THE PESTICIDE REVIEW 1966

H. H. Shepard
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Contents

A report from the Defense Activities Staff prepared by
Harold H. Shepard, staff specialist
John N. Mahan, fertilizer specialist
D. Lee Fowler, pesticide specialist
Agricultural Stabilization and Conservation Service
U. S. Department of Agriculture
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Pesticide Review - 1966

General Situation

Use of pesticides in the United States continues to expand rapidly. Domestic sales to consumers in 1965 gained 10 to 12 percent to exceed a billion dollars for the first time. Preliminary indications show further increase in agricultural pesticide usage in 1966. Many of the more popular brands were reported sold out early in the season despite sharply increased pesticide production.

The 28 percent reduction in cotton acreage this year would tend to reduce consumption of herbicides proportionately more than insecticides. Increases in crop acreage of 7 percent for soybeans and 9 percent for rice will require the use of more herbicides. Delayed planting in many areas because of the cold spring will likely increase the insect problems on late crops.

Manufacturers' 1965 sales, including exports, of synthetic organic pesticidal chemicals amounted to $497 million, up 16 percent from the previous year. The volume sold was 763 million pounds, up only 10 percent from 1964. The higher average unit value is related to the introduction of new higher cost chemicals. Sales of herbicides alone rose to $211 million, up 29 percent. Herbicides accounted for 42 percent of the 1965 total dollar value at the primary producers' level. Growth of herbicide sales will continue at a high rate, taking over an even greater share of the pesticide market. In fact, the value of herbicide sales may soon overtake that of insecticides.

Herbicides and insecticides prepared as granules are showing exceptional growth. Demand for these formulations doubled between 1964 and 1965, with a further increase expected in 1966 to nearly 250 million pounds.

Production and Sales. -- Total production and sales of synthetic organic pesticides surged ahead at a greater rate in 1965 than for several years (table 1). Producers' sales rose 84 percent in weight and 225 percent in dollar value from 1955 to 1965. The sale of chemicals such as carbon disulfide, carbon tetrachloride, ethylene dibromide, paradichlorobenzene and sulfur, used only in part for pest control, would augment the 1965 production figure of 875 million pounds of pesticide chemicals (table 2) to around 1,150 million pounds going into domestic and export trade.

Production and sales statistics for individual pesticides are published only when the chemical is produced by three or more principal manufacturers. Otherwise these data are grouped to maintain their confidentiality. The Tariff Commission reports as pesticides only those synthetic organic chemicals used principally for this purpose. The

Table 1. -- Production and sales of synthetic organic pesticides, United States, 1962-65 1/

Calendar year	Quantity	Increase over previous year	Value	Increase over previous year
	1,000 pounds	Percent	1,000 dollars	Percent
Production				
1962	729,718	4.3	427,373 2/	18.1
1963	763,477	4.6	456,068 2/	6.7
1964	782,749	2.5	481,955 2/	5.7
1965 3/	876,914	12.0	562,118 2/	16.6
Sales (domestic and export)				
1962	633,962	3.6	346,301	14.3
1963	651,471	2.8	369,140	6.6
1964	692,355	6.3	427,111	15.7
1965 3/	762,745	10.2	496,673	16.3

1/ Includes a small quantity of soil conditioners.
2/ Calculated from production and unit sales value, manufacturers' level.
3/ Preliminary.

Tariff Commission, Chemical Division, "Synthetic Organic Chemicals, United States Production and Sales," except calculated values of production.

Commission, to meet its own requirements for chemical subdivision, must include with insecticides, some fumigants and rodenticides in the same group to avoid disclosure. These limited data on organic pesticides provide the best present measure of growth in the industry.

Some organic compounds used as pesticides, especially carbon disulfide, carbon tetrachloride and ethylene dibromide, have other larger uses. These are not classified by the Tariff Commission as pesticides. No precise use breakdown exists for these chemicals. A figure for total pesticide production or consumption must therefore include some rough estimates of these chemicals based upon information from many other sources.

The growth of herbicide production and sales is the most interesting feature of the pesticide picture (table 3). While manufacturers' dollar sales of all major classes of pesticides rose, the greater growth rate of herbicides leaves these now but little behind the insecticide-fumigant-rodenticide group. Insecticides having a lower unit value, the tonnage of these used in the United States will continue to exceed that of herbicides for some time.

Table 2. -- Production of pesticidal chemicals, United States, 1963-65

Chemical	1963	1964	1965 1/
	1,000 pounds	1,000 pounds	1,000 pounds
Fungicides:			
Copper naphthenate	1,834	1,897	3,153
Copper sulfate 2/	35,216	41,816	47,272
Ferbam	2,500	1,838	2,384
Mercury fungicides	1,376	1,138	1,602
Nabam	2,420	2,251	2,489
Pentachlorophenol (PCP) 3/	33,912	36,901	39,965
Pentachlorophenol, sodium salt	---	---	(11,113) 4/
2,4,5-Trichlorophenol and salts 5/	5,370	4,790	3,967
Zineb	3,575	6,664	5,075
Other organic fungicides	53,024	48,352	44,268
Total 6/	139,227	145,647	150,175
Herbicides:			
2,4-D acid 4/	(46,312)	(53,714)	(63,320)
2,4-D acid esters and salts	44,484	54,366	62,743
Disodium methyl arsonate	2,497	2,167	7/
DNBP	---	4,146	4,619
DNBP, ammonium salt	---	55	59
Phenyl mercuric acetate (PMA) 8/	749	495	588
Sodium chlorate 9/	35,000	35,000	32,000
2,4,5-T acid 4/	(9,090)	(11,434)	(11,601)
2,4,5-T acid esters and salts	10,015	12,963	13,516
Other organic herbicides	61,380	87,046	107,589
Total	154,125	(196,238)	221,114
Insecticides, fumigants, rodenticides: 10/			
Aldrin-toxaphene group 11/	105,986	105,296	118,832
Benzene hexachloride (BHC) (gross) 12/	6,778	7/	7/
Calcium arsenate	3,310	6,958	6,000 13/
DDT	178,913	123,709	140,783
Dibromochloropropane	4,268	5,314	3,433
Lead arsenate	7,842	9,258	8,000 13/
Methyl bromide 14/	17,394	16,994	14,303
Methyl parathion	15,999	18,640	29,111
Parathion	7/	12,768	16,607
TEPP	477	669	7/
Other organics	148,071	163,715	166,792
Total	489,038	463,321	503,861
Grand total	782,390	805,206	875,150

1/ Preliminary.
2/ Shipments by producers to agriculture (including for use as minor plant nutrient).
3/ Not only a wood preservative for wood rot control but a herbicide and desiccant.
4/ Figures in parentheses, because of duplication, are not included in totals.
5/ Requirement as a 2,4,5-T intermediate is subtracted from Tariff Commission figures.
6/ Sulfur preparations not included amount to about 200 million pounds.
7/ Separate figure not available.
8/ Also a fungicide.
9/ Estimated shipments to producers of herbicides and defoliants.
10/ Includes a small quantity of synthetic soil conditioners; does not include the fumigants, carbon tetrachloride, carbon disulfide, ethylene dibromide and ethylene dichloride, which have many other uses; nor does it include paradichlorobenzene (classed by Tariff as an intermediate) or inorganic rodenticides.
11/ Includes aldrin, chlordane, dieldrin, endrin, heptachlor and toxaphene.
12/ Includes lindane; gamma content of BHC produced was 1,800,000 lb. in 1963.
13/ Estimated.
14/ Fumigant for control of both insects and weeds.

Tariff Commission, Bureau of the Census, Bureau of Mines, communications from chemical industry.

Publication of production figures for specific pesticides is limited to those few which will not disclose operations of any one manufacturer (table 2). Each synthetic organic pesticide with these few exceptions is made by only one producer.

Table 3. -- Sales of synthetic organic pesticides by type of use, volume and value, United States, 1963-65 1/

Type of usage	1963		1964		1965 2/	
	Amount	Percentage of total	Amount	Percentage of total	Amount	Percentage of total
Volume of sales:	1,000 pounds	Percent	1,000 pounds	Percent	1,000 pounds	Percent
Fungicides	93,265	14.3	95,556	13.8	105,938	13.9
Herbicides and plant hormones	122,872	18.9	152,027	21.9	183,944	24.1
Insecticides, fumigants, rodenticides and soil conditioners 3/	435,334	66.8	444,772	64.3	472,863	62.0
TOTAL	651,471	100.0	692,355	100.0	762,745	100.0
Value of sales:	1,000 dollars	Percent	1,000 dollars	Percent	1,000 dollars	Percent
Fungicides	46,282	12.5	45,465	10.6	48,603	9.8
Herbicides and plant hormones	115,893	31.4	163,450	38.3	210,753	42.4
Insecticides, fumigants, rodenticides and soil conditioners 3/	206,965	56.1	218,196	51.1	237,317	47.8
TOTAL	369,140	100.0	427,111	100.0	496,673	100.0

1/ Classified by Tariff Commission by most important use; many of the chemicals actually fall in more than one major use category; a few involve some repetition (see table 2).

