Pesticide Applications---
Commercial Charges

D. Curtis Mumford

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COMMERCIAL APPLICATIONS of agricultural chemicals is now big business in Oregon. Total bill for pesticide applications (not including cost of chemicals) is estimated at more than one million dollars annually. This study summarizes 2,780 individual jobs on 195,630 acres utilizing 44 separate chemicals and 36 combinations of chemicals. Pests attacked by commercial applicators included 36 separate types of insects, 27 types of weeds, and 9 distinct diseases. Even mice and rabbits appeared in the combat lineup. For each of these many pests the bulletin summarizes custom charges both by "ground" and "air" applicators. The economic significance of important applications is shown in terms of increased product necessary to cover combined costs of chemical and application.

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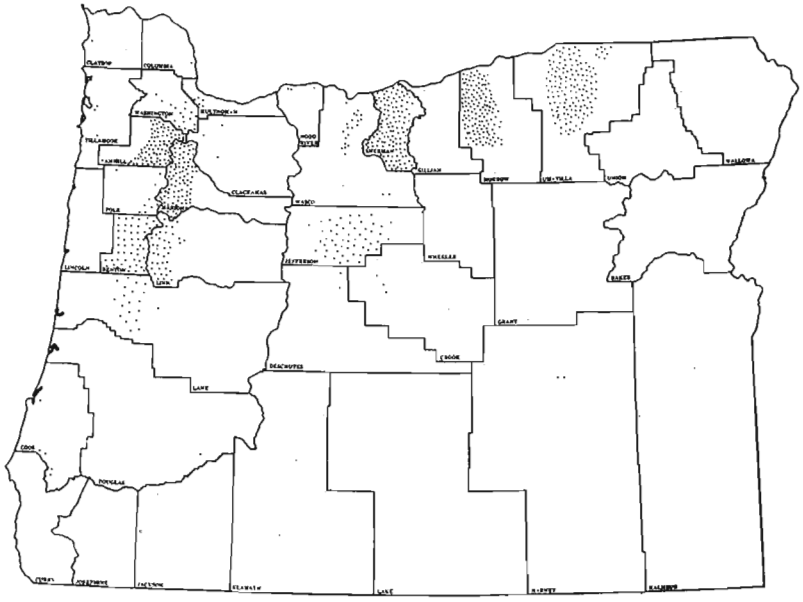


Each dot represents 250 acres of chemical applications studied.

Introduction

This report presents a summary of more than one quarter million dollars worth of commercial applications (not counting cost of materials applied). It includes 2,780 chemical application jobs performed by commercial applicators on 195,630 acres of farm, ranch, and forest lands in Oregon during 1957. It brings up to date material summarized and published in Station Bulletin 566, issued in January, 1958.

Objectives of this study were to find out (1) acreages of specific crops treated by commercial applicators, (2) pests attacked, (3) kinds and amounts of chemicals used, and (4) customary charges for different methods of application. Results are presented from three standpoints: crops treated, pests attacked, and chemicals used. "Air" and "ground" applications are considered separately.

Findings

Data were obtained through cooperation of 13 commercial applicators who sent copies of their daily job sheets to Oregon State College to be tabulated and analyzed.

Table 1 presents a summarized picture of all work done by cooperating applicators in this study. From an acreage standpoint, air applications accounted for 95% of total work done. From standpoint of number of jobs, however, air applications accounted for only 73% of the total. This is because average size of air jobs was 88.3 acres compared with 13.4 acres for ground jobs. As a rule, smaller jobs are more expensive per acre than larger jobs. Perhaps largely for this reason, average ground charge per acre in this study was $2.60 compared with an average charge of $1.35 per acre for jobs done from the air. (See Table 1.) As a sideline to their regular operations, the chemical applicators did some fertilizing, seeding, and combinations of other operations, but these activities were not too important from the overall standpoint. (See Table 1.)

Table 1. Summary of Work

Type of operation	No. of jobs	Total area	Area per job	Charge* per acre	Total application charges*
		Acres	*Acres*		
Air application					
Dusting	730	23,207	31.8	$2.01	$ 46,635
Spraying	1,111	123,273	111.0	1.21	148,646
Fertilizing	212	14,635	69.0	1.58	23,093
Other	46	24,204	526.2	1.33	32,271
Total	2,099	185,319	88.3	$1.35	$250,645
Ground application					
Dusting	178	1,315	7.4	$1.74	$ 2,283
Spraying	589	8,957	15.2	2.72	24,392
Fertilizing	3	26	8.7	2.96	77
Other	1	12	12.2	4.92	60
Total	771	10,310	13.4	$2.60	$ 26,812
Total ground and air applications					
Dusting	908	24,523	27.0	$1.99	$ 48,918
Spraying	1,700	132,230	77.8	1.31	173,038
Fertilizing	215	14,661	68.2	1.58	23,170
Other	47	24,216	515.2	1.34	32,331
Grand total	2,870	195,630	68.2	$1.42	$277,457

* Application charge does not include cost of chemical.

Table 2. Summary of All Chemical Work Done by Crop and Land Use

Crop or land use	Ground application				Air application			
	No. of jobs	Total area	Av. area per job	Av. appl. charge per acre	No. of jobs	Total area	Av. area per job	Av. appl. charge per acre
		Acres	*Acres*			*Acres*	*Acres*	
Dusting								
Alfalfa	.....	.....	.....	.....	1	32.0	32.0	$1.50
Barley	.....	.....	.....	.....	1	48.0	48.0	2.75
Clover	.....	.....	.....	.....	4	139.0	34.8	1.27
Field peas	.....	.....	.....	.....	123	3,354.0	27.3	1.78
Vetch	.....	.....	.....	.....	152	5,408.5	35.6	1.77
Other legumes	.....	.....	.....	.....	4	111.0	27.8	1.88
Root crops	.....	.....	.....	.....	1	8.0	8.0	1.50
Peppermint	.....	.....	.....	.....	3	265.0	88.3	2.06
Sugar beets	.....	.....	.....	.....	1	6.0	6.0	3.00
Cherries	7	52.0	7.4	$1.60	135	2,272.5	16.8	2.98
Peaches	7	26.0	3.7	2.12	3	165.0	55.0	5.00
Prunes and plums	6	35.5	5.9	1.77	1	16.0	16.0	2.00
Other tree fruits	1	1.0	1.0	5.00	1	10.0	10.0	2.00
Filberts and hazelnuts	157	1,201.0	7.6	1.73	16	347.0	21.7	2.93
Walnuts	.....	.....	.....	.....	1	30.0	30.0	1.50
Blackberries	.....	.....	.....	.....	3	21.0	7.0	3.48
Red raspberries	.....	.....	.....	.....	7	79.5	11.4	3.50
Strawberries	.....	.....	.....	.....	18	730.0	40.6	2.61
Other small fruit	.....	.....	.....	.....	1	7.0	7.0	3.29
Beans	.....	.....	.....	.....	161	7,342.0	45.6	1.64
Beets	.....	.....	.....	.....	11	209.0	19.0	1.48
Onions	.....	.....	.....	.....	1	3.0	3.0	5.00
Peas	.....	.....	.....	.....	45	1,530.0	34.0	2.41
Potatoes	.....	.....	.....	.....	28	738.0	26.4	2.64
Nursery crops	.....	.....	.....	.....	3	51.0	17.0	4.02
Other speciality horticultural crops	.....	.....	.....	.....	4	66.0	16.5	3.39
Combinations of different crops	.....	.....	.....	.....	1	219.0	219.0	2.37
Dust								
Total	178	1,315.5	7.4	$1.74	730	23,207.5	31.8	$2.01

Table 2. Summary of All Chemical Work Done by Crop and Land Use (Continued)

Crop or land use	Ground application				Air application			
	No. of jobs	Total area	Av. area per job	Av. appl. charge per acre	No. of jobs	Total area	Av. area per job	Av. appl. charge per acre
		Acres	*Acres*			*Acres*	*Acres*	
Spraying								
Barley	34	996.4	29.3	$0.79	35	4,035.5	115.3	$1.04
Corn	12	288.5	24.0	2.53	4	170.0	42.5	1.41
Oats	13	170.0	13.1	1.41	4	270.5	67.6	1.23
Rye	.....	.....	.....	.....	1	325.0	325.0	1.00
Wheat	93	1,432.0	15.4	1.78	320	83,487.8	260.9	1.08
Grain or mixture	73	1,593.3	21.8	1.74	28	3,005.5	107.3	1.22
Other grains	6	111.0	18.5	0.70	8	460.0	57.5	1.22
Alfalfa	5	103.0	20.6	2.02	21	248.5	11.8	1.88
Clover	24	476.5	19.9	2.20	106	2,566.0	24.2	1.91
Field peas	1	16.2	16.2	3.52	54	1,344.0	24.9	1.53
Vetch	.....	.....	.....	.....	168	7,815.0	46.5	1.47
Other legumes	.....	.....	.....	.....	2	150.5	75.3	1.61
Bentgrass	3	152.0	50.7	1.85	1	353.0	353.0	1.00
Bluegrass	.....	.....	.....	.....	28	628.0	22.4	1.48
Fescue	4	93.0	23.3	2.00	11	702.0	63.8	1.28
Ryegrass	2	19.7	9.9	2.18	31	2,060.0	66.5	1.28
Other grasses	.....	.....	.....	.....	10	1,060.5	106.1	1.05
Root crops	.....	.....	.....	.....	7	193.0	27.6	1.48
Idle land	28	173.5	6.2	3.53	18	1,884.5	104.7	1.12
Peppermint	.....	.....	.....	.....	3	121.0	40.3	1.49
Sugar beets	7	197.3	28.2	2.14	2	42.0	21.0	1.50
Other specialty field and drug crops	.....	.....	.....	.....	3	102.0	34.0	2.51
Apples	2	3.5	1.8	4.29	.....	.....	.....	.....
Peaches	1	3.0	3.0	6.67	.....	.....	.....	.....
Prunes and plums	2	3.3	1.7	8.79	.....	.....	.....	.....
Other tree fruits	4	14.9	3.7	3.89	.....	.....	.....	.....
Filberts and hazelnuts	6	62.5	10.4	4.14	1	4.0	4.0	.....
Blackberries	2	11.8	5.9	5.42	.....	.....	.....	.....
Red raspberries	1	16.0	16.0	5.00	.....	.....	.....	.....
Strawberries	80	692.6	8.7	6.09	4	104.0	26.0	2.88
Asparagus	4	50.5	12.6	2.02	.....	.....	.....	.....
Beans	12	225.4	18.8	2.65	10	119.5	12.0	3.15
Beets	.....	.....	.....	.....	9	221.0	24.6	1.67
Cabbage	.....	.....	.....	.....	1	3.0	3.0	1.33
Cucumbers	3	19.0	6.3	1.53	.....	.....	.....	.....
Peas	5	332.5	66.5	2.14	25	1,405.0	56.2	2.45
Potatoes	3	11.0	3.7	3.64	146	5,232.5	35.8	1.98
Other vegetables	.....	.....	.....	.....	2	9.0	4.5	1.00
Permanent pasture	8	52.1	6.5	3.82	3	35.5	11.8	1.41
Rangeland	.....	.....	.....	.....	2	2,672.0	.....	0.73
Timber	.....	.....	.....	.....	6	392.0	65.3	5.73
Other uses	147	1,577.9	10.7	4.87	26	1,749.0	67.3	0.67
Combinations of different crops	4	58.2	14.6	4.73	11	302.5	27.5	1.64
Spray								
Total	589	8,956.6	15.2	$2.72	1,111	123,273.3	111.0	$1.21
Dust and Spray								
Grand total	767	10,272.1	13.4	$2.60	1,841	146,480.8	80.0	$1.33

