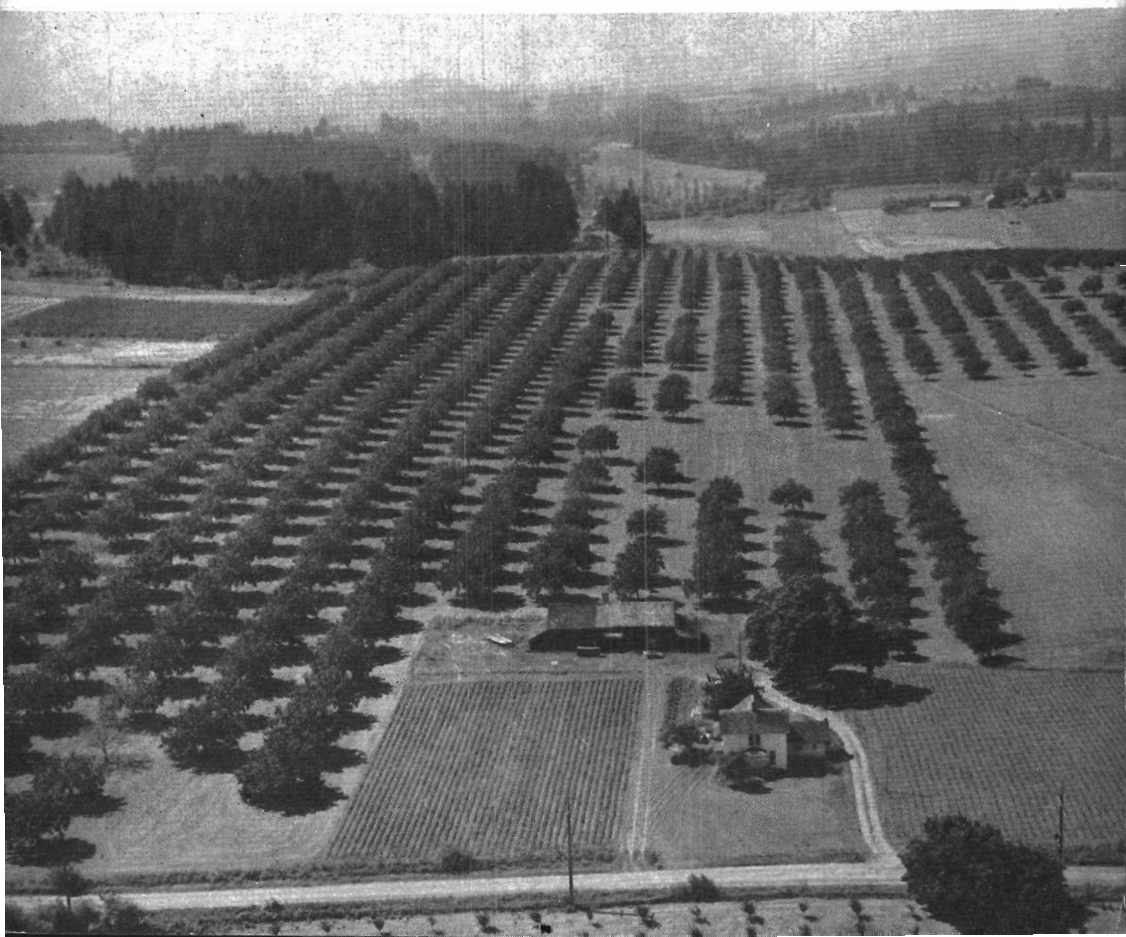
Cost of Producing Walnuts

in Oregon

Gustav W. Kuhlman

Agricultural Experiment Station
Oregon State College
Corvallis

Station Bulletin 518 June 1952



Foreword

In times such as these when the margin between farm production costs and prices is decreasing, an understanding of the cost factors involved is especially worthwhile to growers.

This bulletin presents a detailed analysis of walnut production costs in Oregon. The wide variation in costs reported by individual growers cooperating in the study may serve as a basis for individual evaluation of the efficiency of operations.

It will be useful also as a guide to governmental agencies charged with the responsibility of arriving at fair decisions regarding freight rates, marketing agreements, tariff provisions, and wages.