2/ Preliminary.

3/ A grouping required by the Tariff Commission to meet its need for separate data on cyclic chemicals; fumigants included may be fungicidal and/or herbicidal as well as insecticidal.

Tariff Commission, Chemical Division.

Manufacturers' shipments as shown in the Annual Survey of Manufactures give further indication of the continued rise in the agricultural market for pesticides (table 4). However, the value of shipments of agricultural preparations increased only 7 percent in 1965 over 1964 compared to 22 percent in 1964 over 1963.

The 1963 Census of Transportation (TC63(P)C 1-8) shows the proportions of agricultural chemicals moved by various means of transport:

	Tonnage basis	Ton-mile basis
Private truck	59.1 percent	40.5 percent
Motor carrier	29.0 "	28.9 "
Rail	9.7 "	25.8 "
Water	.1 "	.1 "
Unknown	2.1 "	4.7 "

Private trucks are those owned by manufacturers or their customers. Local shipments are excluded. Only 14.8 percent of the tonnage was shipped over 400 miles.

Table 4. -- Shipments of pesticides and related chemicals, 1958-64 1/

Year	Pesticides and other agricultural chemicals not formulated (Product code 28184)	Household insecticides and repellents (preparations) (Product code 28421)	Agricultural pesticides and similar chemical preparations (Product code 28790)
	1,000 dollars	1,000 dollars	1,000 dollars
1958	96,186	85,918	347,628
1959	122,718	86,421	342,187
1960	147,484	86,709	356,040
1961	164,980	93,903	372,787
1962	220,476	115,021	398,522
1963 2/	223,381	110,841	484,378
1964	244,125	111,705	518,107

1/ Includes interplant transfers.
2/ Revised figures.

Bureau of the Census, 1962 Annual Survey of Manufactures, M62(AS)-2, "Value of Shipments of Selected Classes of Products;" 1963 Census of Manufactures, MC63(2)-28A, -28D and -28F; and Annual Survey of Manufactures - 1964, M64(AS)-2, "Value of Shipments by Classes of Products."

Chemical Production Requisites. -- The manufacture of pesticides requires various chemical intermediates. Some are manufactured by the producer of the pesticide (captive use); the rest must be purchased elsewhere from merchant production. For instance, most of the intermediate chemical monochloroacetic acid is made by herbicide manufacturers who use 55 percent of their own production in making 2,4-D and 10 percent in making 2,4,5-T. Depending upon the economy of quantity production a manufacturer may produce an intermediate solely for sale or make more than he needs for his own use and sell the surplus. Another manufacturer may find it more economical to buy than to make the intermediate himself. Carbaryl insecticide is made from captive phosgene but requires monomethylamine purchased from merchant producers.

Nearly 20 million gallons of benzene were consumed in the 1965 production of DDT and the parathions (ethyl and methyl). Other benzene derivatives used as pesticides include lindane, 2,4-D and many others.

Imports. -- No statistics are available showing total U. S. pesticide imports. Synthetic benzenoid pesticides and botanical products make up most of such imports. The value of U. S. imports of benzenoid (cyclic) type of organic pesticides in 1965 was 42 percent above 1964 (table 5). The United Kingdom, Denmark and West Germany shipped 88 percent of the 1965 tonnage, including large quantities of dichlone, diquat, MCPP, and methyl parathion (table 6). Imports of the major botanical products pyrethrum, rotenone and nicotine in 1965 had a value of $6,515,000.

Table 5. -- Imports of benzenoid pesticides and sheep dip, 1964-65

Country of origin	Quantity		Value	
	1964	1965	1964	1965
	Pounds	Pounds	Dollars	Dollars
United Kingdom	1,045,959	1,341,917	730,986	1,054,677
Denmark	806,678	848,679	671,788	647,627
West Germany	285,055	405,463	566,027	924,650
Switzerland	9,329	169,561	2,558	216,334
Canada	9,757	85,009	4,188	38,182
Japan	40,435	47,918	56,787	105,587
France	42,201	24,750	71,742	11,011
Australia	19,686	21,470	2,985	4,248
Other	5,544	5,600	4,767	6,128
Total	2,264,644	2,950,367	2,111,828	3,008,444

Bureau of the Census Report No. FT 125, SITC code 599-2000.

Table 6. -- Imports of benzenoid pesticides, 1962-65 1/

Material	1962	1963	1964	1965
	Pounds	Pounds	Pounds	Pounds
Fungicides:				
Chloranil	0	0	2,206	28,334
Dichlone	163,158	154,320	50,705	179,525
Pentachloronitrobenzene	0	1,100	5,000	71,902
Herbicides:				
Chloroxuron	0	0	0	154,622
4-(2,4-DB)	59,700	138,000	0	0
Diquat	103,942	297,736	798,280	219,520
Maleic hydrazide	0	701,059	0	0
MCPP	0	4,265	131,879	446,593
MCPA	132,250	0	2,000	30,000
Paraquat	1,310	4,746	0	60,605
2,4,5-T	70,000	0	0	0
Insecticides and miticides:				
Baygon	0	8,007	0	74,985
Binapacryl	2,000	100,000	0	0
Dinitro-o-cresol	0	0	0	22,000
Fenthion, "Dexon," and their mixtures	18,847	149,437	0	0
Lindane	315,626	178,538	61,700	0
Methyl parathion	73,304	435,785	275,024	220,461
"Morestan"	0	0	10,925	52,164
Parathion	0	76,085	33,069	0
Sumithion	0	714	0	11,023
Rodenticides:				
ANTU	0	0	500	4,500
Pival	170	60	100	0
Warfarin	132	83	0	12,591

1/ Minor items not shown.

Tariff Commission, Chemical Division, "Imports of Benzenoid Chemicals and Products."

Exports. -- U.S. pesticide exports in 1965 were valued at $133 million (table 7), slightly under the previous year. Technical organic chemicals made up 58.5 percent and technical inorganic 1.6 percent. Herbicide exports (technical and formulated) rose to 22 percent of all pesticide exports in 1965 from 19 percent the year before.

Table 7. -- Exports of pesticides, United States, 1965 1/

Material	Volume	Value	Unit Value
	1,000 pounds	1,000 dollars	Cents
Fungicides:			
Inorganic fungicides, tech. 2/	4,270	1,288	30.2
Organic fungicides, tech.	8,497	5,127	60.3
Fungicide formulations 3/	20,226	10,769	53.2
Total dollar value	---	17,184	--
Herbicides:			
Inorganic herbicides, tech. 4/	724	276	38.1
2,4-D and 2,4,5-T, tech. acid basis 5/	6,924	2,822	40.8
Other organic herbicides, tech.	12,973	11,297	87.1
Herbicide formulations 6/	19,510	14,939	76.6
Total dollar value	---	29,334	--
Insecticides:			
Inorganic insecticides, tech. 7/	1,430	613	42.9
DDT, tech.	28,838	4,628	16.0
DDT, 20-74%, 100% basis	5,862	1,138	19.4
DDT, 75% plus, 100% basis	55,714	10,900	19.6
Other polychlor insecticides, tech. 8/	32,882	13,603	41.4
Other polychlor formulations	5,898	1,750	29.7
Organic phosphorus insecticides, tech.	29,049	19,236	66.2
Organic phosphorus insecticide formulations	2,222	1,765	79.4
Other organic insecticides, tech.	34,629	18,594	53.7
Other organic insecticide formulations	12,742	4,888	38.4
Household & industrial insecticide formulations 9/	9,099	4,378	48.1
Total dollar value	---	81,493	--
Other:			
Organic rodenticides, tech.	154	85	55.2
Household & industrial disinfectants	3,835	1,954	51.0
Dips, growth regulators	1,012	590	58.3
Organic fumigants	9,063	2,563	28.3
Total dollar value	---	5,192	--
Grand total dollar value	---	133,203	--

1/ A new classification of exports has replaced that used previously.
2/ Includes copper sulfate, sulfur, etc.: see next footnote.
3/ Includes conditioned sulfur dust and sulfur pastes; precipitated, colloidal, and flowers of sulfur are not shown.
4/ Includes sodium arsenite.
5/ Includes technical salts and esters on acid basis.
6/ Includes calcium cyanamide for weed control and defoliation.
7/ Includes calcium arsenate and lead arsenate; also inorganic fumigants and rodenticides.
8/ Includes technical BHC and paradichlorobenzene.
9/ Includes repellents and rodenticide preparations.