Pest Control

Chemicals were applied for pest control on 162,619 acres, comprising 2,629 jobs. Seventy-four individual pests and 88 combinations were treated—some from the air and some from the ground. These included 36 individual insects and 21 combinations of insects; 27 individual weeds and 58 combinations; 9 individual diseases and 9 combinations; and two kinds of rodents—mice and rabbits. These two latter pests were attacked from the air.

Pest control in this publication is summarized under three headings: (1) Crops and land uses treated, (2) pests attacked, and (3) chemicals used.

Crops and land uses treated

Almost every crop has at least one pest capable of reducing total production and/or impairing quality. To combat these many pests, farmers are turning to application of more and more chemicals.

Tabulations in Table 2 show that 50 crops or land uses received some type of chemical treatment by commercial applicators in this study. Principal crops to which chemical dusts and sprays were applied commercially for the purpose of controlling pests were in the following order: wheat, vetch, pole snap beans, potatoes, barley, field peas, canning peas, clover, cherries, ryegrass, and filberts.

Data are presented in Table 2 to show all dusting jobs separately from spraying jobs. "Ground" jobs have been kept separate from "air" jobs. In each case, number of jobs, total area, average area per job, and average commercial charge per acre for the application (not including charge for the chemical itself) are shown.

All dusting jobs done by ground rigs were in orchards. Other dusting jobs, including also many orchard dusting jobs, were done from the air (Table 2). Spraying, in this study, was far more popular than dusting. In fact, over five times as many acres were sprayed as were dusted. A glance at Table 2 will show that application of spray from the air has been many times more popular than application from the ground. Most probably the chief reason for this was the relative cost of each. Average charge per acre for "ground" application was $2.72 compared to only $1.21 for "air" application. Perhaps the main reason for less costly "air" application was that air jobs averaged 111 acres each, whereas the ground jobs averaged only 15 acres. Usually larger jobs can be done for less cost per acre than smaller jobs.

Pests attacked

Table 3 has been constructed to show each group of pests separately. Insects are listed first, then weeds in alphabetical order, and finally various diseases. Table 3 describes a specific pest, when it was treated, and what chemical was used. Shown for each pest separately are time range of treatment, number of jobs done, area treated, and name of the chemical or chemicals used. Number of jobs done and acreage covered by "air" have been kept separate from ground jobs.

Insects: Some pests are attacked over a much longer period than others. For example, aphids, first insects listed in Table 3, are attacked or combatted from May 16 to September 15—a period of four months—while the Colorado potato beetle was attacked only during June. A longer time span is required for aphids because they attack several different crops. Note different chemicals used: DDT, malathion, methoxyclor, parathion, sulfur, systox, and TEPP.

Mice and rabbits were listed with insects for convenience. They both were attacked from the air. Mice were combatted over an 8-month period.

Weeds: Under weeds (Table 3) the more important ones treated were tarweed, sagebrush, mustard, and morning glory. The chemical 2,4-D played a big part in this attack which was made chiefly from airplanes. Approximately 116,000 acres were treated for weeds in this study.

Disease: Blight, brown rot, and rust were most important diseases attacked. Note the several kinds of chemicals used (Table 3). Control of blight started in early April and extended through early October.

Chemicals used

A total of 44 individual chemicals and 36 combinations of 2, 3, and 4 chemicals were reported applied by commercial applicators (Table 4).

Chemicals used for pest control are called pesticides. The term includes all insecticides, fungicides, herbicides, and defoliants applied to agricultural crops. Table 4 summarizes pesticide materials applied to agricultural crops and land uses. The chemical 2,4-D, a weed killer, was most important. In this study alone it was used to treat 102,802 acres in 750 jobs—mostly from the air and in spray form (Table 4). DDT was next with 22,343 acres divided almost equally between spray and dust. Malathion was third in importance with 6,080 acres treated mostly in form of dust and from the air.

Charges for chemical materials varied with kinds used, methods of application, and with individual operators. Most chemicals were supplied by farmers, especially with "air" jobs. Shown for each chemical and each combination of chemicals in Table 4 are number of jobs, method of application (whether ground or air), whether spray or dust, acreage treated, average amount of chemical applied per acre, its cost when known, and per acre charge for its application.

Table 3. Summary of All Pests Treated

Pest	Time range	Number of jobs		Area treated		Chemicals used
		air	ground	air	ground	
				Acres	*Acres*	
Insect						
Aphids	May 16-Sept. 15	149	5	7,063.0	72.5	DDT, Malathion, Methoxyclor, Parathion, Sulfur, Systox, TEPP
Colorado Potato Beetle	June 1-June 30	15	.....	576.5	.....	DDT
Flea Beetle	June 1-Aug. 31	12	2	325.0	5.0	DDT, Aldrin, Malathion
Mint Flea Beetle	July 16-July 31	1	.....	70.0	.....	DDT
Syneta Beetle	Apr. 16-Apr. 30	10	.....	153.5	.....	Kolokill, Niatox
Diabrotica	May 1-Sept. 15	6	.....	213.0	.....	DDT, Copper, Methoxyclor, Sulfur
Beetles (unidentified)	July 1-Oct. 15	3	.....	106.0	.....	DDT, Toxaphene
Clover Root Borer	Apr. 1-Apr. 15	.....	1	.....	5.3	Aldrin
Peach and Prune Root Borer	July 16-Aug. 31	.....	2	.....	3.3	DDT
Lygus Bug	Apr. 16-Aug. 15	23	4	449.0	111.0	DDT, BHC Gamma, Systox, Toxaphene
Meadow Spittle Bug	Apr. 16-May 31	3	1	42.0	12.2	DDT, Malathion, Methoxyclor
Bugs (unidentified)	June 16-June 30	1	.....	200.0	.....	DDT
Tent Caterpillar	May 16-June 15	4	1	52.0	.5	DDD, DDT, Malathion
Cherry Fruitfly	May 1-July 15	94	1	1,538.5	3.0	DDT, Kolokill, Lead Arsenate, Malathion, Methoxyclor, Parathion, Rotenone
Flies	June 16-June 30	1	.....	30.0	.....	Lindane, Malathion
Mosquitoes	June 1-Sept. 15	18	.....	1,475.0	.....	DDT, Pyrenone
Filbert Moth	July 1-Aug.15	9	.....	237.0	.....	DDT, Lead Arsenate
Mineola Moth	Apr. 1-Apr. 15	6	.....	108.0	.....	DDT
Nitidulids	July 16-Aug. 15	2	2	5.0	10.3	Perthane, Phosdrin, Toxaphene
Slugs	Oct. 16-Nov. 15	2	.....	98.0	.....	Metag (slug bait pellets)
Spiders	June 16-June 30	.....	1	.....	1.8	Lime Sulfur
Symphyllids	May 1-May 31	.....	2	.....	17.0	Aldrin, Parathion
Filbert Leaf Roller	Apr. 1-June 30	7	46	120.0	361.4	DDD, DDT, Lead Arsenate
Tier, Omniverous Leaf	May 1-June 30	11	2	596.0	14.0	DDT, Lead Arsenate, Methoxyclor, Ziram
Thrips	July 16-July 31	1	.....	20.0	.....	TEPP
Clover Leaf Weevil	June 16-June 30	1	.....	24.0	.....	DDT
Pea Weevil	May 1-July 15	214	.....	6,168.0	.....	2,4-D, DDT, Malathion, Parathion, TEPP
Strawberry Root Weevil	Apr. 16-Apr. 30	.....	14	.....	57.0	Aldrin
Vetch Weevil	June 1-July 15	317	.....	13,180.5	.....	DDT, Parathion
Cutworms	May 16-July 31	5	.....	109.0	.....	DDT, Toxaphene
Lesser Apple Worm	June 16-June 30	.....	1	.....	3.0	Ferbam, Lead Arsenate
Wireworms	Apr. 16-June 15	11	3	757.0	22.0	Aldrin, Heptachlor
Alfalfa Looper	June 1-June 15	2	.....	120.0	.....	DDT
Army Worm	June 1-June 15	3	.....	600.0	.....	Toxaphene
Worms (unidentified)	Apr. 1-Aug. 31	.....	115	.....	883.8	DDT, Ferbam, Lead Arsenate, Malathion, Sulfur
Insects (unnamed)	Apr. 16-June 30	4	2	146.5	19.4	DDT, Aldrin, Malathion, Parathion
Mice	Apr. 1-Nov. 30	52	.....	935.5	.....	Poison Bait, Toxaphene
Rabbits	Mar. 16-June 30	8	.....	129.0	.....	Toxaphene
Two Insects						
Aphids-Diabrotica	July 1-Aug. 15	47	.....	1,869.5	.....	DDT, Malathion, Methoxyclor, Sulfur, TEPP
Aphids-Potato Beetle	June 1-June 30	17	.....	504.5	.....	DDT, Malathion
Aphids-Lygus Bug	June 16-Aug. 31	93	1	2,694.0	60.0	DDT, 2,4-D, Aldrin, Malathion, Parathion, Systox, Toxaphene
Aphids-Nitidulids	July 16-Aug. 15	2	.....	66.0	.....	Malathion
Aphids-Thrips	July 16-July 31	1	.....	3.0	.....	Parathion

