	37	18
Phenylphenol	80	-	-
PMA	254	-	±
Sulfur	56,606	19	36
Terrazole	88	±	-
Thiabendazole	10	-	-
Thiram	1,322	73	-

	Agriculture	Government	Industry
Zineb	1,538	±	20
Ziram	51	±	37
Others	21	47	44
Total Fungicides	96,426	1,770	710
Insecticides and Acaricides			
Acaraben	2,448	-	±
Aldrin	11,565	±	833
Azinphosmethyl	6,731	±	±
Azodrin	1,906	±	-
Bacillus thuringiensis	220	-	-
Benzene Hexachloride	±	±	19
Bidrin	213	±	-
Bux	1,452	-	-
Carbaryl	18,066	600	280
Chlordane	2,665	519	5,420
Chlordimeform	4,408	-	±
C-1 Hydrocarbons	124	-	-
Chlorpyrifos	±	17	219
Ciodrin	255	-	-
Copper Acetoarsenite	±	19	-
Coumaphos	617	±	-
Cresylic Acid	-	13	-
Crufomate	310	-	-
Cryolite	342	-	-
Cyhexatin	269	-	±
DDT	±	468	-
DDVP	416	±	81
Deet	-	-	±

	Agriculture	Government	Industry
Delnav	68	-	±
Demeton	120	±	±
Demeton, Methyl	343	-	±
Dialiphor	100	-	-
Diazinon	3,349	65	536
Dicofol	833	±	±
Dieldrin	168	29	86
Dimethoate	1,993	±	±
Disulfoton	6,451	±	±
DMP	-	-	-
Dyfonate	2,599	±	-
Endosulfan	1,602	±	±
Endrin	1,270	±	±
EPN	1,119	±	-
Ethion	2,815	-	±
Famphur	356	-	-
Fenthion	16	86	38
Heptachlor	1,958	14	679
Kepone	-	±	±
Lead Arsenate	334	±	53
Leptophos	14	-	-
Lethane	-	3	-
Lindane	324	±	11
Malathion	5,521	3,268	773
Methoxychlor	1,693	70	96
Methyl Parathion	63,418	29	±
Methamidophos	552	-	-
Methidathion	303	-	-
Mevinphos	353	-	±
Mexacarbate	±	55	-
Mirex	-	67	-

	Agriculture	Government	Industry
Naled	1,016	235	±
Organotin	109	-	-
Parathion	13,609	26	26
Perthane	118	-	-
Phorate	7,804	±	±
Phosalone	263	-	-
Phosmet	1,378	-	-
Phosphamidon	540	-	±
Phostoxin	-	±	±
Propargite	976	-	-
Propoxur	11	20	39
Pyrethrum	12	±	44
Ronnel	567	±	±
Rotenone	±	±	±
Sodium Fluoride	-	-	±
Sulfuryl Fluoride	-	-	314
Temophos	±	71	±
TEPP	49	-	-
Tetrachlorvinphos	73	±	±
Toxaphene	74,469	56	148
Trichlorfon	449	80	42
Trithion	201	-	-
Others	273	164	173
Total Insecticides	254,596	5,974	9,910
Combination Products and Rodenticides			
Aldicarb	1,459	-	-
Arsenic Sulfide	-	39	-

	Agriculture	Government	Industry
Butoxy Polypropylene Glycol	-	-	54
Carbofuran	12,327	±	-
Carbon Bisulfide	27	-	-
Chlorophacinone	-	-	50
Chloropicrin	85	14	-
Dinocap	203	-	-
Diphacinone	-	-	±
DNOC	505	±	-
Ethoprop	2,654	-	-
Ethylene Dibromide	1,710	±	11
Fensulfothion	1,940	-	±
Lime Sulfur	1,157	±	-
Metam-sodium	51	±	-
Methomyl	4,118	-	-
Methyl Bromide	5,177	279	340
Morestan	145	-	-
Oxamyl	24	-	-
para-Dichlorobenzene	-	-	±
Petroleum Oil	29,053	12,203	1,841
Pindone	-	±	±
Pine Oil	-	-	19
Piperonyl Butoxide	±	±	44
Silica Gel	-	-	±
Sodium Arsenite	87	20	238
Strychnine	12	±	-
Tetrachloroethylene	-	-	±
TFN	-	107	-
Vorlex	417	32	-
Warfarin	-	10	23

	Agriculture	Government	Industry
Others	1,007	75	231
Total Combination Products	62,158	12,779	2,851
TOTAL ALL PESTICIDES	847,071	32,809	23,225

Table 21

TWENTY-FIVE LEADING PESTICIDES AS ESTIMATED BY ESP SURVEY, 1974

Rank of Use	Pesticide	Lbs. A.I. (million)	% U. S. Total
1	Atrazine	76.8	8.5
2	Toxaphene	74.7	8.3
3	Methyl Parathion	63.4	7.0
4	Sulphur	56.6	6.3
5	Alachlor	54.4	6.0
6	Petroleum Oil	43.1	4.8
7	Dichloropropane/ Dichloropropene	38.3	4.2
8	2,4-D	30.3	3.4
9	Butylate	28.6	3.2
10	Trifluralin	22.9	2.5
11	Carbaryl	18.9	2.1
12	Propachlor	18.9	2.1
13	DSMA/MSMA	16.5	1.8
14	Parathion	13.7	1.5
15	Linuron	12.8	1.4
16	Aldrin	12.4	1.4
17	Carbofuran	12.3	1.4
18	Chloramben	11.8	1.3
19	Maneb/Mancozeb	10.8	1.2
20	Sodium Chlorate	10.5	1.2
21	Propanil	9.9	1.1
22	DBCP	9.8	1.1
23	Malathion	9.6	1.0
24	Dinoseb	8.7	.9
25	Chlordane	8.6	.9
	TOTALS	674.3	74.6

[1]Agriculture, government & industry usage reported in this survey.