Bureau of the Census Report No. FT 410; compiled and unit values computed by the U. S. Department of Agriculture.

Canada, Mexico, Egypt and Brazil led in that order as recipients of U. S. exports of pesticides. Egypt and Brazil rose to the third and fourth places held by Japan and Colombia in 1964. Sizeable quantities of pesticides went to the Soviet Union in recent years (table 8). Exports to Yugoslavia have been sizeable each year, with smaller amounts lately going to Czechoslovakia, Hungary, Poland and Bulgaria.

Table 8. -- Pesticide exports to certain eastern European countries, United States, 1960-65

Country	1960	1961	1962	1963	1964	1965
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Czechoslovakia	0	0	0	0	0	2,574
Hungary	0	0	0	0	160,943	167,177
Poland	0	0	7,125	0	1,279	472
USSR	8,528	55,482	25,740	805,891	4,887,055	1,477,609
Yugoslavia	212,212	156,709	93,108	89,226	160,377	465,208
Bulgaria	0	18,714	0	0	0	38,070

Bureau of the Census Report No. FT 410.

Exports during the period January through June, 1966, had a value of $92,861,000, compared to $68,461,000 for the same period in 1965, an increase of 36 percent. The increase was in several categories, principally as follows:

Herbicides, technical	$5.7 million
Fungicides, preparations	4.1 "
Polychlor insecticides, technical	4.0 "
Organic phosphorus insecticides, technical	2.0 "
Organic phosphorus insecticides, preparations	5.4 "

Exports to Viet-Nam have ranged in recent years from a value of $500,000 to $1,000,000 annually. These figures do not include military shipments. The pesticide exported in the largest quantity in 1965 was 75 percent DDT, equivalent to 1,773,000 pounds actual DDT. This was appreciably less DDT, however, than was shipped to Viet-Nam any year recently.

Not only have large quantities of DDT been employed in ridding India of malaria but increasingly large quantities of U. S. agricultural insecticides have been shipped there (table 9). This accords with India's indicated desire that its 425 million acres of cropland be protected with pesticides by 1971.

Table 9. -- U. S. exports of selected insecticide categories to India

Material	1962	1963	1964	1965	First six months of 1966
	Dollars	Dollars	Dollars	Dollars	Dollars
DDT	9,034,750	4,313,244	3,948,105	2,830,279	1,478,876
Organophosphorus insecticides	30,825	12,774	27,140	277,879	288,336
Polychlor insecticides	262,097	436,217	586,195	1,450,867	708,128
Insecticides, n.e.c.	10,128	1,032,903	47,397	232,854	2,417,294

Bureau of the Census Report No. FT 410.

End-of-season Inventories. -- End-of-season stocks of pesticides held on September 30, 1965 by both primary producers and formulators were at about the usual level (table 10). Fungicide stocks were generally higher, presumably because dry weather in fruit areas held plant diseases below normal. Of the herbicides, 2,4,5-T inventories were more than 80 percent higher than a year earlier. The aldrin group and parathion were in much heavier inventory than in 1964, as was calcium arsenate which, however, is now a small production item. DDT inventories dropped appreciably from the unusually high level of 1964.

Consumption. -- Domestic disappearance at the manufacturers' level can be calculated for only a few chemicals. Use of DDT in 1964-65 was only 2,444,000 pounds above the 1963-64 crop year, but over 8 million pounds under 1962-63. Disappearance of the other items in Table 11 differs little from the 1963-64 year.

Preliminary results of the 1964 Census of Agriculture have, at the time this was written, appeared for most of the States east of the Rockies (table 12). Every one of the North Central States showed more acreage treated for weed control than for insect and disease control. These States all together treated over 40 million acres with herbicides and less than 15 million acres with insecticides and/or fungicides.

The number of farmer cooperatives handling farm chemicals (sprays and dusts) increased from 3,089 in the fiscal year 1962-63 to 3,211 in 1963-64, the latest year for which data are available. The farm chemical business of the cooperatives has continued to grow steadily:

Fiscal year	Gross value	Net value (excludes inter-cooperative business)
1961-62	$ 92,067,000	$62,328,000
1962-63	96,445,000	64,714,000
1963-64	104,687,000	69,855,000

Table 10. -- Manufacturers' inventories of pesticides (technical basis), September 30 1/

Material	Stocks of primary producers only 2/		Stocks of all manufacturers and formulators who reported in both 1964 and 1965	
	1965	1965 as percentage of 1964	1965	1965 as percentage of 1964
Fungicides:				
Copper sulfate (pentahydrate)	10,544 3/	114	11,164	129
Copper sulfate, basic and other coppers	4,684	106	6,183	101
Sulfur, ground 4/	18,884	133	21,892	126
Miscellaneous	12,363	112	16,075	92
Total	46,476	119	55,314	111
Herbicides:				
2,4-D (acid basis)	14,264	93	16,437	98
Sodium arsenite	2,195	95	2,118	89
2,4,5-T (acid basis)	6,265	188	6,745	183
Miscellaneous 5/	38,246	107	42,475	110
Total	60,970	108	67,775	110
Insecticides:				
Aldrin, chlordane, dieldrin, endrin, heptachlor and toxaphene	42,020	141	51,243	129
BHC (gamma basis)	839	90	2,452	101
Calcium arsenate	2,386	161	2,490	151
DDT	13,757	39	24,361	53
Lead arsenate	2,032	103	2,363	86
Phosphorus insecticides:				
Methyl parathion	2,913	83	4,017	83
Parathion	1,698	148	3,460	137
Other	16,838	124	21,490	118
Miticides, non-phosphorus	1,726	69	2,892	136
Miscellaneous 6/	13,913	131	25,457	126
Total	98,122	97	140,224	100
Fumigants:				
Grain and soil fumigants 6/	57,863	135	59,246	134
Rodenticides	133	155	305	65
Other	129	24	349	64
Grand Total	263,692	109	323,213	109

1/ Final report; totals may not agree with sums of items because of rounding.
2/ Chemicals in possession of their primary manufacturers; i.e., DDT stocks of DDT producers.
3/ Producers' reports to U. S. Bureau of Mines.
4/ The principal use of sulfur is in control of plant diseases such as apple scab but considerable is applied also against spider mites, an insecticidal use.
5/ Includes chlorates, defoliants, desiccants and miscellaneous organic herbicides.
6/ Miscellaneous insecticides includes carbaryl, botanicals, etc.; grain and soil fumigants includes methyl bromide.

U. S. Department of Agriculture.

Table 11. -- Domestic disappearance of some major pesticidal chemicals for the crop year 1964-65

	Stocks 1/ Sept. 30, 1964	Production 1964-65	Exports 1964-65	Stocks 1/ Sept. 30, 1965	Disappearance 1964-65
	1,000 pounds	1,000 pounds	1,000 pounds	1,000 pounds	1,000 pounds
Aldrin-toxaphene group 2/	29,795	113,049	20,256	42,020	80,568
Calcium arsenate	1,481	4,379	n.a. 3/	2,386	3,474
Copper sulfate	9,240	93,540	n.a. 3/	10,544	92,236 4/
2,4-D (acid equivalent)	15,201	57,645	8,047 5/	14,264	50,535
DDT	34,975	130,755	98,987	13,757	52,986
Lead arsenate	1,968	8,154	n.a. 3/	2,032	8,090
2,4,5-T (acid equivalent)	3,338	11,591	1,420 5/	6,265	7,244

1/ Stocks of primary producers only; for 2,4-D and 2,4,5-T, stocks of formulated concentrates held by such producers included also.
2/ Includes aldrin, chlordane, dieldrin, endrin, heptachlor and toxaphene.
3/ Export statistics for this item no longer available.
4/ Total disappearance, including industrial and export; includes imports of 1,252,000 pounds; see page 5 for agricultural shipments.
5/ Assumed 2,4,5-T to make up 15 percent of the total exports of 2,4-D and 2,4,5-T reported under commodity number 5120620.

(Stocks) U. S. Department of Agriculture, except copper sulfate by Bureau of Mines.
(Production) Tariff Commission; Bureau of the Census; chemical industry.
(Exports) Bureau of the Census.