Table 3. Summary of All Pests Treated (Continued)

Pest	Time range	Number of jobs		Area treated		Chemicals used
		air	ground	air	ground	
				Acres	*Acres*	
Aphids-Alfalfa Weevil	July 16-Aug. 15	4	.....	41.0	.....	DDT, Malathion, Toxaphene
Aphids-Clover Leaf Weevil	July 16-July 31	3	.....	68.0	.....	Toxaphene
Aphids-Pea Weevil	May 16-July 15	4	.....	73.0	.....	DDT, Parathion
Aphids-Mice	July 16-July 31	1	.....	26.0	.....	Toxaphene
Caterpillars-Diabrotica	June 1-June 15	1	.....	23.0	.....	DDT
Lygus Bug-Midge	June 16-June 30	2	.....	21.0	.....	DDT, Toxaphene
Lygus Bug-Alfalfa Weevil	July 1-July 31	7	.....	105.0	.....	DDT, Kolokill, Malathion, Toxaphene
Lygus Bug-Clover Leaf Weevil	July 1-Aug. 31	18	.....	425.0	.....	DDT, Kolokill, Malathion, Toxaphene
Lygus Bug-Clover Seed Weevil	June 16-June 30	1	.....	30.0	.....	DDT, Malathion
Lygus Bug-Pea Weevil	July 1-July 15	3	.....	87.0	.....	DDT, Malathion, Parathion
Lygus Bug-"Weevils"	Apr. 30-July 15	2	.....	50.0	.....	Toxaphene
Lygus Bug-Mice	July 1-July 15	1	.....	5.0	.....	Toxaphene
Clover Leaf Weevil-Vetch Weevil	June 16-June 30	1	.....	80.0	.....	DDT
Clover Leaf Weevil-Mice	July 16-July 31	1	.....	24.0	.....	Toxaphene
Pea Weevil-Vetch Weevil	June 1-June 15	4	.....	109.0	.....	DDT
Spiders-Thrips	July 1-July 15	1	.....	26.0	.....	TEPP
Insects—subtotal		1,209	206	41,977.0	1,662.5	
Weeds						
Alfalfa	Apr. 16-Sept. 15	3	3	27.0	72.0	2,4-D
Brush	Apr. 16-Nov. 15	7	27	407.0	1,040.2	2,4-D, 2,4-5TP, Brush Killer
Canada Thistle	Mar. 1-Sept. 15	4	43	357.0	421.5	2,4-D, 2,4-5T, ATA, Brush Killer
Clover	Apr. 1-July 31	14	.....	249.5	.....	2,4-D, 2,4-5T, Brush Killer
Dandelion or Daisy	May 1-May 15	1	.....	10.0	.....	2,4-D
Fanweed	June 1-June 30	2	.....	197.0	.....	2,4-D
Garlic or Onion	Mar. 16-Apr. 30	4	.....	106.0	.....	2,4-D
German Alfalfa	July 1-July 15	1	.....	33.0	.....	2,4-D
Gorse	Aug. 16-Aug. 31	.....	1	.....	1.0	Brush Killer
Grass	Feb. 1-Nov. 15	3	8	67.0	119.1	2,4-D, 2,4-DB, ATA, Chloro IPC, Dalapon, DCMU (Karmex DW), IPC
Lambs Quarter	Apr. 1-Aug. 31	2	9	20.0	92.5	2,4-D
Lupine	May 1-May 15	1	.....	10.0	.....	2,4-D
Morning Glory	May 16-Nov. 15	10	10	1,375.5	50.2	2,4-D, Dinitro P.E.
Mustard	Apr. 16-June 30	12	3	2,491.0	20.0	2,4-D
Pigweed	Apr. 1-July 31	1	11	57.0	243.0	2,4-D, Dinitro P.E.
Quackgrass	Feb. 15-Feb. 28	1	.....	60.0	.....	ATA
Radish	June 1-June 15	.....	1	.....	9.0	2,4-D
Russian Thistle	May 1-May 15	.....	1	.....	9.0	2,4-D
Ryegrass	Oct. 16-Oct. 31	.....	1	.....	30.0	IPC
Sagebrush	May 16-June 15	3	.....	2,682.0	.....	2,4-D
Sunflower	Apr. 16-Apr. 30	1	1	105.0	12.0	2,4-D
Tansy Ragwort	June 16-Aug. 15	.....	4	.....	11.3	Brush Killer
Tarweed	Mar. 1-Dec. 31	59	1	21,942.0	30.0	2,4-D
Tussock	Sept. 16-Sept. 30	.....	1	.....	1.5	Brush Killer
Vetch	Jan. 1-Dec. 15	13	25	410.0	559.7	2,4-D, MCP
Weeds (unnamed)	Jan. 1-Nov. 30	271	239	40,387.3	3,215.6	2,4-D, 2,4-5T, Aldrin, ATA, Brush Killer, Chlorea, Chloro IPC
Wild Blackberry	June 16-Sept. 30	.....	18	.....	42.5	2,4-5T, Brush Killer
Defoliation	June 16-Oct. 15	37	5	1,251.0	56.5	2,4-D, Arsenic Compounds, Atlas A, Dinitro General

Table 3. Summary of All Pests Treated (Continued)

Pest	Time range	Number of jobs		Area treated		Chemicals used
		air	ground	air	ground	
				Acres	*Acres*	
Two weeds						
Alfalfa-Canada Thistle	Apr. 16-Apr. 30	1	1	35.0	56.0	2,4-D
Alfalfa-Lambs Quarter	May 16-May 31	.....	3	.....	46.0	2,4-D
Alfalfa-Pigweed	Apr. 16-Apr. 30	.....	1	.....	8.0	2,4-D
Barley-Pigweed	May 1-May 15	.....	1	.....	27.0	2,4-D
Brush-Alder	Aug. 16-Aug. 31	.....	1	.....	5.0	2,4-D, Brush Killer
Brush-Tansy Ragwort	May 16-May 31	.....	1	.....	4.6	2,4-D, Brush Killer
Brush-Inhibit Sprouting	July 16-July 31	.....	1	.....	2.5	2,4-D, Brush Killer
Canada Thistle-Brush	May 16-Aug. 31	.....	1	.....	.1	2,4-5T, ATA
Canada Thistle-Morning Glory	June 16-Sept. 15	1	6	169.0	45.7	2,4-D
Canada Thistle-Mustard	Apr. 16-June 15	2	2	760.0	108.0	2,4-D
Canada Thistle-Nettles	May 16-May 30	.....	1	.....	6.3	2,4-D
Canada Thistle-Pigweed	June 1-June 30	.....	2	.....	117.0	2,4-D, Brush Killer
Canada Thistle-Radish	Apr. 16-June 15	.....	4	.....	70.0	2,4-D, ATA
Canada Thistle-Sunflower	May 1-May 15	.....	1	.....	75.0	2,4-D
Canada Thistle-Tansy Ragwort	May 16-July 15	.....	11	.....	44.0	2,4-D, ATA, Brush Killer
Canada Thistle-Vetch	Apr. 16-May 31	.....	4	.....	84.0	2,4-D
Canada Thistle-Weeds	Apr. 16-Aug. 31	1	13	150.0	220.3	2,4-D, ATA, Brush Killer
Canada Thistle-Wild Blackberry	Aug. 1-Aug. 15	.....	2	.....	1.8	2,4-5T, Brush Killer
Chinese Lettuce-Mustard	Apr. 1-Apr. 30	.....	2	.....	23.0	2,4-D
Chinese Lettuce-Pigweed	Apr. 1-June 15	.....	4	.....	87.0	2,4-D
Chinese Lettuce-Weeds	Apr. 1-Apr. 30	.....	2	.....	51.0	2,4-D
Clover-Weeds	Apr. 16-Apr. 30	12	2	405.0	24.0	2,4-D
Lambs Quarter-Dock	Apr. 16-Apr. 30	.....	1	.....	21.0	2,4-D
Lambs Quarter-Garlic	May 1-May 15	.....	1	.....	3.0	2,4-D
Lambs Quarter-Morning Glory	May 16-June 30	1	1	32.0	40.0	2,4-D
Lambs Quarter-Mustard	May 1-May 31	.....	4	.....	45.7	2,4-D
Lambs Quarter-Pigweed	Apr. 1-July 15	2	23	40.0	418.2	2,4-D, MCP
Lambs Quarter-Salt Bush	Apr. 1-May 15	.....	2	.....	10.0	2,4-D
Lambs Quarter-Sunflower	May 16-May 31	.....	2	.....	45.0	2,4-D
Lambs Quarter-Weeds	May 16-July 31	.....	5	.....	84.0	2,4-D, MCP
Morning Glory-Pigweed	May 16-June 30	1	1	28.0	130.0	2,4-D, MCP
Morning Glory-Weeds	May 16-May 31	.....	1	.....	15.0	2,4-D
Mustard-Fanweed	May 1-May 15	1	.....	120.0	.....	2,4-D
Mustard-Filaree	Apr. 16-Apr. 30	1	.....	64.0	.....	2,4-D
Mustard-Grass	Mar. 1-Apr. 30	12	.....	3,789.0	.....	2,4-D
Mustard-Pigweed	May 16-May 31	.....	3	.....	29.0	2,4-D
Mustard-Tarweed	Mar. 1-May 31	58	3	24,090.0	200.0	2,4-D
Mustard-Russian Thistle	May 16-May 31	1	.....	400.0	.....	2,4-D
Mustard-Weeds	Feb. 1-May 31	1	1	75.0	7.0	2,4-D, MCP
Pigweed-Weeds	Apr. 1-June 15	.....	4	.....	80.0	2,4-D
Radish-Vetch	Apr. 16-Apr. 30	.....	1	.....	15.0	2,4-D
Radish-Weeds	May 1-May 15	.....	1	.....	33.0	2,4-D
Russian Thistle-Weeds	May 16-May 31	1	.....	390.0	.....	2,4-D
Tarweed-Dandelion	Mar. 16-Mar. 31	1	.....	70.0	.....	2,4-D
Tarweed-Filaree	Mar. 1-Apr. 15	6	.....	2,755.0	.....	2,4-D
Tarweed-Grass	Apr. 1-Apr. 15	3	.....	777.0	.....	2,4-D