Information on other phases of walnut production is available from local County Extension Agents or from Oregon State College.

F. E. Price
Dean and Director

ACKNOWLEDGMENTS: The author is grateful for the fine cooperation received from the growers who provided the data for this report, from the processors whose generous help made possible a representative sample of the enterprise, from the County Extension Agents for aid in contacting growers, and from members of the resident staff for many helpful suggestions in planning the study.

Particular credit is due John H. Painter, horticulturist, U. S. Department of Agriculture, for rendering valuable service and counsel throughout the study.

Table of Contents

Summary

► **The situation.** Walnuts comprised more than 40 per cent of the major tree nuts produced in the United States during the period 1945-49. Oregon, with about 27,650 acres of walnuts in 1950, had about one-fifth of the walnut acreage in this country.

► **Size of planting.** The 93 bearing walnut tracts on the 91 farms in the study varied in size from 2 to 300 acres and averaged 37.5 acres.

The estimated capital investment in the enterprise averaged $22,216 per planting or $592 per acre, of which $495 was for the orchard.

► **Cost of production.** The cost of producing walnuts in Oregon in 1949 averaged $117 per acre or 15.8¢ per pound with an average yield of 741 pounds (orchard run) per acre.

Cost of all labor averaged $40 per acre or one-third of the total cost. Harvest labor comprised two-thirds of the entire labor cost or one-fifth of all costs.

Harvest labor and drying, designated as *variable costs* because they vary with yield, were 31 per cent of the total cost. *Fixed costs*, including depreciation, interest, and property taxes, were 33 per cent of all costs. *Semifixed costs*, including maintenance and miscellaneous items, were 36 per cent of the total cost of production.

The cost on 31 plantings (one-third of the total studied) with the *lowest* costs averaged 11.5¢ while the 31 plantings with the *highest* costs averaged 34.5¢ per pound in 1949.

Orchards producing less than 400 pounds per acre had average costs of nearly 38¢ per pound, while those with more than 1,600 pounds per acre averaged 10.5¢.

Bottom land orchards were the most productive during the 3-year period 1947-49, while the younger hill orchards were the lowest-cost tracts in 1949. The use of cover crops and fertilizer and dusting or spraying increased yields and lowered the cost per pound.

The largest orchards, averaging 97 acres, had the lowest labor and machinery costs per acre.

The estimated costs of establishing walnuts (11 years) averaged $960 per acre, plus the land valued at $216 per acre in 1949, equalled a total cost of $1,176 during the growing period of 11 years.

► **Estimated returns.** The price received by the walnut growers in Oregon averaged 102 per cent of the estimated cost of production during the period of 1940-50.

Cost of Producing Walnuts

in Oregon

GUSTAV W. KUHLMAN
Agricultural Economist

Objectives of Study

The general purpose of this study was to give to growers and others interested facts concerning the economic status of the Persian or English walnut (*Juglans regia*) enterprise on Oregon farms. The specific objectives were to determine:

- The cost of producing walnuts.
- The factors that have a major influence on costs.
- The cost of growing walnut plantings to bearing age (12 years).

The information, when adjusted for changes in yield and in the level of costs, provides a basis for estimating the cost for any given year if no major changes have occurred in production techniques.

The Situation

World production of major tree nuts

The United States, with an average annual production of nearly 180,000 tons, was the leading producer of tree nuts during the 5-year period 1945-1949 (Table 1). This was nearly 30 per cent of the entire tonnage produced by 10 of the leading countries. The United States also ranked first in walnut production with an average of 73,300 tons per year, or nearly three-fifths of the total production reported by eight leading countries.[1]

Walnuts comprised more than two-fifths of the combined tonnage of almonds, filberts, pecans, and walnuts produced in the United States in 1949 (Figure 1).

United States consumption of major tree nuts

The amount of tree nuts consumed annually in this country has varied with the total available supply (Figure 2). Besides the almonds, pecans, and filberts produced in the United States, imported Brazil nuts, cashew and other nuts compete with walnuts for the consumer's dollar.

[1] *Agricultural Statistics*, U. S. Department of Agriculture.

Table 1. TREE NUTS: COMMERCIAL PRODUCTION (IN-THE-SHELL)[1] IN SPECIFIED COUNTRIES.