Table 12. -- Pest control; acres of crops and numbers of livestock treated, 1964

State	Acres treated for insect and disease control	Acres treated for weed control	Livestock treated externally for insect control
Maine	169,879	161,877	39,377
New Hampshire	11,860	9,982	17,735
Vermont	16,584	28,152	67,017
Massachusetts	45,499	26,870	36,829
Rhode Island	8,001	6,669	3,794
Connecticut	45,580	36,529	25,464
New York	552,535	773,439	371,219
New Jersey	192,748	98,049	86,114
Pennsylvania	639,333	770,993	461,805
Ohio	757,096	2,392,450	1,967,199
Indiana	914,712	3,020,325	3,531,570
Illinois	2,959,806	5,502,142	5,340,423
Michigan	676,802	1,185,336	749,550
Wisconsin	547,351	1,738,179	1,322,564
Minnesota	816,138	5,386,210	2,583,852
Iowa	2,512,058	4,998,429	10,155,579
Missouri	1,426,941	1,829,275	4,359,173
North Dakota	962,246	6,901,845	1,175,063
South Dakota	873,937	3,448,466	2,969,811
Nebraska	1,641,532	2,291,398	4,439,268
Kansas	567,377	1,874,071	3,752,805
Delaware	66,977	163,309	14,970
Maryland	184,178	282,216	174,814
Virginia	430,698	420,557	746,136
West Virginia	52,510	46,632	197,395
North Carolina	976,282	795,167	710,209
South Carolina	811,593	441,447	338,093
Georgia			
Florida	1,371,261	388,108	1,429,336
Kentucky	206,352	458,335	1,602,479
Tennessee	344,195	554,723	1,293,688
Alabama	662,817	530,174	1,220,266
Mississippi	1,451,850	1,289,395	1,267,796
Arkansas	2,099,918	1,230,482	968,194
Louisiana	982,051	1,021,565	1,038,013
Oklahoma	604,322	453,901	2,698,843
Texas			
Montana	948,257	4,024,465	1,381,106
Idaho	603,861	732,115	979,639
Wyoming	141,619	169,047	1,191,595
Colorado	377,031	712,563	1,850,702
New Mexico	122,737	100,668	1,024,693
Arizona	531,467	212,009	1,075,955
Utah	148,621	136,426	442,482
Nevada	52,488	29,420	239,907
Washington	575,401	1,599,160	777,347
Oregon	377,200	1,013,917	1,061,552
California			
Alaska	905	3,942	16,903

1964 Census of Agriculture, Preliminary Reports Series AC64-PI.

Estimated total cost of pesticide preparations to all U. S. users in 1965 was over a billion dollars. Farmers used pesticides costing an estimated $590 million, 58 percent of the total. Residential (home, lawn and garden) purchases amounted to about $200 million, or 20 percent of the total cost and industrial, institutional, and governmental purchases the remaining $220 million or 22 percent. The tonnage used by the farmer is greater than 58 percent of the total weight consumed because of his bulk purchases in contrast to the small-package residential trade with its much higher unit cost.

The cost of raising cotton is probably investigated more than that for any other crop. The nature of cotton farming differs greatly according to production potential of the area -- large and small farms, rich and poor soil, single crop versus mixed farming (table 13). A large cotton farm in an area of intensive farming may require several thousand dollars a year spent for pesticides.

Table 13. -- Pesticides and other chemicals: selected cotton farm types, cash expenditures per farm, 1965 with comparisons

Type of farm	Average 1957-59	1963	1964	1965 1/
	Dollars	Dollars	Dollars	Dollars
Cotton farms, Southern Piedmont	90	252	290	360
Small cotton farms, Mississippi Delta	61	98	95	107
Large-scale cotton farms, Mississippi Delta	1,900	2,555	2,454	2,779
Cotton farms, Black Prairie, Texas	158	312	281	238
Nonirrigated cotton farms, High Plains, Texas	35	36	19	9
Irrigated cotton farms High Plains, Texas	163	322	248	215
Cotton-speciality crop farms, San Joaquin Valley, Calif.	2,309	2,925	2,910	3,240
Medium-sized cotton-general crop farms, San Joaquin Valley, California	1,971	2,146	2,209	2,473
Large cotton-general crop farms, San Joaquin Valley, California	6,402	7,054	7,159	7,853
Peanut-cotton farms, Southern Coastal Plains	94	371	378	436

1/ Preliminary.

"Farm Costs and Returns: Commercial Farms, by Type, Size, and Location"; Agriculture Information Bulletin No. 230, 1966.

Cooperative Pest Control Programs. -- The U. S. Department of Agriculture cooperates with interested States and the Republic of Mexico in programs to suppress, control or eradicate certain agricultural plant pests. The latter are mainly pests of foreign origin and those native pests capable of sudden widespread outbreaks which individual persons and small communities cannot control. The average annual cost of control under these programs has been estimated at about $31 million. Although Federal and State agencies use significant quantities of pesticides in these programs, the volume of chemicals is small (only 0.9 percent) as compared to that in all of agriculture where the cost of control amounts to an estimated $3,475 million.

Price Levels. -- Annual averages of manufacturers' quotations published weekly for a limited number of pesticides are shown in Table 14. Of the 21 materials listed, even though far from a representative sample, the prices of seven are increased and three reduced over last year while the remaining 11 are quoted the same. Quotations for nine have not been changed since 1963.

Table 14. -- Wholesale prices per pound of certain pesticidal materials, average weekly quotations, 1963-65 and Jan.-June, 1966 1/

Material	1963	1964	1965	1966 (Jan.-June)
	Dollars	Dollars	Dollars	Dollars
Aldrin	.990	.990	.990	.990
Chlordane	.650	.650	.650	.650
Copper sulfate, pentahydrate	.125	.140	.153	.165
Copper sulfate, tribasic	.286	.309	.325	.350
Cube (root)	.171	.160	.178	.185
2,4-D acid	.345	.345	.339	.322
2,4-D, isopropyl ester	.355	.355	.350	.331
DDT	.187	.166	.170	.180
Dichlorvos	3.720	3.750	3.684	3.600
Dieldrin	1.850	1.850	1.850	1.850
Endrin	2.770	2.724	2.700	2.700
Heptachlor	.960	.960	.960	.960
Lead arsenate	.260	.268	.278	.290
Lindane	1.893	1.850	1.850	1.850
Malathion	.900	.900	.900	.900
Methyl bromide	.670	.670	.670	.670
Methyl parathion	.880	.880	.880	.880
Parathion	.840	.866	.880	.880
Pyrethrum flowers, 1.3%	.700	.708	.749	.780
2,4,5-T	1.136	.950	.954	.975
Toxaphene	.220	.220	.220	.220

1/ Computed from weekly quotations in "Oil, Paint, and Drug Reporter."

Producers of synthetic organic chemicals reported to the Tariff Commission their net selling price or delivered value whichever represents normal industry practice. The average value for all organic pesticides so classified by the Tariff Commission has risen from 50 cents in 1961 to 65 cents in 1965 (table 15).

Table 15. -- Average value per pound, synthetic organic pesticides, manufacturers' level

Group	1961 1/	1962	1963	1964	1965
Fungicides	$ 0.36	$ 0.47	$ 0.50	$ 0.48	$ 0.46
Herbicides	.93	.97	.94	1.08	1.15
Insecticides, rodenticides and fumigants	.46	.47	.48	.49	.50
Overall	.50	.55	.57	.62	.65

1/ Soil fumigants such as methyl bromide were included with fungicides in 1961.

Computed from data of Tariff Commission.

Fungicides

Recognizing that the root systems of many maturing crop plants are attacked by disease organisms in the soil, manufacturers are developing soil fungicides for general application around the plants instead of for seed treatment alone.

Producers' 1965 sales of synthetic organic fungicides amounted to 106 million pounds. This is 11 percent above the average for the previous three years, when sales varied little from 95.5 million pounds each year. Sales in 1965 were valued at $48.6 million, 10 percent of all producer sales of synthetic organic pesticides for the year (table 3).

The U. S. exported 33 million pounds of fungicides in 1965 valued at $17 million. These figures include inorganic and organic chemicals, both technical and preparations. Fungicides made up 13 percent of the total value of exports (table 7).

Revised figures from the 1963 Census of Manufactures for production and shipments of inorganic pesticides containing sulfur or copper compounds are shown in Table 16.