Table 3. Summary of All Pests Treated (Continued)

Pest	Time range	Number of jobs: air	Number of jobs: ground	Area treated: air	Area treated: ground	Chemicals used
				Acres	*Acres*	
Tarweed-Lupine	May 16-May 31	1	.....	120.0	.....	2,4-D
Tarweed-Weeds	Mar. 16-Apr. 30	3	.....	1,169.0	.....	2,4-D
Weeds-Brush	July 1-July 15	.....	2	.....	3.4	2,4-D, 2,4-5T, ATA, Brush Killer
Weeds-Garlic	Apr. 1-Apr. 30	3	.....	233.0	.....	2,4-D
Weeds-Grass	Feb. 1-Oct. 31	2	5	16.0	186.6	2,4-D, ATA, Captan, Chloro, IPC, CMU, Dinitro General, IPC
Weeds-Rattail Fescue	May 16-May 31	1	.....	55.0	.....	2,4-D
Weeds-Ryegrass	May 1-May 15	1	.....	10.0	.....	2,4-D, Dalapon
Weeds-Vetch	Apr. 16-Apr. 30	.....	1	.....	10.0	2,4-D
Weeds-Wild Blackberry	June 16-June 30	.....	1	.....	1.0	ATA
Wild Blackberry-Brush	Aug. 16-Sept. 30	.....	2	.....	4.0	Brush Killer
Wild Blackberry-Poison Oak	July 16-Sept. 30	.....	1	.....	1.0	Brush Killer
Weeds—subtotal		567	544	107,996.3	8,524.8	
Disease						
Bacterial Canker	Sept. 1-Sept. 15	1	.....	30.0	.....	Polybor
Blight	Apr. 1-Oct. 15	31	2	940.0	22.0	Copper, Copper Sulfate, Culperin, DDT, Kolokill, Sulfur, Zineb, Ziram
Brown Rot	May 1-Sept, 15	19	14	448.5	72.5	Kolokill, Sulfur
Leaf Curl	May 15-May 31	1	.....	4.0	.....	Captan
Leaf Spot	May 1-May 15	1	.....	28.0	.....	Kolokill
Mildew	Sept. 1-Sept. 15	1	.....	16.0	.....	Sulfur
Mold	June 1-Aug. 15	6	.....	42.0	.....	Sulfur, Terrachlor, Ziram
Rust	May 1-July 15	8	.....	204.5	.....	Kolokill, Dichlone
Silver Tip	May 1-May 31	4	.....	195.0	.....	DDT
Disease—subtotal		72	16	1,908.0	94.5	
Miscellaneous						
Flea Beetle-Blight	July 16-July 31	1	.....	45.0	.....	DDT, Copper
Diabrotica-Mold	June 16-June 30	3	.....	184.0	.....	DDT, Copper, Malathion, Sulfur
Syneta Beetle-Brown Rot	Apr. 16-Apr. 30	1	.....	14.0	.....	Kolokill
Cherry Fruitfly-Brown Rot	June 1-June 15	.....	1	.....	2.0	Kolokill
Fruit Worm-Brown Rot	May 16-May 31	1	.....	3.0	.....	Malathion, Ziram
Fruit Worm-Mold	May 16-May 31	1	.....	87.0	.....	DDT, Ziram
Thrip-Blight	Apr. 1-Apr. 15	1	.....	14.0	.....	Kolokill
"Worms"-Leaf Spot	Apr. 1-Apr. 15	.....	1	.....	.5	Lead Arsenate, Lime, Sulfur
Lygus Bug-Weeds	May 16-May 31	3	.....	81.0	.....	2,4-D, Toxaphene
Mice-Weeds	May 1-May 31	2	.....	25.0	.....	2,4-D, Toxaphene
Miscellaneous—subtotal		13	2	453.0	2.5	
Grand total		1,861	768	152,334.3	10,284.3	
Grand total (air and ground)		2,629		162,618.6		

Table 4. Summary of All Chemicals Applied by Air and Ground

Chemical	Air method*	No. of jobs	Area treated	Chemical applied per acre	Application charges per acre	Chemical charges per acre‡
			Acres	*Pounds*		
2,4-D	S	477	98,044.3	0.9	$ 1.09	$ .67
2,4-D, Aldrin	S	2	60.0	.....	1.75	.....
2,4-D, Chloro IPC	S	1	120.0	.....	1.25	.....
2,4-D, Dalapon	S	1	10.0	.....	1.00	6.00
2,4-D, Toxaphene	S	5	106.0	.....	1.75	.....
2,4-D, 2,4-5T	S	4	138.0	.....	1.49	.....
2,4-5T, 2,4-5TP	S	1	110.0	.....	7.73	.....
Aldrin	S	13	824.0	2.4	2.21	.....
Amino Triozole, ATA	S	1	60.0	6.4	3.00	.....
Arsenic Compounds	S	2	458.0	5.3	2.50	.....
Atlas A	S	10	202.0	4.1	2.75	.....
Bait	D	10	189.5	6.3	1.49	.75
Brush Killer (2,4-D, 2,4-5T) comb.	S	5	174.0	3.3	4.06	1.60
Captan	D	2	12.0	1.9	3.00	.....
Chloro IPC	S	14	1,795.0	2.7	1.03	5.40
Copper	D	9	205.0	4.2	2.73	.....
Copper, DDT	D	6	105.0	.....	2.75	.....
Copper, DDT, Sulfur	D	3	249.0	.....	2.00	.....
Copper, Sulfate	D	1	30.0	33.3	1.50	.....
Culperin, DDT	D	2	90.0	.....	2.76	.....
Dalapon	S	1	15.0	4.0	1.47	4.00
DCMU	S	1	57.0	2.0	2.00	.....
DDD	D	7	131.0	2.0	3.14	.....
DDT	D	352	10,125.0	.9	1.81	.84
DDT	S	276	11,893.5	1.0	1.40	.64
(All DDT)		(628)	(22,018.5)	(.9)	(1.59)	(.72)
DDT, Kolokill	D	2	57.0	.....	1.51	.....
DDT, Malathion	D	10	830.0	.....	2.74	.....
DDT, Malathion	S	76	2,381.5	.....	1.77	2.48
(All DDT, Malathion)		(86)	(3,211.5)	(.....)	(2.02)	(2.48)
DDT, Malathion, Sulfur	D	5	504.0	.....	2.24	1.33
DDT, Parathion	S	7	178.0	.....	1.57	2.39
DDT, Pyrenone	S	2	300.0	.....	.50	.....
DDT, Sulfur	D	1	75.0	.....	2.25	.....
DDT, TEPP	S	1	15.0	.....	1.73	2.60
DDT, Toxaphene	S	3	31.0	.....	1.77	.....
DDT, Zineb	D	4	150.0	.....	2.81	.....
DDT, Ziram	D	3	209.0	.....	2.96	.....
Demeton (Systox)	S	27	876.0	.2	2.00	.....
Dichlone	D	1	125.0	.5	2.75	.....
Dinitro General	S	25	591.0	1.4**	2.85	1.78
Dinitro IPC	S	1	8.0	.....	2.50	.....
Dinitro PE	S	1	26.0	24.0**	2.23	.....
IPC	S	3	159.0	2.0	1.53	.....
Kolokill	D	80	1,256.5	43.0	3.03	3.13
Lead Arsenate	D	46	884.0	45.2	2.88	6.00
Lindane, Malathion	S	1	30.0	.....	2.50	.....
Malathion	D	129	5,985.0	.9	1.39	8.38
Malathion	S	7	83.5	1.8	2.08	5.43
(All Malathion)		(136)	(6,068.5)	(.9)	(1.40)	(7.11)
Malathion, Methoxyclor	D	5	88.0	.....	3.41	.....
Malathion, Methoxyclor, Sulfur	D	1	30.0	.....	3.00	.....
Malathion, TEPP	D	1	16.0	.....	3.38	.....
Malathion, Toxaphene	S	2	32.0	.....	1.75	.....
Malathion, Ziram	D	1	3.0	.....	5.00	.....
MCP	S	8	451.0	.5	1.47	.....
Metag (slug bait)	D	2	98.0	8.2	1.00	.....
Methoxyclor	D	9	301.0	2.3	2.47	.....
Methoxyclor, Sulfur	D	1	4.0	.....	3.75	.....
Methoxyclor, TEPP	S	2	17.0	.....	3.53	.....