(Averages 1945-49)[2]

Country	Almonds	Brazil nuts	Cashews (meats)	Filberts	Pecans	Walnuts	Total
	1,000 tons	*1,000 tons*	*1,000 tons*	*1,000 tons*	*1,000 tons*	*1,000 tons*	*1,000 tons*
Brazil	.....	23.7	.....	.....	.....	.....	23.7
France	2.3	.....	.....	.....	.....	16.3	18.6
Morocco	9.0	.....	.....	.....	.....	.....	9.0
India[3]	.....	.....	25.0	.....	.....	.....	25.0
Iran	23.3	.....	.....	.....	.....	.....	23.3
Italy	115.2	.....	.....	26.5	.....	17.3	159.0
Portugal	9.3	.....	.....	.....	.....	.....	9.3
Spain	76.9	.....	.....	20.0	.....	.....	96.9
Turkey	.....	.....	.....	67.5	.....	6.2	73.7
Total 9 foreign countries	236.0	23.7	25.0	114.0	.....	39.8	438.5
United States	34.3	.....	.....	8.0	64.2	73.3	179.8
Total 10 countries	270.3	23.7	25.0	122.0	64.2	113.1	618.3

[1]Shelled nuts are converted to in-the-shell basis at ratios as follows: Almonds 1:3.33; Brazil nuts 1:2; Cashews 1:4.55; Filberts 1:2.22; Pecans 1:2.5; Walnuts 1:2.38.

[2]Data were compiled from *Agricultural Statistics 1950* and *Foreign Crops and Markets*, September 17, 1951, U. S. Department of Agriculture.

[3]Includes 14,000 tons (meats) estimated production in East Africa, shelled in India.

There has been a marked decline in net imports of walnuts during the 20-year period 1929-1948.[1] In 1929 the imports were 24,073 tons or 36 per cent of the total supply of 67,473 tons for that year while during the period 1940-1948 imports were less than 1 per cent of the domestic consumption.

Location of walnut acreage in the United States

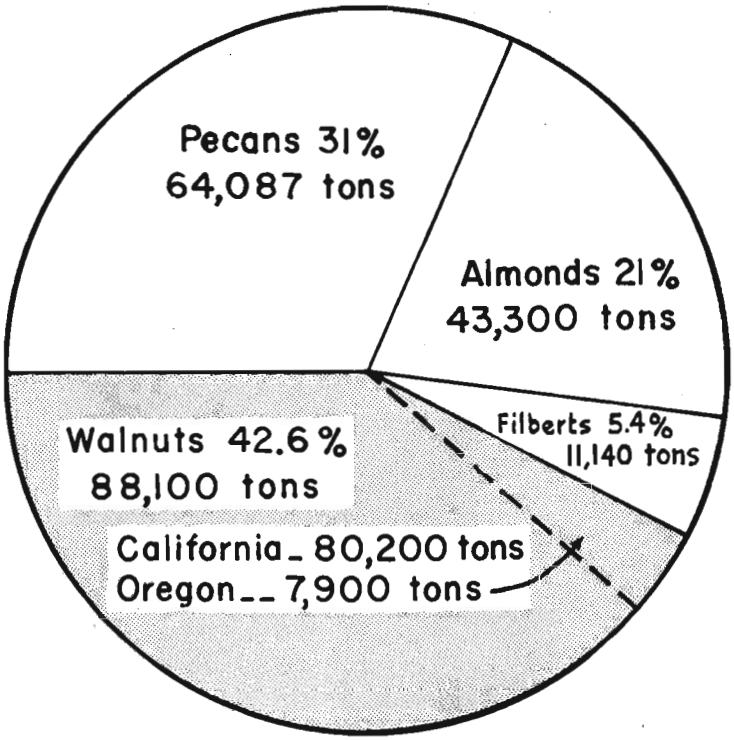
The commercial production of walnuts in the United States is confined almost exclusively to California and Oregon. According to one estimate, the commercial bearing walnut orchards in 1950 occupied 138,400 acres.[2] California reported 110,800 acres or 80 per cent of the total. The other 27,600 acres, or 20 per cent, was listed as in Oregon, although a small portion of this acreage was actually across the state line in Washington.