Table 16. -- Production and shipments of inorganic sulfur- and copper-containing pesticides, 1958 and 1963

Material	Production		Shipments 1/	
	1958	1963 2/	1958	1963 2/
	1,000 pounds	1,000 pounds	1,000 pounds	1,000 pounds
Sulfur preparations	320,089	202,947	324,460	193,885
Copper preparations 3/	23,541	19,761	21,781	19,026

1/ Includes interplant transfers.
2/ Revised figures.
3/ Excluding paris green and technical copper sulfate (bluestone).

Bureau of the Census, 1963 Census of Manufactures, Final Report MC63(2)-28F (code 28790).

Copper sulfate has various uses in agriculture, principally as an ingredient of fungicides for use on fruit and vegetable crops, an algaecide for treatment of ponds, and an essential trace element in plant and animal nutrition. Producers reported to the Bureau of Mines that shipments in 1965 for all agricultural uses amounted to 47,272,000 pounds, 52 percent of total shipments including industrial and export. This is a substantial increase over the last few years. Indications are that 1966 will see some further increase, production in the first seven months being up 8 percent over the same period last year. Published price quotations for copper sulfate have gradually risen since early 1964, following the market for metallic copper.

Zinc sulfate likewise is used both in fungicidal formulations and as a trace element, the latter use apparently being much the larger one. Shipments for agricultural use in 1965 were 12,449 tons dry weight (14,331 tons gross weight), an increase of 27 percent in dry weight over 1964. Although zinc oxide has some fungicidal usage, its chief agricultural uses are for application to citrus foliage as a nutritional spray and as a source of zinc in animal feed.

Zineb is a dithiocarbamate fungicide containing 24 percent zinc. Production of zineb in 1966 is expected to be about 6 million pounds compared to 3.6 million in 1963.

After a slump of 20 to 25 percent in 1964, production of organic mercurials for fungicides and herbicides returned in 1965 to the 1963 level. These chemicals are used in paints as well as for agricultural purposes.

Although industries use much more wood preservative, farmers apply appreciable quantities to fence posts and structural elements in contact with the soil. Creosote and its solutions and mixtures has the largest share of the market, principally the industrial, i.e., for treatment of utility poles and railroad cross-ties. Consumption of creosote for wood preservation amounted to 144 million gallons in 1965.

Pentachlorophenol (PCP) is the solid material most used in solution for wood preservation but some is applied also as a herbicide and slimicide. Production in 1965 amounted to 39,965,000 pounds, up 8 percent from the previous year. Six producers have an annual capacity of 56 million pounds, highly flexible to permit variable manufacture of other chlorophenols.

An estimated breakdown of PCP use is:

Preservation of poles, timbers, etc.	42 percent
Preservation of fiberboard, plywood, etc.	14 "
Captive manufacture of sodium pentachlorophenate (Includes for anti-sapstain formulations, 16 percent; and slimicides, 3 percent)	19 "
Slimicides	9 "
Herbicides	3 "
Bulk, retail and export sales	13 "
	100 percent

Herbicides

Herbicide production and sales soared in 1965 and 1966 to meet heavy demand for weed control. Soybean acreage up seven percent and rice up nine percent offset a 28 percent cut in 1966 cotton acreage down to 9.8 million acres. Most herbicides used on these crops are pre-emergence, hence application time is short, even shorter if rains interfere with field work at planting time. Consumption on an unexpectedly large soybean acreage together with the short buying season resulted in supplies of some popular materials being completely sold out. Generally the volume of herbicide usage is in proportion to acreage and but little affected by weather, although the proportion of treated crops increases gradually year by year.

The 1967 wheat allotment of 68.1 million acres is 38.9 percent above the August 1 estimate of acreage to be harvested in 1966. This additional wheat acreage may be treated for weed control in nearly the same proportion (about 25 percent) as this year.

Producers' sales of synthetic organic herbicides in 1965 amounted to $211 million, up 29 percent from 1964. Synthetic organic herbicides are generally more expensive than either fungicides or insecticides; the average unit value of sales by the producers was $1.146 per pound in 1965, 20 cents higher than two years before.

Revised figures from the 1963 Census of Manufactures for production and shipments of herbicidal preparations are shown in Table 17.

Table 17. -- Quantity and value of U. S. shipments of herbicidal preparations, 1958 and 1963

Product	1958		1963 1/	
	Quantity	Value	Quantity	Value
	1,000 pounds	1,000 dollars	1,000 pounds	1,000 dollars
Arsenical preparations	46,681	2,045	24,959	2,326
Sodium chlorate preparations	91,524	4,699	57,697	10,634
2,4-D and derivatives	n.a.	19,198	n.a.	25,570
2,4,5-T and derivatives	n.a.	7,852	n.a.	12,831
Other weed killers, defoliants, desiccants, algaecides, etc.	n.a.	21,921	186,051	67,758
Total	----	55,715	----	119,119

1/ Revised figures.

Bureau of the Census, 1963 Census of Manufactures, Final Report MC63(2)-28F (code 28790).

The acreage treated with herbicides more than doubled between 1949 and 1959 (table 18). The latter year herbicides were applied to 53 million acres; by 1965 they had been applied to 85 million acres of agricultural land (crops, pasture and range) and over 30 million acres of other land (forest, roadside, industrial, aquatic, etc.).

Table 18. -- Estimated acreages treated for weed control in the United States 1/

Year	Corn	Small grains	Grazing lands	All other	Total
	Acres	Acres	Acres	Acres	Acres
1949	4,559,000	18,751,000	---	---	23,310,000
1952	8,150,000	16,792,000	2,192,000	2,629,000	29,763,000
1959 2/	20,051,000	20,723,000	4,411,000	7,738,000 3/	52,923,000

1/ Estimates for 1949 and 1952 from U. S. Department of Agriculture Statistical Bulletin 156, April 1955; 1959 estimates from U. S. Department of Agriculture ARS 34-23 (1962).

2/ Estimated from Alaska, California, Delaware, Hawaii, New Jersey, New York, Ohio, Oklahoma, and Washington not included.

3/ Estimated 2 million acres treated noncrop land included.

From Advances in Agronomy, vol. 15, p. 167, 1963, "Impact of Chemical Weed Control on Farm Management Practice," W. B. Ennis, Jr., et al.

Sixty percent of the Minnesota acreage of corn, small grains and flax was chemically treated for weeds in 1965 compared with 54 percent in 1963 and 23 percent in 1954.

Of those crops weeded chemically, corn has become the leading one with small grains close behind (table 19). Eight principal midwestern corn States in 1964 treated 20.3 million acres or 50.2 percent of their corn acreage, according to the 1964 Census of Agriculture (table 12). Other reports from Illinois have indicated that 44 percent was treated in 1958 and only 12 percent in 1952.

Cotton and soybeans show somewhat the same growth of herbicidal use. In Georgia, cotton acreage treated for weeds was up 34 percent in 1965 over 1963. Cotton acres receiving herbicides in the United States totalled 5.4 million in 1962 compared with only 250,000 acres so treated in 1952. Seventy-three percent of soybean growers applied pre-emergence herbicides in 1965 while only 59 percent used this type of weed control in 1964.

Exports of herbicides in 1965 had a value of $29 million, up 14 percent from the year before. Herbicide exports in 1966 through June were valued at $18.6 million.

Table 19. -- Comparison of estimated extent and cost of chemical weed control in the United States, 1959 and 1962

Crop or area	Total acreage treated		Total cost, all herbicides and applications	
	1959	1962	1959	1962
	1,000 acres	1,000 acres	1,000 dollars	1,000 dollars
Corn	20,051	25,302	37,980	57,600
Cotton	1,554	5,433	4,709	16,805
Soybeans	556	2,827	2,315	10,835
Small grains	20,723	18,931	37,095	29,579
Rice	502	940	889	6,250
Peanuts	35	310	116	2,565
Sugarbeets	125	362	625	2,237
Sorghum	2,093	2,665	6,512	5,258
Tree Fruits and nuts	5	267	43	2,397
Other crops except hay	563	1,633	3,341	13,018
Ornamentals	2	51	45	969
Lawns	60	672	1,489	15,368
Hay	272	412	1,692	1,794
Pastures	2,400	4,714	5,789	13,340
Rangeland	2,011	2,262	6,174	6,265
Forest plantings	---	274	---	2,752
Noncropland	1,971	3,612	19,738	83,714
Total	52,923	70,667	128,552	270,746

Adapted from U. S. Department of Agriculture ARS 34-23-1, August 1965.