Table 4. Summary of All Chemicals Applied by Air and Ground (Continued)

Chemical	Air method*	No. of jobs	Area treated	Chemical applied per acre	Application charges per acre	Chemical charges per acre‡
			Acres	*Pounds*		
Methoxyclor, Ziram	D	2	227.0	.....	2.30	.....
Niatox	D	2	26.5	50.0	3.40	.....
Parathion	D	2	13.0	1.0	3.46	.....
Parathion	S	42	1,879.0	.5	2.34	2.07
(All Parathion)		(44)	(1,892.0)	(.5)	(2.34)	(2.07)
PCP (Terrachlor)	D	2	14.0	5.7	2.14	.....
Perthane	D	1	4.0	8.8	.....	.....
Polybor	S	1	30.0	10.0	2.50	.....
Phosdrin	S	1	1.0	2.0	.....	.....
Rotenone	D	4	322.0	.3	2.76	.....
Sulfur	D	17	388.5	57.7	3.94	.....
TEPP	D	10	302.0	.4	4.09	.....
TEPP	S	1	13.5	.6	3.48	4.44
(All TEPP)		(11)	(315.5)	(.4)	(4.06)	(4.44)
Toxaphene	D	1	16.0	2.2	2.50	.....
Toxaphene	S	86	2,104.0	3.2	1.65	1.97
(All Toxaphene)		(87)	(2,120.0)	(3.2)	(1.66)	(1.97)
Zineb	D	3	279.0	1.7	2.34	.....
Ziram	D	2	7.0	3.0	4.71	.....
TOTAL—dust	D	739	23,351.0	.....	2.00	.....
TOTAL—spray	S	1,111	123,273.3	.....	1.21	.....
Air subtotal—dust and spray		1,850	146,624.3	.....	1.33	.....
2,4-D	S	273	4,757.9	.9	1.65	1.04
2,4-D, ATA	S	2	18.0	.....	1.00	2.67
2,4-D, Brush Killer	S	1	2.5	.....	12.40	15.20
2,4-D, CMU	S	1	.5	.....	20.00	82.00
2,4-D, 2,4-5T	S	1	15.0	.....	.73	2.53
2,4-5T	S	6	9.8	5.0	10.10	13.37
2,4-5T, ATA	S	2	.5	.....	42.00	112.00
Aldrin	S	21	91.6	4.8	3.52	12.81
ATA	S	20	50.0	5.9	4.86	19.32
ATA, Brush Killer	S	1	6.0	.....	7.83	19.50
ATA, CMU	S	1	.1	.....	100.00	300.00
ATA, Dalapon	S	3	21.6	.....	2.18	14.35
Brush Killer	S	92	1,357.2	4.0	4.79	5.63
Chlorea	S	15	4.4	693.6	122.95	132.72
Chloro IPC	S	3	145.0	1.4	1.83	4.40
CMU	S	3	10.5	1.5	2.57	6.95
DCMU	S	4	84.0	1.9	2.93	2.35
DDD	D	4	17.0	2.4	2.18	5.00
DDT	D	42	324.4	2.2	1.70	3.46
DDT	S	7	60.9	1.7	4.84	2.94
(All DDT)		(49)	(385.3)	(2.1)	(2.20)	(3.40)
DDT, Systox	S	1	4.0	.....	2.00	6.00
Demeton (Systox)	S	4	123.0	.3	2.00	3.93
Demeton, Toxaphene	S	1	12.0	.....	2.00	.....
Dinitro General	S	9	117.0	1.3**	4.41	5.68
Dinitro General, IPC	S	55	525.8	.....	6.38	13.27
Dinitro PE	S	20	454.8	1.0	2.65	2.83
Ferbam, Lead Arsenate	S	2	8.0	.....	3.62	1.12
Gamma BHC	S	1	80.0	.5	2.00	1.09
Heptachlor	S	1	6.0	2.0	2.50	.....
IPC	S	8	164.8	3.5	2.29	9.48
Kolokill	D	3	16.0	50.0	1.69	6.88
Lead Arsenate	D	108	847.1	42.4	1.72	7.27
Lead Arsenate	S	1	20.0	4.2	2.90	1.75
(All Lead Arsenate)		(109)	(867.1)	(41.5)	(1.75)	(7.14)

Table 4. Summary of All Chemicals Applied by Air and Ground (Continued)

Chemical	Air method*	No. of jobs	Area treated	Chemical applied per acre	Application charges per acre	Chemical charges per acre‡
			Acres	*Pounds*		
Lead Arsenate, Lime Sulfur	S	1	.5	.....	10.00	6.00
Lead Arsenate, Sulfur	D	3	19.5	.....	1.74	10.77
Lime Sulfur	S	1	1.8	4.4***	7.78	.....
Malathion	D	3	8.0	31.8	2.88	8.75
Malathion	S	1	3.0	1.0	3.33	3.33
(All Malathion)		(4)	(11.0)	(23.4)	(3.00)	(7.27)
MCP (Methoxones)	S	23	778.1	.3	2.17	.81
Parathion	S	2	12.0	5.0	5.00	.....
Sulfur	D	15	83.5	51.5	1.82	3.45
Toxaphene	S	2	10.3	1.0	2.23	1.55
Total—dust		178	1,315.5	.....	1.74	.....
Total—spray		589	8,956.6	.....	2.72	.....
Ground total—dust and spray		767	10,272.1	.....	2.60	.....
Grand total—air and ground		2,617	156,896.4	.....	1.42	.....

* S—Spraying — D—Dusting
** Indicates number of quarts
*** Indicates number of gallons
‡ Chemical charges are included only when the applicator furnished them.

Average charges per acre for ground rigs were determined for spraying apples, peaches, prunes, and other tree fruits and nut crops.

Consideration of Individual Crops

Ten representative crops, namely wheat, ryegrass, vetch, clover, cherries, filberts, strawberries, snap beans, canning peas, and potatoes, were selected for more detailed analysis.

Work done on each crop is summarized according to purpose of application. Shown within each pest group are: pest or operation, chemical or fertilizer, area treated, number of jobs, amount of chemical applied per acre, and average charge per acre in dollars and cents for work of applying the chemical.

Wheat

In this study, more commercial work was done on wheat than on any other crop. In fact, almost one-half of the total acreage was wheat. Data presented in Table 5 summarize fertilizing, weeding, insect and rodent control work done on almost 96,000 acres of wheat at an average cost of only $1.12 per acre for work of applying fertilizers and chemicals to this crop.

Table 5. Wheat—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Fertilizer	Ammonium Nitrate	1,238.0	19	87.9	$1.37
	Ammonium Sulfate	168.0	6	109.5	1.57
	Calcium Nitrate	65.0	2	107.7	1.52
	Nitrogen Solutions	3,233.0	9	79.6	1.00
	Urea	99.0	8	110.1	1.38
Fertilizer-Weeds	Uran-2,4-D	5,455.0	11	.....	1.46
Alfalfa	2,4-D	9.0	1	.8	1.78
Alfalfa (combination)	2,4-D	109.0	4	.8	1.51
Canada Thistle	2,4-D	58.0	5	1.0	1.12
Canada Thistle-Radish	2,4-D-Amino Triozole	15.0	1	.....	.73
Canada Thistle-Vetch	2,4-D	84.0	4	.6	2.00
Canada Thistle-Weeds	2,4-D	10.0	1	1.0	1.00
	Brush Killer	20.0	1	1.1	.60
Clover	2,4-D	32.0	1	1.9	1.50
Dandelion	2,4-D	10.0	1	.9	.....
Fanweed	2,4-D	197.0	2	.8	1.00
Lambs Quarter	2,4-D	99.5	9	.8	1.72
Lambs Quarter (combination)	2,4-D	160.0	14	.8	1.72
Morning Glory	Dinitro P.E.	13.0	1	3.2[2]	2.46
Mustard	2,4-D	1,240.0	6	.8	1.04
Mustard (combination)	2,4-D	5,182.7	24	.7	1.04
Pigweed	2,4-D	41.0	5	.7	1.73
Pigweed (combination)	2,4-D	106.0	6	.7	1.75
Russian Thistle	2,4-D	9.0	1	.8	1.78
Sunflower	2,4-D	117.0	2	.8	1.08
Tarweed	2,4-D	21,024.0	56	.9	1.03
Tarweed-Mustard	2,4-D	23,080.0	57	.8	1.05
Tarweed (combination)	2,4-D	4,403.0	11	.8	1.01
Vetch	2,4-D	288.1	15	.9	2.32
Weeds	2,4-D	28,905.5	173	1.0	1.18
Weeds-Rye Grass	2,4-D-Dalapon	10.0	1	.....	1.00
Weeds (combination)	2,4-D	26.0	2	.9	1.15
Aphids	DDT-Malathion	26.0	1	.....	1.77
	Parathion	18.0	1	.4	1.50
Aphids-Lygus Bug	Toxaphene	41.0	2	3.0	1.76
Mice	Poison Bait	37.0	2	4.1	1.76
	Toxaphene	108.0	5	3.7	1.74
Rabbits	Toxaphene	33.0	1	2.9	1.76
Total		95,769.8	471	.....	$1.12

[1] Application charge does not include cost of chemical.
[2] Denotes quarts.