Location and age of walnuts in Oregon

The 1950 U. S. census reported a total of 533,692 walnut trees in Oregon, of which 91 per cent was bearing age and 9 per cent was nonbearing age. Among the counties, Yamhill had about 30 per cent

[1]*Agricultural Statistics*, U. S. Department of Agriculture.

[2]*Tree Nuts*, Crop Reporting Board, Bureau of Agricultural Economics, August 1951.



Source of data: Agricultural Statistics, 1950.

Figure 1. Production of the four major tree nuts (in the shell) in the United States, 1949.

of the walnut trees; Washington, 20 per cent; Marion, 15 per cent; Lane, 10 per cent; Clackamas, 7 per cent; other Willamette Valley counties, 12 per cent; and all other counties in the state, 6 per cent (Table 2).

Walnut production in Oregon developed largely within the past 30 years. A survey made in 1949 indicated that only one-fourth of the walnut trees in the state were 30 years or older, 40 per cent were between 20 and 30 years, nearly 28 per cent were between 10 and 20 years, and less than 8 per cent were under 10 years of age.[3] The annual planting rate since 1935 steadily decreased. More trees were removed than were planted during the 5-year period 1945-1949.

[3]Oregon Extension Bulletin 708, *Oregon-Washington Nut-Tree Survey, 1949.*

Table 2. WALNUT TREES: DISTRIBUTION OF PLANTINGS; BY LEADING COUNTIES.

(Oregon, 1950)[1]

County	Percentage of total trees	Number of trees		
		Bearing	Non-bearing	Total
	Per cent			
Willamette Valley				
Yamhill	29.8	151,967	6,786	158,753
Washington	20.4	97,116	11,785	108,901
Marion	15.0	75,506	4,617	80,123
Lane	9.8	46,847	5,501	52,348
Clackamas	7.0	29,009	8,304	37,313
Polk	5.1	25,947	1,329	27,276
Linn	3.9	19,313	1,715	21,028
Multnomah	1.3	6,097	877	6,974
Benton	1.3	6,373	530	6,903
Total, Willamette Valley	93.6	458,175	41,444	499,619
Other counties				
Douglas	3.4	16,743	1,374	18,117
Total other counties	3.0	13,096	2,860	15,956
Total in state	100.0	488,014	45,678	533,692

[1] U. S. Department of Commerce, Bureau of Census, *1950 Census of Agriculture (Preliminary)*. October 11, 1951.

Oregon walnut returns decline

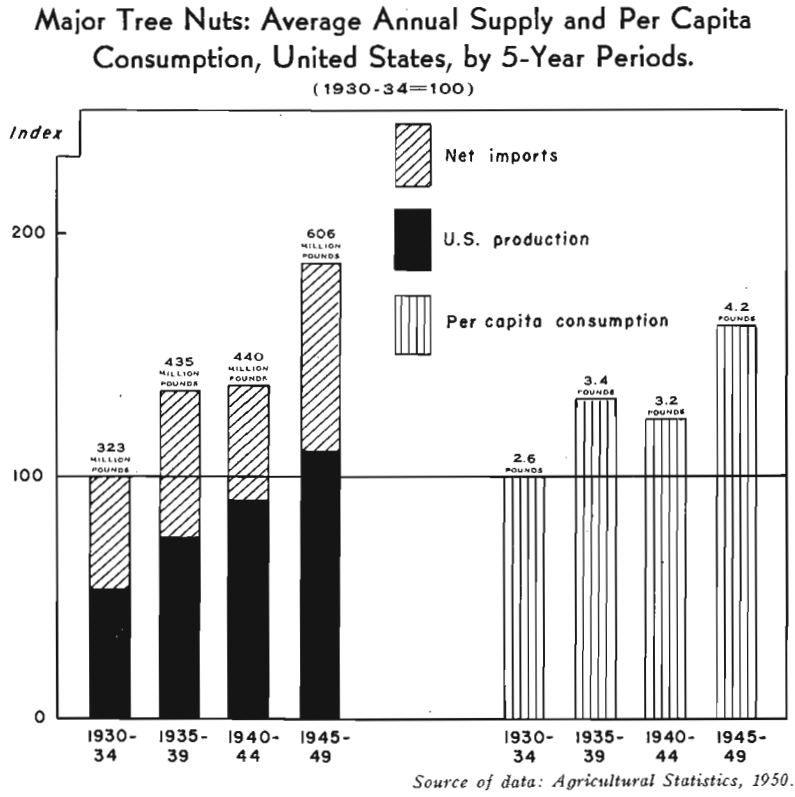
In 1920 the production of walnuts in Oregon had reached only a half million pounds.[1] Five years later the tonnage first exceeded a million (1,100,000) pounds. In 1930 it was 1,800,000 pounds, although previously, in 1928, there had been a crop of 3,000,000 pounds.