Sodium chlorate continues to be a cheap and effective inorganic chemical for the non-selective control of weeds. About 12 percent of U. S. production is consumed in weed control and crop defoliation. Sodium chlorate is almost the only herbicide applied for soil sterilization prior to asphalting parking lots, driveways, etc. It is applied in State programs to control noxious weeds, and is used industrially along railroad rights-of-way, etc. Small amounts are used for agricultural weed control, as along ditch banks. The chief farm use is probably for cotton defoliation. U. S. total consumption for weed control is believed to be about 24 million pounds, down somewhat owing to competition by organic herbicides. Considerable borax (perhaps 20 million pounds) is used mixed with the chlorate to eliminate fire hazard in both weed control and crop defoliation.

Sodium arsenite usage in agriculture is declining because of the hazard from run-off and from the attraction of the salty taste to livestock. Some is applied to kill off potato foliage before harvest; small quantities are used as an algaecide in farm ponds.

2,4-D (2,4-dichlorophenoxy acetic acid) production has risen rapidly to 63 million pounds in 1965, an increase of 37 percent in two years. Production in the first seven months of 1966 was 39,811,000 pounds, up 7 percent over the same period a year ago. 2,4,5-T production also has risen; 1965 production amounted to 11.6 million pounds, up 28 percent from 1963. 2,4,5-T produced through July in 1966 amounted to 8,235,000 pounds, up 27 percent from the first seven months a year ago. Exports of 2,4-D and 2,4,5-T appear to have declined. However, unlike previous years the data for 1965 include only technical material. Large uses of 2,4-D in the United States are for the control of weeds in corn and small grains. U. S. disappearance of 2,4-D during the 1965 season amounted to 50.5 million pounds, that of 2,4,5-T was 7.2 million pounds. These disappearance figures, however, include the military shipments to Viet-Nam.

Many proprietary herbicides have been developed which have advantages on specific crops and against particular types or species of weeds. Production of 2,4-D and 2,4,5-T acids increased nearly 50 percent in the period 1962 to 1965. Between the same years production of all other synthetic organic herbicides more than doubled:

	Production of 2,4-D and 2,4,5-T acids	Production of other organic herbicides
1962	51,366,000 lb.	51,913,000 lb.
1963	55,402,000	64,626,000
1964	65,148,000	93,909,000
1965	74,921,000	112,855,000

MCPA (methylchlorophenoxy acetic acid) is related to 2,4-D but costs much more to produce. It is in general use to control weeds in flax. North Dakota reported 1.1 million pounds used in 1965 of which 730,000 pounds were on flax. The U.S. market for MCPA has been estimated at about a million dollars.

Aminotriazole imports from Canada were 616,000 pounds in 1965; a further importation of 40,000 pounds was made from France.

PCP (pentachlorophenol) and its sodium salt are used industrially as slimicides (see breakdown of uses, page 18). The phenol itself has now only small application as a herbicide and desiccant, this use having declined markedly in the last ten years.

Petroleum fractions are applied extensively for weed control. Kerosene and diesel fuel used as nonselective herbicides amount to about 15 million gallons, and mineral spirits for selective control of weeds to between 15 and 20 million gallons.

Defoliants and desiccants. Annual use of sodium chlorate as a defoliant is believed to be 8 million pounds, somewhat higher than previously estimated. It will probably decline gradually (10 to 15 percent) as it is replaced by organic phosphate defoliants. About half of cotton defoliation is done with sodium chlorate; this is largely west of the Rocky Mountains.

Half or more of the Louisiana cotton crop is defoliated each year. Fifty percent or more of this probably is treated with organic phosphate defoliants, most of the remainder with sodium chlorate and calcium cyanamide.

Arsenic acid (75 percent) is commonly used in Oklahoma and Texas as a cotton desiccant. PCP is not registered for use as a desiccant on cotton except on a seed crop where the seed will not be channelled into food, feed or oil.

Insecticides

Revised figures from the 1963 Census of Manufactures for production and shipments of insecticide preparations are shown in Table 20. Exports of insecticides in 1965 amounted to $81 million, 61 percent of all pesticide exports for the year.

Current Insect Conditions. -- U. S. cotton acreage for harvest in 1966 was reported in August down to 9,793,000 acres, the smallest since 1872. Although cotton acreage was cut 28 percent from the 13,617,000 acres of a year ago, use of cotton insecticides unlike herbicides might not be reduced proportionately. That part of the cotton acreage which requires any insecticide at all varies greatly with area and season. The Census of Agriculture reported 90 percent of cotton acreage in Louisiana and South Carolina treated in 1964 for insect and disease control while only 56 percent was treated in Arkansas and 35 to 40 percent in Tennessee and Missouri.

Control of major insect pests such as the European corn borer, corn rootworms, alfalfa weevil, and numerous others regularly requires large quantities of insecticides.

Table 20. -- Production and shipments of agricultural insecticide preparations, 1958 and 1963

	Production		Shipments 1/	
	1958	1963 2/	1958	1963 2/
	1,000 pounds	1,000 pounds	1,000 pounds	1,000 pounds
Calcium and lead arsenates	n.a.	5,576	n.a.	4,873
Other arsenical insecticides and fungicides, including mixtures	14,352	n.a.	13,987	n.a.
DDT preparations, excluding aerosols and fly sprays	207,775	191,954	210,406	181,717
Same with other toxicants	123,559	156,261	121,972	153,757
Other chlorinated hydrocarbon preparations	n.a.	308,394	n.a.	298,606
Organic phosphate preparations	92,184	219,765	95,157	204,561

1/ Includes interplant transfers.
2/ Revised figures.

Bureau of the Census, 1963 Census of Manufactures, Final Report MC63(2)-28F (code 28790).

Pesticide-Fertilizer Mixtures. -- Considerable tonnages of mixed fertilizers containing insecticides for the control of soil insects are sold in some areas. Aldrin appears to lead as the insecticide with dieldrin and certain others used in less volume.

Pressurized Dispensers (Aerosols). -- When developed early in World War II aerosol "bombs" were solely insecticide dispensers. Less than 10 million units were made in 1947, while in 1965 an estimated 1.8 billion units, the majority in other product categories (hair sprays, food products, etc.), were filled. Total pressurized insect spray production, exclusive of pet products, was 83.9 million units in 1965 compared to 79.8 million the previous year. This was the first time that the number of insecticide units increased since 1962; the peak year was 1960 at 92.5 million units. Insecticide aerosols made in Europe in 1964 were 20 percent ahead of U. S. output of this class of unit.

DDT is still the most economical and useful of insecticides. Consumption in the United States has declined gradually from the high crop year 1958-59 (table 21). Production in the first seven months of calendar 1966 amounted to 89.5 million pounds, four percent more than in the same period of a year ago. Exports in the first six months were 52.7 million pounds of which 29.7 million were shipped as 75 percent formulation. These figures account for reports in May 1966 that DDT was in short supply, even with the six producers manufacturing at capacity. Large quantities had been shipped for use in malaria eradication in India, Pakistan and Thailand. Stocks appear to have recovered somewhat since the large export shipments earlier in the year.

Table 21. -- DDT: U. S. production, inventory change, exports and disappearance, by crop years

Crop Year	Production	Inventory change	Exports	Disappearance
	1,000 pounds	1,000 pounds	1,000 pounds	1,000 pounds
1958-59	156,150	+ 1,099	76,369	78,682
1959-60	160,007	+ 3,250	86,611	70,146
1960-61	175,657	+ 7,893	103,696	64,068
1961-62	162,633	-11,552	106,940	67,245
1962-63	187,782	+12,860	113,757	61,165
1963-64	135,749	+ 8,029	77,178	50,542
1964-65	130,755 1/	+21,218	98,987	52,986

1/ Estimated.

Tariff Commission (production); U. S. Department of Agriculture (inventory); Bureau of the Census (exports).

About three-quarters of the DDT exported is in the form of 75 percent wettable powder primarily for malaria eradication. Thirty to 45 million pounds 100 percent basis are purchased annually by the Agency for International Development (AID), and about half as much by the United Nations Children's Fund (UNICEF). Nine countries each received in 1965 more than a million pounds:

India	17,443,172 lb.	Brazil	2,509,742 lb.
Pakistan	9,873,921	Viet-Nam	1,773,190
Thailand	6,855,468	Republic of the Philippines	1,271,401
Iran	4,263,150	Nepal	1,087,500
Mexico	2,509,771		

Benzene hexachloride (BHC) demand has been rather stationary in the United States but rising rapidly in some other countries. Exports (gamma basis) in 1962 and 1963 accounted for about half of U. S. production. No production figure is available for 1964 when U. S. exports amounted to 2,467,000 pounds gamma basis, indicating increased foreign interest. This was the last year that BHC export data were published.