Table 6. Ryegrass—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Fertilizer	Ammonium Nitrate	1,901.0	29	160.3	$1.88
	Ammonium Phosphate	28.0	1	108.6	1.32
	Ammonium Phosphate	85.0	3	112.9	1.36
	Ammonium Phosphate-Ammonium Nitrate	42.0	1	251.4	2.76
	Ammonium Sulfate	2,600.5	45	170.8	1.94
	Ammonium Sulfate-Urea	1,552.0	24	149.6	1.75
	Land Plaster	120.0	1	148.3	1.73
	Superphosphate	90.0	1	223.1	2.48
	Urea	515.0	3	133.7	1.84
Clover	2,4-D	6.0	1	.5	3.00
Garlic or Onion	2,4-D	106.0	4	2.0	1.56
Vetch	2,4-D	50.0	1	.6	1.36
Weeds (unnamed)	2,4-D	1,056.7	14	1.1	1.23
	Chloro IPC	280.0	3	2.0	1.00
	MCP	122.0	2	.3	1.42
Weeds (unnamed)-Grass	Chloro IPC	15.0	1	2.0	2.20
Weeds (combination)	2,4-D	296.0	5	1.2	1.48
Mice	Toxaphene	8.0	1	3.0	2.25
Pea Weevil	2,4-D	140.0	1	.7	1.25
Total		9,013.2	141	.....	$1.74

[1] Application charge does not include cost of chemical.

Ryegrass

The commercial work done on ryegrass is presented in Table 6. Two-thirds of the work involved application of fertilizer. The other third was devoted to control of vetch and other weeds in ryegrass.

Vetch

Almost all commercial applications to the 13,317 acres of vetch in this study were made to control the vetch weevil. Chief chemical used was DDT in an average amount of 0.9 pound per acre (Table 7).

Table 7. Vetch—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Fertilizer	Ammonium Sulfate	64.0	1	156.3	$1.81
	Land Plaster	30.0	1	100.0	1.50
Defoliation	Dinitro General	29.0	2	1.5[2]	2.76
Leaf Tier	Methoxyclor	14.0	1	1.7	2.71
Vetch Weevil	Parathion	109.0	2	.5	1.50
	DDT	13,071.5	315	.9	1.59
Total		13,317.5	322	.....	$1.60

[1] Application charge does not include cost of chemical.
[2] Denotes quarts.

Clover

Data in Table 8 indicate most important jobs performed on clover crop were defoliation (to assist in harvest of seed), control of vetch, and extermination of mice. Principal chemicals applied were Dinitro General, MCP, and Toxaphene, respectively.

Table 8. Clover—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Fertilizer	Ammonium Sulfate	19.0	1	100.0	$1.47
	Land Plaster	11.0	1	109.1	1.64
Defoliation	Atlas A (Sodium Arsenate)	10.0	1	4.0	3.00
	Dinitro General	600.4	26	1.3[2]	2.79
Grass	Chloro IPC	52.0	2	3.4	2.02
	IPC	10.5	1	5.2	2.19
Vetch	MCP	598.0	20	.3	1.98
Weeds (unnamed)	2,4-D	168.0	7	.5	1.52
	Chloro IPC	34.0	1	4.0	1.00
	MCP	58.0	1	.7	1.34
Weeds-Mustard	MCP	75.0	1	.8	1.49
Aphids-Clover Leaf Weevil	Toxaphene	68.0	3	4.0	1.75
Aphids-Lygus Bug	Malathion	33.0	1	1.1	1.76
	Toxaphene	8.0	1	5.0	2.00
Aphids-Mice	Toxaphene	26.0	1	4.0	1.73
Beetles (unidentified)	Toxaphene	16.0	1	2.2	2.50
Cucumber Beetle	DDT	23.0	1	1.0	1.52
Clover Leaf Weevil	DDT	24.0	1	1.0	1.50
Clover Root Borer	Aldrin	5.3	1	2.1	2.26
Lygus Bug	DDT	48.0	3	2.0	1.77
	Toxaphene	14.0	1	3.0	1.71
Lygus Bug-Clover Leaf Weevil	DDT	45.0	1	2.2	1.76
	DDT-Kolokill	25.0	1	.....	1.52
	DDT-Malathion	50.0	1	.....	1.76
	DDT-Toxaphene	10.0	1	.....	1.80
	Toxaphene	295.0	14	3.8	1.84
Lygus Bug-Clover Seed Midge	DDT-Toxaphene	21.0	2	.....	1.76
Lygus Bug-Clover Seed Weevil	DDT-Malathion	30.0	1	.....	1.73
Lygus Bug-Weeds	2,4-D-Toxaphene	81.0	3	.....	1.74
Lygus Bug-Weevil	Toxaphene	26.0	1	4.0	1.77
Mice	Toxaphene	480.0	22	3.9	1.66
Mice-Clover Leaf Weevil	Toxaphene	24.0	1	3.3	1.75
Nitidulids	Toxaphene	10.3	2	1.0	2.23
Slugs	Metag (slug bait pellets)	98.0	2	8.2	1.00
Rabbits	Toxaphene	90.0	6	2.7	1.22
Weeds-Mice	2,4-D-Toxaphene	25,0	2	.....	1.76
Total		3,211.5	136	.....	$1.92

[1] Application charge does not include cost of chemical.
[2] Denotes quarts.

Table 9. Cherries—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Fertilizer	Calcium Nitrate	11.0	1	200.0	$2.45
Moisture Control	----(with helicopter)	367.0	11	.....	3.10
Blight	Kolokill	87.0	5	39.0	2.66
	Sulfur	22.0	2	52.3	1.55
Blight-Thrip	Kolokill	14.0	2	50.0	3.00
Brown Rot	Kolokill	115.0	8	60.0	3.19
	Sulfur	179.5	9	47.1	3.23
Brown Rot-Fruit Fly	Kolokill	2.0	1	62.5	2.50
Brown Rot-Syneta Beetle	Kolokill	14.0	1	40.0	3.00
Leaf Spot	Kolokill	28.0	1	50.0	3.25
Cherry Fruit Fly	DDT	20.5	2	2.4	1.71
	Kolokill	806.0	51	41.7	2.00
	Lead Arsenate	657.0	38	49.5	2.90
	Malathion	20.0	1	1.6	3.00
	Methoxyclor	10.0	1	2.5	3.00
	Parathion	10.0	1	1.0	3.00
	Rotenone	18.0	1	.4	3.00
Syneta Beetle	Kolokill	127.0	8	30.0	2.24
	Niatox	26.5	2	50.0	3.40
Mineola Moth	DDT	108.0	6	2.3	2.84
Leaf Tier	Lead Arsenate	14.0	2	50.0	1.57
Total		2,656.5	154	.....	$2.97

[1] Application charge does not include cost of chemical.

Cherries

Principal commercial jobs done on cherries (Table 9) were to combat the cherry fruit fly, control brown rot, and eliminate excess moisture on fruit due to rain. The latter, which involved 11 jobs and 367 acres of cherries, was accomplished with a helicopter flying low over trees to blow off excess moisture. This work was done for an average of $3.10 per acre of orchard.

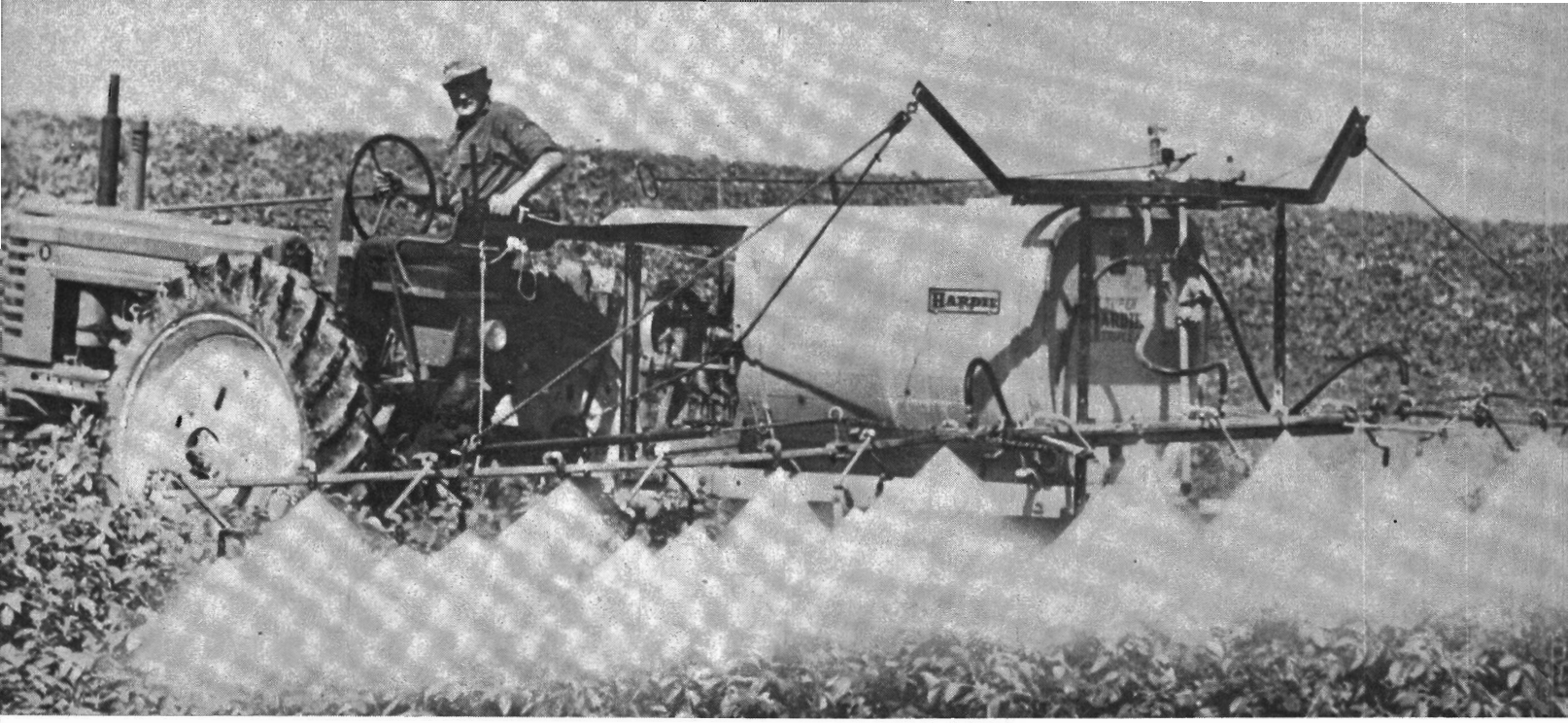
Filberts

Most important jobs done on filberts were to control worms, filbert leaf roller, and filbert moth (Table 10). DDT and lead arsenate were chief chemicals used.