Four explanations may account for this variance: (1) The ESP study may have overestimated agriculture, (2) the ESP project may have underestimated government and industry use, (3) the ESP survey did not consider household applications, or (4) estimates from other studies may be faulty.

Validation testing, however, on 61% of the total usage reported in this survey suggested an under-reporting for the aggregate of agriculture, industry, and government.

One of the national PCO concerns (not identified here in order to protect its data given in confidence) supplied pesticide usage and marketing figures for each state of its business operations. The market share data represented households treated by this concern and when compared to the number of households in the country, a national market share was derived. With a national market share figure and the total pounds of active ingredient pesticides used by this company in 1974, a national PCO usage figure could then be extrapolated. This extrapolated estimate came to 15,850,000 pounds active ingredient, some 2,330,000 pounds over the usage survey estimate of 13,520,000 pounds.

If the pesticide usage and market share data supplied by this concern are correct and representative of tne PCO industry, then the PCO usage estimate of this survey is within 15% of actual PCO usage. As regards industries besides PCOs, certain industrial chemicals, such as pentachlorophenol and sodium chlorate, were not entirely within the purview of the ESP survey protocol.

Contacts with knowledgeable industry sources suggest that the ESP study for agriculture may have underestimated usage of sulfur and copper

by 100%. This difference in sulfur probably occurred because of consistant under-reporting by users in California and confused patterns of usage in Florida. It is possible that study consultants in this latter state over-estimated use of synthetic miticides, when indeed most citrus growers continued to use sulfur. The problem with copper may have occurred because of misunderstanding of the types of copper needed to be reported. For instance, industry's estimate may have contained nutritional uses of copper. By the same token, one leading manufacturer, whose products account for 10% of this study's total estimate, declined to react to his products' estimate except to indicate that on some of them the ESP figures were as much as three fold too high. In summary, however, the authors of this report believe that on balance, weighing under- and overestimates, the agricultural pesticide estimate reported in this survey approximates total actual usage in 1974. Governmental use figures are considered to be adequate since they were obtained from a user survey and validated, in many instances, by official reports.

The data reported by this study provide potentially fertile information for epidemiologic studies. These data identify high and low usage areas which may be the starting point of mortality and morbidity studies. Additional detail about class of chemical compound or the type of farmer which has the greatest exposure potential is also available and may be examined across a gradient of use.

Factors which may have biased this study arose mostly in connection with inadequate training of some field investigators, apparent ineffective contacts with USDA by EPA (OPP) and contract personnel, apprehension about (if not animosity toward) motives and purposes of the

study by USDA officials and extension personnel, timing of the survey, inadequate cooperation and response from PCOs and distributors of PCO supplies.

Three of the four quality control features of this study functioned well and effected good results. The fourth method, while not entirely satisfactory, suggested a good level of reproducibility in the agricultural estimates.

In summary, it is felt that the objectives of the survey were met. These being (1) to provide denominator data for the development of incidence of poisonings and other health effects, (2) to determine usage patterns which may assist in the identification of potential areas of concern, (3) to have available data which may assist in the evaluation of the economic impact of discontinuance of chemicals, and (4) to provide baseline data so that secular trends of usage may be identified by subsequent surveys.

Recommendations

The authors recommend that a feasibility study be undertaken jointly by the U. S. Department of Agriculture and EPA to examine estimation mechanisms. Such a study might consider the time and funding required for:

a) a sampling program

b) utilizing a panel of users, strategically located

c) the "Knowledgeable Concept Method" used in this study

d) a reporting of deliveries by distributors and formulators

Uses of Data

Finally, the readers of this report are asked to carefully consider how this pesticide usage information might be utilized.

Initially, information about patterns of use and quantities applied should provide an inventory of environmental pressures. These pressures could be of an adverse nature with a direct influence on the natural environmental control system and a beneficial effect (perhaps balancing effect) via indirectly relieving disease or pestilence and synergizing food production. Thus, a beginning may be made to assess the effect of pesticides on our environmental system's equilibrium.

Another application of this knowledge about pesticide practices would be to assess chronic and acute human health effects of the chemicals used and may be the most immediate and pressing of all possible uses.

SUMMARY

Nine hundred and three million pounds of all type pesticides were reported in this survey of the United States for 1974. Almost 94% of this was in agriculture, with 3.5% in government, and 2.5% in industry sectors. The greatest use of pesticides occurred in the Southeastern and mid-southern states. Low use areas were in the Northeastern part of the United States.

Inspection of the data, following analysis of possible bias, quality control, and validation procedures, suggest a slight underestimation of use in the agricultural and industrial sectors.

Data from this survey provide potentially fertile information for epidemiologic studies by identifying high and low pesticide use areas,

by giving application patterns by class of compound, and by recognizing the type of farmer having the greatest exposure.

The survey utilized gathered data from the agricultural area, utilities, federal, and state governmental agencies, and estimates from leading pest control operators. The objectives of the survey were to provide a reliable pattern of use and an inventory of the chemicals disbursed to the environment, to serve economic, health, and ecologic purposes.

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I N D E X

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