The chlorinated hydrocarbons aldrin, chlordane, dieldrin, endrin, heptachlor and toxaphene as a group are used extensively against many insect pests in a variety of situations. U. S. consumption, amounting to 34 million pounds in 1953, rose steadily to a level of about 80 million pounds a year since 1961. Production ranged from 104 to 106 million pounds between 1961 and 1964, but increased to 119 million in 1965. Exports of "polychlor" insecticides rose sharply last year.

Methoxychlor is applied mostly in dairy and related industries where its lower animal toxicity permits its use. It is a moderate-volume insecticide with slowly advancing demand.

U. S. production of organophosphorus insecticides in 1965 was 95,561,000 pounds, up 18 percent from 1964, and estimated use in the United States is 65 million pounds. Seventeen percent of the 1965 production was parathion and 30 percent methyl parathion, with most of the remainder proprietary compounds. Exports of technical organophosphates in 1965 amounted to 29 million pounds of which 46 percent went to Mexico, Guatemala, El Salvador and Nicaragua. Central America is a particularly active U. S. market where at least one U. S. firm has located parathion formulating facilities to serve cotton growers. All U. S. firms making the parathions have expanded their production facilities or have expansions under construction, but the growth rate for these insecticides abroad has outstripped even that achieved in the United States.

Parathion is applied mainly to control insect pests of deciduous and citrus fruit trees, forage, and vegetables. Production of methyl parathion in 1966 through July amounted to 26,393,000 pounds. Most production of methyl parathion is in the spring and summer months for use as a cotton insecticide in the United States and abroad.

Malathion, being an oily liquid, can be applied undiluted at rates of a pint or less per acre. Since its approval, this low-volume technique has been used increasingly in campaigns against plant pests conducted cooperatively by the U. S. Department of Agriculture, State agencies and growers. The boll weevil, grasshopper, cereal leaf beetle and Mediterranean fruit fly programs alone consumed 1.6 to 2 million pounds of malathion in 1966. Many thousands of acres of cotton, blueberries, corn and other crops are sprayed using this method by aerial applicators under contract with individual growers.

Carbaryl is the major carbamate insecticide on the U. S. market. Being low in toxicity to fish and warm-blooded animals and breaking down quickly to leave no residue, it is utilized in a number of Federal and State spray programs and in much private insect control. Nearly 95,000 acres of northeastern forests were treated in 1966 with this insecticide under the Federal-State program for gypsy moth control. Carbaryl is employed in the State-financed campaign to eradicate the pink bollworm in California. Several other carbamate insecticides have been cleared recently for limited use.

Mirex baits were applied in 1965 to over four million acres in States from North Carolina to Texas infested with the imported fire ant. At the rate of 3.4 grams applied per acre over 30,000 pounds of technical chemical would be required. This is the third year that mirex bait has been the principal insecticide used in the fire ant control program.

Pyrethrum has been in tightening supply owing to unfavorable weather and labor conditions in eastern Africa. Kenya, Tanganyika (now with Zanzibar known as Tanzania) and Ecuador are the three leading producers in that order. Kenya produced 5,000 tons of dried flowers during the 1964-65 season, down 13 percent from the previous July-June crop year. The Tanzania crop

amounted to over 2,600 tons, up 20 to 25 percent over the previous season. Ecuador produced 2,000 tons and is expanding its acreage to become soon the second largest producing country. Total world production of flowers last year was 9,800 tons or more.

U. S. imports of pyrethrum flowers were down to 41.8 percent of 1964 imports; imports of extract were up 20.5 percent (table 22). The value of all pyrethrum imported in 1965 was $5,992,000, up 14.5 percent from 1964. Imports from Kenya fell off while those from Tanzania and Ecuador rose to more than make up the difference (table 23).

Table 22. -- Pyrethrum imports, volume by country of origin, 1964-65

Source	Flowers (crude)		Extract (advanced)	
	1964	1965	1964	1965
	Pounds	Pounds	Pounds	Pounds
Kenya	700,222	0	274,314	206,630
Tanzania 1/	0	0	91,750	201,400
Burundi and Rwanda	264,260	406,951	0	0
Republic of the Congo	57,240	56,000	1,465	19,356
Ecuador	323,927	66,138	126,000	179,824
Peru 2/	90,305	49,500	0	0
Other	0	22,046	15,250	5,941
Total	1,435,954	600,635	508,779	613,151

1/ From Tanganyika.
2/ Imports of "advanced" from Peru are assumed on the basis of value not to be extract.

Bureau of the Census Report No. FT 246, TSUSA schedules 493-5500 and 493-5600.

Imports of cube root (whole and powdered), nearly all from Peru, amounted in 1965 to 1,766,000 pounds valued at $182,376. The corresponding figures for 1964 were 1,664,000 pounds valued at $166,036, and for 1963 were 3,706,000 pounds valued at $386,201. From one-third to one-half of present imports is used in fishpond management.

Nicotine imports in 1964 were chiefly from England while in 1965 the Netherlands furnished 27 percent (table 24). Imports last year were more than twice those of 1964 and nearly as high as in 1962. Nicotine exports are small and no longer reported separately, but are included with all "vegetable alkaloids," not as a pesticide.

Production of calcium arsenate and lead arsenate in 1965 remained at about the 1964 level (table 2). Federal recommendations for use of calcium arsenate are now limited chiefly to control of the bollworm and cotton leafworm,

Table 23. -- Value of pyrethrum imports, 1965, and comparison with 1964

Source	1965 imports			Percentage of total value	
	Flowers	Extract	Total	1964 1/	1965
	Dollars	Dollars	Dollars	Percent	Percent
Kenya	0	1,996,319	1,996,319	54.8	33.3
Tanzania	0	1,938,225	1,938,225	16.8	32.3
Burundi and Rwanda	126,972	0	126,972	1.6	2.1
Republic of the Congo	18,200	124,212	142,412	.5	2.4
Ecuador	3,839	1,707,495	1,711,334	22.7	28.6
Other	24,514	52,152	76,666	3.6	1.3
Total	173,525	5,818,403	5,991,928	100.0	100.0

1/ Total value of pyrethrum imports in 1964 was $5,235,384.

Adapted from Bureau of the Census data in Report No. FT 246.

Table 24. -- Imports of nicotine and its compounds, 1964-65

Country	Quantity		Value	
	1964	1965	1964	1965
	Pounds	Pounds	Dollars	Dollars
United Kingdom	98,186	153,414	122,385	232,934
Bulgaria	2,094		4,202	
Netherlands		60,604		93,496
France		1,323		5,210
West Germany		4,200		4,445
India	4,410	1,763	3,240	1,371
Pakistan		2,205		1,714
Japan		2,000		2,015
Total	104,690	225,509	129,827	341,185

Bureau of the Census Report No. FT 246, TSUSA schedule 437-1300.

and of lead arsenate to fruit insects (currantworm, apple maggot, codling moth, plum curculio, pear slug, and a variety of caterpillars infesting apple, pear and grape).

Production of horticultural spray oil in 1964 was reported by the Bureau of Mines as 446,000 barrels. At 42 gallons per barrel this amounts to 18,732,000 gallons. This type of petroleum is largely of the light lubricant fraction having a viscosity between 65 and 110 seconds. Spray oils are applied against certain mites and scale insects infesting citrus and deciduous fruit trees, as well as certain leafrollers, treehoppers and aphids. They are sometimes used in mixtures with other insecticides. Florida citrus growers use a sizeable proportion (5 to 7 million gallons) of the annual U. S. spray oil consumption. A large part of the remainder is used on California citrus and in deciduous fruit areas.

Biological Insecticides. -- No great number of nonchemical insect control materials can be expected to be effective and adopted in the near future. However, chemical tools such as attractant baits will no doubt become significant factors during the coming years in helping to reduce need for wider use of the less selective persistent chemical insecticides. The process of development in this field is far slower than for pesticides that rely solely upon their direct action.

Use of insect disease organisms for the control of pest insects has interested entomologists for decades; attempts to spread a disease of grasshoppers date back at least half a century. The difficulty of identifying the organisms, even before learning to culture them, if that be feasible, has resulted in little basic research until lately. The commercial application of many insect disease organisms is impractical because their activity depends upon specific environmental conditions (temperature, moisture, etc.). However, a few biological products already are sold for special uses.

Milky disease spores, dispersed in a calcium carbonate-talc mixture, have been available commercially for 20 to 30 years for the control of Japanese beetle larvae. A culture medium not being available, the spores have been, and still are, propagated in the bodies of the grubs themselves, a laborious procedure. Research is being done on a method by which bacteria can be induced to form spores on a synthetic medium. It is hoped a breakthrough will be made in the near future, thus providing more adequate supplies of the spores for large scale use.