Actually the year 1930 marked the beginning of a long period of hardship for the then relatively young Oregon enterprise. Following that year's small crop which brought the growers 20¢ per pound, the price of the next crop fell to 13¾¢. During the entire 12-year period, 1931-1942, prices averaged only 12¢, varying from 8½ to 14.3¢. The enterprise appeared to have reached a position where high-cost producers would be forced out of business unless they could lower their costs.

Marketing agreement adopted

In order to cope with the depressed price situation the growers entered into a Federal Marketing Agreement in October 1933. Protection of the domestic unshelled market was the chief aim of the

[1] *Agricultural Statistics*, U. S. Department of Agriculture.



Source of data: Agricultural Statistics, 1950.

Figure 2. After the close of World War II the supply of tree nuts in the United States increased faster than the per capita rate of consumption.

program. This aim was accomplished by diverting a portion of the merchantable crop into export and domestic shelled markets, sales in these markets being made at prices lower than those prevailing in the protected markets.

With the exception of the World War II period, the walnut industry has utilized the marketing agreement program to regulate the quantity of in-shell walnuts shipped in interstate commerce. During World War II the program was suspended and a War Food Order was established, requiring "set-asides" for shelling. The control features of the program have remained essentially the same since 1933 although a growing proportion of the production is going directly to shellers. In other words, shelling no longer forms a true "diversion" outlet.

Need for economic research

It is evident that the individual grower cannot hope to have his investment safeguarded merely by having the domestic output of walnuts adjusted to the local demand or even to the world market, but must keep his costs in line with the long-time average income possible to him from the operation of his orchard (see Table 24).

The established grower is familiar with the fact that his walnut planting usually involves a high investment in land and trees, owing partly to the fact that a long waiting period must elapse before the orchard produces sufficiently to pay its way (see Table 22). Many growers have at times suffered the losses accompanying insect infestations and disease. At irregular intervals some orchardists have experienced the effects of unfavorable weather conditions, particularly a severe freeze, which not only curtailed production temporarily, but resulted in partial or complete loss of trees and therefore of much of the investment. Some people who have never produced walnuts are attracted by the widely reported, though infrequent, high yields and prices. In many cases they are not aware of the serious hazards of the enterprise.

Some farmers are not familiar with methods of studying the various factors affecting their cost of production. The information presented in this bulletin is designed to be helpful to present walnut growers interested in avoiding an unwise increase in the total walnut acreage, and more particularly to serve as a guide to those who are still in the process of considering whether or not to include a walnut planting in their farm organization.

Increasing income by decreasing the production costs

The following analysis reveals that the costs of the different operations varied among growers, some having costs considerably above and others considerably below the average. The findings should be especially helpful to the grower having higher-than average costs in any phase of his production. By ascertaining the items on which he is expending more than the average of all growers, the individual grower should be enabled to focus his attention on these items and thus try to work out means for reducing such costs so as to leave a larger margin of profit.

Description of the Study

A detailed report of the production costs and the practices was obtained for the year 1949 by means of the survey method on 93 representative orchards operated by 91 growers cooperating in the

Table 3. WALNUTS: NUMBER, ACREAGE, AND PRODUCTION OF BEARING PLANTINGS STUDIED ON 91 FARMS; BY COUNTIES.