Table 10. Filberts—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Brush	2,4-D	10.0	1	1.6	$1.90
Morning Glory	2,4-D	3.0	1	3.0	3.67
Weeds-Inhibit Sprouting	2,4-D-Brush Killer	2.5	1	.....	12.40
Aphids	DDT	14.0	1	2.5	3.29
	Malathion	6.5	1	1.9	2.00
	Malathion	4.0	1	2.0	.....
Tent Caterpillar	DDD	41.0	2	1.8	3.05
	Malathion	.5	1	4.0	10.00
Filbert Leaf Roller	DDD	42.0	6	2.3	2.67
	DDT	358.4	43	2.2	1.98
	Lead Arsenate	16.0	1	40.6	3.00
Filbert Moth	DDT	26.0	2	2.5	3.27
	Lead Arsenate	211.0	7	32.2	2.82
Worms (unnamed)	DDT	2.0	1	2.5	2.50
	Lead Arsenate	853.1	107	41.4	1.75
	Lead Arsenate-Ferbam	5.0	1	.....	3.80
	Lead Arsenate-Sulfur	19.5	3	.....	1.74
Total		1,614.5	180	.....	$2.08

[1] Application charge does not include cost of chemical.



Chemicals were applied to 6,152 acres of potatoes in this study. The above rig is boom spraying of potatoes to control insect pests.

Strawberries

Table 11 lists a variety of control jobs which strawberry growers had done by commercial applicators. The 103 jobs included weed control, defoliation, and several types of disease and insect control, both above and below ground surface. Some newer chemicals appear in the list of materials used to combat strawberry pests. Average charge for application of these chemicals was $4.21 per acre (not including cost of material).

Table 11. Strawberries—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Weeds (unnamed)	Aldrin	1.3	1	4.6	$ 3.85
	Brush Killer	2.5	1	4.8	10.00
	Dinitro General	60.5	4	1.5[2]	6.35
	IPC	14.0	2	2.6	8.00
	Dinitro General-IPC	525.8	55	.....	6.38
Defoliation	Dinitro General	8.1	1	1.0[2]	3.21
Leaf Curl	Captan	4.0	1	1.3	4.50
Mold	Ziram	4.0	1	2.8	4.50
Meadow Spittle Bug[3]	DDT-Nitrogen	12.2	1	.....	4.92
	Methoxyclor	16.0	2	12.5	2.88
	DDT-Malathion	26.0	1	.....	3.46
Symphyllids	Aldrin	7.0	1	6.0	5.00
	Parathion	10.0	1	5.0	5.00
Leaf Tier	DDT	10.0	2	21.0	3.00
	Methoxyclor	255.0	4	1.8	2.40
	Ziram	3.0	1	3.3	5.00
	DDT-Ziram	87.0	1	.....	3.00
	Methoxyclor-Ziram	227.0	2	.....	2.30
Root Weevil	Aldrin	57.0	14	5.8	3.95
Wireworms	Aldrin	85.0	2	6.0	2.25
Insects (unnamed)	DDT	17.4	1	2.0	5.00
Weeds and Grass	Captan	8.0	1	2.3	2.25
	Dinitro General-IPC	8.0	1	.....	2.50
Leaf Tier-Mold	DDT-Ziram	87.0	1	.....	3.00
Leaf Tier-Brown Rot	Malathion-Ziram	3.0	1	.....	5.00
Total		1,538.8	103	.....	$ 4.21

[1] Application charge does not include cost of chemical.
[2] Denotes quarts.
[3] With fertilizer.

Table 12. Snap Beans—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Fertilizer	Ammonium Nitrate	50.0	3	110.4	$1.34
Mold	Terrachlor	14.0	2	5.7	2.14
Mold-Diabrotica	DDT-Malathion-Sulfur	25.0	1	.....	2.00
	DDT-Copper-Sulfur	159.0	2	.....	2.00
Morning Glory	2,4-D	6.0	1	4.0	3.00
Pigweed	Dinitro P.E.	19.0	1	3.0[2]	2.47
Weeds (unnamed)	Dinitro P.E.	232.4	12	3.9[2]	2.62
Aphids	DDT-Malathion-Sulfur	18.0	1	.....	1.56
	Malathion	4,990.5	102	.6	.98
	Malathion-Methoxyclor-Sulfur	30.0	1	.....	3.00
	Parathion	32.0	2	.9	3.41
	TEPP	22.5	2	.5	3.60
Aphids-Diabrotica	DDT-Malathion	113.0	4	.....	3.50
	DDT-Malathion-Sulfur	461.0	3	.....	2.28
	Malathion	927.5	25	2.4	3.44
	Malathion-Methoxyclor	88.0	5	.....	3.41
	Malathion-TEPP	16.0	1	.....	3.38
	Methoxyclor-TEPP	17.0	2	.....	3.53
	TEPP	247.0	7	.4	4.09
Aphids-Nitidulids	Malathion	66.0	2	2.5	3.52
Diabrotica (cucumber beetle)	DDT-Copper-Sulfur	90.0	1	.....	2.00
	DDT-Sulfur	75.0	1	.....	2.25
	Methoxyclor	6.0	1	1.3	3.00
	Methoxyclor-Sulfur	4.0	1	.....	3.75
Diabrotica-Caterpillars	DDT	23.0	1	1.5	2.74
Nitidulids	Perthane	4.0	1	8.8	.....
	Phosdrin	1.0	1	2.0	.....
Total		7,736.9	186	.....	$1.69

[1] Application charge does not include cost of chemical.
[2] Denotes quarts.

Snap Beans

Most important type of chemical control applied commercially to the snap bean crop was the dusting operation using malathion to control aphids (Table 12). There were 102 of these jobs and total area covered was approximately 5,000 acres. Average charge for application was $0.98 per acre. Other operations included application of fertilizer and chemical control of weeds, diseases, and other insects.

Canning Peas

The principal custom applications of chemicals on canning peas were to combat pea weevils and aphids (Table 13). Parathion was used to attack aphids, and DDT, malathion, and rotenone were all used to control the pea weevil. The 3,267 acres were treated at an average application charge of $2.40 per acre. Average amounts of different chemicals applied are shown in Table 13.

Table 13. Canning Peas—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Lambs Quarter-Pigweed	MCP	193.0	3	.4	$2.04
Morning Glory-Pigweed	MCP	130.0	1	.3	2.27
Weeds (unnamed)	MCP	9.5	1	.5	2.21
Aphids	Parathion	1,395.0	24	.5	2.45
Pea Weevil	DDT	583.0	38	1.3	2.04
	DDT-Malathion	643.0	4	.....	2.58
	Parathion	10.0	1	.4	2.50
	Rotenone	304.0	3	.3	2.75
Total		3,267.5	75	.....	$2.40

[1] Application charge does not include cost of chemical.

Potatoes

Custom applications of chemicals to the potato crop were for fertilization, defoliation, and control of insects, diseases, and rodents (Table 14). Aphids, Colorado potato beetles, and lygus bugs were most common insects combatted. Chief chemicals used for control were demeton, DDT, malathion, and parathion. Average charge for applying chemicals to 6,152 acres of potatoes was $2.04 per acre.

Table 14. Potatoes—Summary of All Commercial Work Done

Pest or operation	Chemical or fertilizer	Area treated	No. of jobs	Chemical applied per acre	Av. charge[1] for appl. per acre
		Acres		*Pounds*	
Fertilizer	Urea	33.0	1	99.4	$1.52
Defoliation	Arsenic Compounds	458.0	2	5.3	2.50
	Atlas A	192.0	9	4.1	2.74
Alfalfa	2,4-D	10.0	1	2.0	1.50
Blight	Copper	205.0	9	4.2	2.73
	DDT-Copper	60.0	5	.....	2.75
	DDT-Culperin	90.0	2	.....	2.76
	DDT-Zineb	150.0	4	.....	2.81
	DDT-Ziram	35.0	1	.....	2.74
	Zineb	60.0	2	1.6	2.25
Blight-Flea Beetle	DDT-Copper	45.0	1	.....	2.76
Aphids	Demeton	285.0	5	.2	2.02
Aphids-Colorado Potato Beetle	DDT	35.0	1	1.4	1.74
	DDT-Malathion	469.5	16	.....	1.77
Aphids-Lygus Bug	Aldrin-2,4-D	60.0	2	.....	1.75
	Demeton	562.0	20	.2	2.00
	DDT	182.5	7	1.3	1.73
	DDT-Malathion	1,523.5	48	.....	1.79
	DDT-Parathion	16.0	1	.....	2.00
	Parathion	129.0	6	.5	2.00
Colorado Potato Beetle	DDT	576.5	15	1.4	1.75
Flea Beetle	Aldrin	5.0	2	2.0	5.00
	DDT	45.0	1	1.0	2.76
Insects (unnamed)	Aldrin	52.5	1	2.0	1.73
Mice	Poison Bait	137.5	7	7.1	1.39
	Toxaphene	57.0	6	3.2	1.61
Wireworms	Aldrin	672.0	9	2.0	2.25
	Heptachlor	6.0	1	2.0	2.50
Total		6,152.0	185	.....	$2.04

[1] Application charge does not include cost of chemical.

Applications

As a sideline to commercial pesticide control, some custom applicators made a practice of applying fertilizer. Two crops most frequently fertilized were wheat and ryegrass, and both were done from the air (Table 15). Specific fertilizers applied and amounts per acre were discussed in another section of this report under "Wheat" and "Ryegrass."

Seeding

There were almost 18,000 acres seeded (Table 15). Although some corn, rye, and permanent pasture were sown, the big item was seeding of forest trees (16,630 acres of timber) at an average application charge of $1.26 per acre.