Another microbiological insecticide commercially produced is based on Bacillus thuringiensis. It has been sold under the names "Thuricide," "Biotrol" and "Bakthane" to control many leaf-eating caterpillars (cabbageworm, cabbage looper, alfalfa caterpillar, tobacco budworm, tobacco hornworm, etc.). It is mass-produced by a fermentation process. The insecticide is used most widely in California on vegetable crops.

Fumigants

Separate production and sales data for methyl bromide and for dibromochloropropane are published (table 2). Figures for chloropicrin, dichloropropene, dichloropropene-dichloropropane mixtures and sodium N-methyldithiocarbamate cannot be shown separately by the Tariff Commission; they are included in a miscellaneous group containing a rodenticide (sodium fluoroacetate), metaldehyde, Lethane 384 and a fly repellent. These pesticide statistics do not include such general-use materials as carbon disulfide, carbon tetrachloride, ethylene dichloride and ethylene dibromide, which are common ingredients of liquid grain fumigants.

Nine million pounds of organic fumigants were exported in 1965. They were valued at $2,563,000, down 17 percent from 1964. The largest value ($399,944) went to Brazil and the greatest quantity (1,862,077 pounds) to Japan.

Soil fumigants are used intensively for nematode control wherever crop values permit. In North Carolina 58 percent of tobacco growers used soil fumigants for nematode control in 1965 at a cost of about $18 per acre or a total of $4,000,000. The U. S. Department of Agriculture, in cooperation with the New York State Department of Agriculture and Markets, used 582,660 pounds of D-D Mixture for the control of the golden nematode on Long Island in 1965. Under the Federal-State cooperative program in Florida during the 1965 fiscal year, the Florida Department of Agriculture used 493,000 pounds of D-D Mixture and 705,900 pounds of ethylene dibromide to control the burrowing nematode which causes spreading decline of citrus.

Figures on total annual use of neither soil fumigants nor nematocides are available. Shipments of soil fumigants were reported in the 1963 Census of Manufactures to be 29,239,000 pounds.

Three bromine derivatives, methyl bromide, dibromochloropropane, and ethylene dibromide, used as fumigants required for their manufacture nearly eight percent of 1965 bromine production totalling 253 million pounds. Methyl bromide, 84 percent bromine, required 4.7 percent of it (12 million pounds).

Paradichlorobenzene has been in short supply for moth control recently owing to one manufacturer of long standing no longer producing and a newer plant having production problems. Refined naphthalene is plentiful for moth balls, cakes, and crystals. The bulk of it is from petroleum sources. Naphthalene is an intermediate which makes up nearly two-thirds of the weight of carbaryl.

Rodenticides

The destructive action of vertebrate pests each year in the United States results in significant economic losses through food consumption, food contamination, disease spread, soil erosion, grazing competition, reforestation hindrance,

plane flight jeopardy, structural damage, and even personal defense. Approximately 800 companies have now registered over 2,000 pesticide products to control vertebrate pests. The majority of these are rodenticides.

Some 800 rat control products containing anticoagulant rodenticides (warfarin, Prolin, Pival, or Fumarin) have been registered. Many rodenticides containing acute toxicants such as strychnine, thallium, arsenic, and sodium fluoroacetate also have been registered. Dealers indicate that the market for red squill as a rodenticide is essentially nonexistent.

Imports of strychnine and its salts in 1965 amounted to 190,310 ounces, 4 percent more than in 1964 and 42 percent over 1963 (table 25). Nux vomica shipments, a source of strychnine, received from abroad in 1965 amounted to 9,005 pounds valued at $781. Although appreciable quantities of nux vomica and strychnine are used in controlling certain vertebrate pests these materials are also important to the drug industry.

Table 25. -- Imports of strychnine and its salts

Country	Quantity		Value	
	1964	1965	1964	1965
	Ounces	Ounces	Dollars	Dollars
United Kingdom	22,300	34,610	19,206	29,478
France	3,500		2,849	
Israel	46,800	45,000	38,531	34,470
Lebanon	1,000		808	
India	106,000	105,700	89,376	56,738
Republic of Korea		5,000		3,500
Japan	3,000		2,426	
Total	182,600	190,310	153,196	124,186

Bureau of the Census FT 246, TSUSA No. 437-1600.

Of vertebrate poisons other than rodenticides, the lampreycide 3-trifluoromethyl-4-nitrophenol (trade designation, Lamprecid 2770) is notable for its 80 percent reduction in the lamprey population of Lake Superior. The U. S. and Canadian Governments are using about 150,000 pounds of this chemical annually. Lake Michigan was treated in 1960-61 but will not show maximum results until 1970. Treatment of Lake Huron is yet to be approved. The eel-like parasitic lamprey had virtually wiped out the Great Lakes fishing industry by the 1950's.

The Post Office Department spent about $200,000 in 1965 for dog repellents for the protection of mail carriers. Use of the repellents was over 84 percent effective under favorable experimental conditions. The repellent is an aerosol preparation containing either capsicum oleoresin or the active alkaloid capsaicin.

Dry Carriers and Diluents

The market for pesticides in granular form is growing rapidly. These preparations owe their popularity to their ability to fall through trees and other vegetation when applied from the air, for placement on or near the ground to have maximum effectiveness against weeds, soil insects, etc. Their use avoids undesirable residue on vegetation in the treated area, drift to susceptible crops, and loss of toxicant by drift. Vermiculite and the clay attapulgite are the carriers used most in granule production. Particle size must be kept within certain limits. The active chemical is coated on the surface of the granule, along with urea when acidity of the clay must be neutralized to avoid breakdown of the pesticide. The demand for clay carrier suitably sized for this purpose in 1964 amounted to 70 million pounds and jumped to an estimated 130 million in 1965, enough to make 150 million pounds of finished preparations. The 1966 market is expected to require 200 million pounds or more of this type of carrier.

Fuller's earth exhibits a marked increase in use as a dry carrier and diluent of pesticides while kaolin continues to decline for this purpose (table 26). Of the total quantities sold or used by producers in the United States 21.3 percent of the pyrophyllite went into pesticide formulation, 20.5 percent of the fuller's earth and 5.5 percent of the talc.

Table 26. -- Consumption of some dry carriers and diluents in pesticide formulation, 1962-65

Material	1962	1963	1964	1965
	1,000 pounds	1,000 pounds	1,000 pounds	1,000 pounds
Talc and soapstone	96,090	79,652	77,854	77,682
Pyrophyllite	62,594	50,816	55,322	58,160
Fuller's earth	178,870	190,764	232,688	276,870
Kaolin	67,878	67,158	39,672	26,028
Fire clay and stoneware clay	n.a.	9,828	12,314	13,130
Bentonite	n.a.	14,526	12,384	12,980

Bureau of Mines, "Minerals Yearbook" and "Mineral Industry Surveys."

Liquid Solvents and Diluents

Large quantities of light petroleum fractions and xylene types are used as solvent carriers of pesticides. Suitable emulsifiers are added to the solutions, thus forming emulsifiable concentrates ready for dilution with water. Kerosene and heavier aromatics are used in large quantities but xylenes are increasing for this purpose as they are adapted to formulating liquids containing multiple (2, 3 or even 4) toxicants. The xylenes are less toxic to plants, they are purer and they are better solvents than heavy aromatic types.

Consumption of liquid formulations is growing, replacing much of the use of dusts (except perhaps where these are in the form of wettable powders). One reason is that liquid sprays do not drift as much as dusts. The total volume of xylenes, heavier aromatics and kerosenes used in 1965 is estimated at 50 million gallons of which nearly half was xylene. It should increase to 55 million gallons by 1967.

Odorless base oils in the kerosene range have long been used as carriers for household insecticides and cattle fly sprays.

No recent estimates of emulsifier use in liquid concentrates are available. Lignosulfonates derived from spent sulfite paper-making liquids, are anionic surfactants used in wettable-powder pesticides.

List of Tables

Mention of brand or trade names does not constitute endorsement by the Department of Agriculture

If you use pesticides, apply them only when needed and handle them with care. Follow the directions and heed all precautions on the container label. If pesticides are handled improperly, they may be injurious to humans, domestic animals, desirable plants, honey bees and other pollinating insects, fish and wildlife, and may contaminate water supplies.

The Agricultural Research Service,
Economic Research Service,
Forest Service,
and Office of Information
cooperated with the
Agricultural Stabilization and Conservation Service
in reviewing this report.