(Oregon, 1949)

County	Number of tracts	Bearing walnuts	Total production	Yield per acre	
				1949	1946-49[1]
		Acres	*Pounds*	*Pounds*	*Pounds*
Polk and Yamhill	35	1,469	810,563	552	656
Washington	23	1,026	1,100,023	1,072	875
Clackamas and Marion	19	720	307,764	427	484
Douglas, Lane, and Linn	16	278	371,221	1,335	1,338
Total	93	3,493	2,589,571	741	739

[1]Four-year average, representing a total of 9,981 acres of walnut production.

study (Table 3). This project embraced 3,493 acres of bearing orchards, producing more than 2½ million pounds of walnuts in 1949. These orchards varied in size from 2 acres to 300 acres, averaging 37½ acres each, and 50 out of the 93 tracts were between 10 and 30 acres. A field schedule showing the investment, man labor, equipment use, and all other costs was obtained from each grower by trained enumerators. The total walnut plantings in the eight counties covered by the survey comprised more than 94 per cent of the walnut trees in the state.

Table 4. WALNUT FARMS: UTILIZATION OF THE LAND ON 91 FARMS STUDIED.

(Oregon, 1949)

Land use	Number of farms	Acreage per farm reporting	Average acreage per farm	Percentage of total farm
		Acres	*Acres*	*Per cent*
Walnuts, bearing age	91	....	38.5	29.6
Other walnuts	15	20	3.3	2.5
Filberts	39	12	5.3	4.1
Other orchards	39	14	6.0	4.6
Berries	13	7	1.0	.8
Vegetable crops	4	24	1.1	.9
Other crops	45	78	38.8	29.8
Total tillable	91	....	94.0	72.3
Other land	68	48	36.0	27.7
Total land	91	....	130.0	100.0

Description of Farms

Land use

The 91 farms in this study averaged 130 acres in size (Table 4). The cropland comprised 94 acres or nearly three-fourths of the farm. Farmstead, woods, and waste accounted for the remaining 36 acres.

Forty-six of the 91 farms had only orchard crops, and 24 farms had only walnuts. The bearing walnuts averaged 38.5 acres per farm. Fifteen farms had nonbearing walnuts, averaging 20 acres each. Two out of every five farms also had filberts, averaging 12 acres per orchard. Filberts and walnuts together comprised 47 acres per farm, or half of the total cropland operated. Thirty-nine growers had some other orchards (prunes, peaches, cherries), averaging 14 acres. Thirteen growers had berries, averaging 7 acres. Four growers had vegetable and cannery crops, averaging 24 acres. Forty-five growers had grain and hay crops, averaging 78 acres on their farms, indicating that they had considerable diversity in their land-use programs.

Livestock was not a major feature on many of the 91 farms studied. Only about half of the farms had any livestock and those averaged 14 animal units (cow equivalents) per farm.

Capital investment in farms

The total capital investment in land and farm buildings, based on estimates made by each of the 91 growers interviewed, averaged $47,333 per farm or $364 per acre (Table 5). Land comprised 81

Table 5. WALNUT FARMS: SIZE AND DISTRIBUTION OF CAPITAL INVESTMENT IN LAND AND IMPROVEMENTS.
(Oregon, 1949)

Investment item	Total acres per farm	Total value per farm	Average value per acre	Percentage of total value
				Per cent
Cropland and orchard	94	$35,891	$382	76
Nontillable land	36	2,479	69	5
All land	130	$38,370	$295	81
Buildings[1]	.....	8,963	69	19
Total farm	130	$47,333	$364	100

[1]Exclusive of drier. The value of operator's dwelling averaged $5,725 or two-thirds of the total value of farm buildings shown.

per cent of the total value of this real estate, and buildings (with a small amount of irrigation equipment) 19 per cent. These figures apply to the whole farm, regardless of how the property was used.

Capital investment in walnut enterprises

The total amount of capital (present value) represented by the walnut tracts in the study averaged $22,216 per tract (37.5 acres each) or $592 per acre (Table 6). These amounts do not include investment in farm nut driers or the cash required to operate.

In this study the growers' estimate of the value of their orchards averaged $495 per acre. This value was estimated by the growers from a conservative, long-term standpoint. The share of the farm buildings utilized for walnut production (exclusive of drier facilities) averaged $51 per acre and machinery $46 per acre. The present (depreciated) values of buildings and other equipment used in production were allocated on each farm according to the extent used in the various enterprises, including walnuts.