Other jobs

In addition to regular commercial pesticide jobs already discussed, more than 5,000 acres were fertilized and sprayed at the same time (Table 15). Another interesting job was that of moisture control of the cherry crop. This was done with helicopters and discussed under "Cherries."

Size of the industry

On the basis of this study and a similar study published in January, 1958, it appears that custom application of agricultural chemicals in Oregon amounts to more than a million dollar business annually. This covers only commercial charges made for application itself and does not include cost of any chemicals.

Table 15. Summary of All Fertilizer and "Other" Work Done by Crop and Land Use

Crop or land use	Ground Application				Air Application			
	No. of jobs	Total area	Av. area per job	Av. appl. charge per acre	No. of jobs	Total area	Av. area per job	Av. appl. charge per acre
		Acres	*Acres*			*Acres*	*Acres*	
Fertilizing								
Barley					2	229.0	114.5	$1.03
Oats					3	99.0	33.0	1.61
Wheat					45	5,358.0	119.1	1.13
Grain mixtures	1	7.0	7.0	$2.57	7	265.0	37.9	1.43
Alfalfa					1	6.0	6.0	1.50
Clover					2	30.0	15.0	1.53
Field peas					2	48.0	24.0	1.48
Vetch					2	94.0	47.0	1.71
Bluegrass					6	527.0	87.8	2.09
Fescue					5	188.0	37.6	1.85
Ryegrass					108	6,933.5	64.2	1.87
Other grasses					4	75.0	18.8	1.83
Root crops					1	51.0	51.0	2.27
Cherries	1	11.0	11.0	2.45				
Blackberries (tame)	1	8.0	8.0	4.00				
Pastures					9	347.0	38.6	2.00
Idle land					1	50.0	50.0	1.26
Peppermint					6	95.4	15.9	2.39
Beans					3	50.0	16.7	1.34
Beets					2	31.0	15.5	1.00
Potatoes					1	33.0	33.0	1.52
Crops grown together as mixtures					2	125.0	62.5	1.33
Total	3	26.0	8.7	$2.96	212	14,634.9	69.0	$1.58
Other—seeding								
Corn					2	73.0	36.5	$1.51
Rye					1	600.0	600.0	1.00
Other grasses					1	30.0	30.0	3.60
Permanent pasture					3	540.0	180.0	.58
Timber					6	16,630.0	2,771.7	1.29
Total					13	17,873.0	1,374.8	$1.26
Other—fertilizing and seeding								
Permanent pasture					1	65.0	65.0	$1.95
Other uses					1	300.0	300.0	1.17
Total					2	365.0	182.5	$1.31
Other—fertilizing and spraying								
Wheat					11	5,455.0	495.9	$1.46
Strawberries	1	12.2	12.2	$4.92				
Total	1	12.2	12.2	$4.92	11	5,455.0	495.9	$1.46
Other—moisture control								
Cherries					10	321.0	32.1	$3.12
Total					10	321.0	32,1	$3.12
Other—poison bait								
Barley					1	15.0	15.0	$1.73
Wheat					2	37.0	18.5	1.76
Potatoes					7	137.5	19.6	1.39
Total					10	189.5	19.0	$1.49
"Other" Total	1	12.2	12.2	$4.92	46	24,203.5	526.2	$1.33
Fertilizer and "Other" Total	4	38.2	9.6	$3.59	258	38,838.4	150.5	$1.43

Economic Aspects of Pesticide Application

For each of the 10 crops just discussed, total costs of typical control measures are shown in Table 16. These costs are "once-over" costs and include not only commercial charges made for application but also cost of chemicals used. Representative pests were chosen, and total charges were expressed in each case in terms of quantity of salable product necessary to pay for chemical treatment on one acre, once-over (see last column in Table 16).

The average price used for each crop is the 5-year (1954-1958) average price received by Oregon farmers. Prices have been calculated on a per pound basis to measure exact amount of product necessary to pay for chemical pest control on a once-over basis.

Some pests were easily controlled with light applications of relatively inexpensive chemicals, such as DDT and 2,4-D. Other pests required heavier applications or more expensive chemicals, or both, to get desired control. Total charges for chemical applications varied from $1.56 to $19.42 per acre once-over (Table 16).

Some pests, such as the cherry fruit fly, required successive chemical applications within a single season, while others could be controlled by one application during life of the crop. To figure total yearly cost per acre of controlling various pests, therefore, take once-over figures shown in Table 16 and multiply them by number of applications administered during the year.

Table 16. Economic Aspects of Pesticide Applications

Crop and pest	Chemical used	Total chemical and application charge per acre (per application)			Average farm price for crop (5-year average) (1954-58)	Amount of salable product needed to pay for control on one acre
		Appl.	Chem.	Total		
		Dollars	*Dollars*	*Dollars*		*Pounds*
Wheat						
Tarweed-Mustard	2,4-D	1.05	.60	1.65	$0.034 per pound or	48.5
Mustard-Combination	2,4-D	1.04	.52	1.56	$2.02 per bushel	45.9
Ryegrass (Perennial)						
Weeds (unnamed)	Chloro IPC	1.00	4.00	5.00	$0.088 per pound	56.8
Weeds (unnamed)	2,4-D	1.23	.82	2.05		23.3
Vetch						
Weevil	DDT	1.59	.72	2.31	$0.06 per pound	38.5
Clover						
Weevil, Lygus Bug	Toxaphene	1.84	2.34	4.18	$0.247 per pound	16.9
Vetch	MCP	2.17	.81	2.98		12.1
Cherries						
Brown Rot	Sulfur	3.23	3.16	6.39	$0.139 per pound	46.0
Cherry Fruitfly	Kolokill	2.00	3.04	5.04		36.3
Filberts						
Filbert Moth	Lead Arsenate	2.82	5.54	8.36	$0.194 per pound	43.1
Filbert Leaf Roller	DDT	1.98	3.46	5.44		28.0
Strawberries						
Root Weevil	Aldrin	3.95	15.47	19.42	$0.133 per pound	146.0
Weeds	IPC	8.00	7.04	15.04		113.1
Beans						
Aphids	Malathion	.98	4.76	5.74	$0.065 per pound or	88.3
Weeds (unnamed)	Dinitro PE	2.62	5.41	8.03	$129.30 per ton	123.5
Canning Peas						
Weevil	DDT	2.04	1.04	3.08	$84.20 per ton or	73.3
Aphids	Parathion	2.45	2.07	4.52	$0.042 per pound	107.6
Potatoes						
Aphids, Lygus Bug	Demeton	2.00	2.63	4.63	$1.70 per cwt. or	272.4
Mice	Toxaphene	1.61	1.97	3.58	$0.017 per pound	210.6

Since soil and climatic conditions vary widely in this state, certain results shown in this publication may only have regional application.

Net economic advantage of pest control

Table 16 shows estimates of how much additional product (or yield) is needed per acre to pay for control of selected pests on each crop. Note how small these amounts are (last column, Table 16). For example, control of the cherry fruit fly is necessary if the crop is to be sold. Usually three applications of a chemical like Kolokill will do the job. According to information presented in Table 16, a fruit grower could hire a custom operator to put on three applications of Kolokill on his cherry orchard for a total charge of $15.12 per acre ($5.04 × 3). One hundred and nine pounds of cherries would be required to pay for control, if cherries sold for 13.9 cents per pound (latest 5-year average farm price). Assuming 50 cherry trees per acre, only a little over 2 pounds of cherries per tree would be needed to pay for commercial application of Kolokill to control the fly and assure a salable crop. Without this control, the crop could not be marketed.

Another example is the killing of weeds in a small grain crop like wheat. We know weeds compete with the wheat crop for moisture and fertility, resulting in a decreased yield. Experimental results at the Pendleton and Sherman Branch Experiment Stations of Oregon State College show that over a 3-year period, average yield of wheat was increased approximately 4 bushels per acre as a result of weed control. Table 16 indicates cost of both the chemical (2,4-D) and its application amounted to considerably less than the value of one bushel of wheat. The price of less than a bushel of wheat is not a very high cost to pay for a probable increase in yield of 4 bushels per acre.

Appendix

All information for this study is based on data tabualted from copies of daily worksheets sent by cooperating custom applicators to Oregon State College for summarization. Each cooperator was furnished with a confidential summary of his own operations for the year.

The worksheet form adopted consisted of a one-page report developed cooperatively by "air" and "ground" operators with help of the Oregon State College project leader (Figure 1). These were made up in book form with three copies of each numbered worksheet. This arrangement provided one copy for the custom applicator, one for the client, and one to be sent to the College for analysis.

Worksheet used by both "air" and "ground" chemical applicators.

Air ☐ Ground ☐ ORDER NO.....

Crop_____

Pest_____
(Give name of insect, disease, or weed)

Dusting ..... ☐ Material
Spraying ..... ☐ Furnished by:
Seeding ..... ☐ Applicator .... ☐
Fertilizing .. ☐ Farmer ..... ☐
(Refer to W. O. No._____)

Date_____ Name_____ Phone_____ Map No._____ No. of Fields_____

Date Promised_____ Address_____ Strip_____ Total Acres_____

DATE	PILOT OR OPERATOR	SHIP OR RIG NO.	TIME A.M.	TIME P.M.	ACRES DONE	MATERIAL USED (gal. or lbs.)	WIND DIR.	WIND VEL.	TEMP.	RATES PER ACRE CHEMICAL ACT. INGREDIENT	LBS.	OIL GAL.	H_2O GAL.	WET AGENT YES	WET AGENT NO

Notes:

APPLICATION: Date_____ Acres_____ @ $_____ per acre ..... $_____

CHEMICAL: Brand_____ Amount_____ lbs. gal. @ $_____; Oil or Wet Agent_____ gal. @ $_____ _____

Signature_____ TOTAL AMOUNT DUE .... $_____