After each grower had estimated the value of his orchard he was asked to evaluate similar land without the trees. The values

Table 6. WALNUT ENTERPRISE INVESTMENT: AVERAGE VALUE OF CAPITAL INVESTED IN 93 PLANTINGS STUDIED.

(Oregon, 1949)[1]

Item	Value per planting	Value per acre	Percentage of total
			Per cent
Land	$ 8,126	$216	36.5
Trees	10,460	279	47.1
Buildings	1,920	51	8.7
Duster, sprayer	186	5	.8
Other machinery	547	15	2.5
Tractor	615	16	2.8
Automobile, truck	362	10	1.6
Total	$22,216	$592	100.0

[1]The present (depreciated) values of buildings and other equipment were allocated on each farm according to the extent used in the various farm enterprises.

that were thus placed on the land averaged $216 per acre (Table 7). The highest average value for an area was $579 per acre placed on the land by the growers in Douglas, Lane, and Linn counties, where the competitive uses for the land combined to determine the high valuation.

Table 7. WALNUT PLANTINGS: VALUATION PER ACRE OF BEARING ORCHARDS STUDIED, AND VALUES IMPUTED TO LAND AND TREES; BY AREAS.

(Oregon, 1949)

Area	Estimated value per acre		
	Land	Trees	Total orchard
Clackamas and Marion counties	$215	$290	$ 505
Douglas, Lane, and Linn counties	579	432	1,011
Polk and Yamhill counties	170	234	404
Washington County	200	278	478
All orchards	$216	$279	$ 495

The Cost of Walnut Production

The cost of producing walnuts in 1949, with the production averaging 741 pounds of dried nuts (orchard run) per acre, was 15.8¢ per pound (Table 8). The costs include all items of expense incurred in producing and delivering the nuts to the drier plus the charge for drying.

Labor

The cost of man labor was $40.09 per acre or 34 per cent of the total cost of producing walnuts. Labor costs averaged 5.41¢ per pound of dried nuts. The average labor requirement per acre was 45 hours, of which about 30 hours or two-thirds of the total was for harvesting. (The number of hours shown for picking was computed by dividing the cost of picking by 75 cents. The rate for all other labor averaged $1.02 per hour.) The cost of all the harvesting labor averaged 2.1¢ per pound (green) walnuts.

Materials

The cost of cover crop seed, and commercial fertilizers used on the walnut orchards averaged $7.29 per acre, or about 1 cent per pound of nuts. Dust, spray, and bait materials averaged $2.86 cost per acre (see Tables 18 and 19).

General expense

The various charges for equipment operation and all miscellaneous expenses averaged $33.33 per acre, or 4.5¢ per pound of walnuts produced. The cost of drying comprised more than one-third of the total general expense. This item, figured at the usual custom rates paid, averaged about $20 per ton (green weight) of walnuts.

Table 8. WALNUTS: PRODUCTION COSTS BASED ON 93 ORCHARDS, AVERAGING 37.5 ACRES, AND PRODUCING 741 POUNDS OF DRIED NUTS (ORCHARD RUN) PER ACRE.

(Oregon, 1949)

Item	Man labor per acre	Cost per acre	Cost per pound	Percentage of cost
	Hours		*Cents*	*Per cent*
Labor				
Pruning	1.6	$ 1.56	.21	1.3
Brush removal	.9	.89	.12	.8
Machine cultivating	2.9	2.76	.37	2.4
Cover cropping	.4	.44	.06	.4
Fertilizing	.4	.41	.06	.3
Spraying, dusting	1.2	1.18	.16	1.0
Supervision and miscellaneous	8.2	8.76	1.18	7.5
Total preharvest	15.6	16.00	2.16	13.7
Picking	24.5	18.59	2.51	15.9
Other harvest	5.4	5.50	.74	4.7
Total labor	45.5	$ 40.09	5.41	34.3
Materials				
Fertilizers	.....	$ 4.07	.55	3.5
Cover crop seed	.....	3.22	.43	2.8
Sprays, dust	.....	2.86	.39	2.4
Total materials	.....	$ 10.15	1.37	8.7
General expense				
Building repair	.....	$ .57	.08	.5
Machinery repair	.....	3.38	.46	2.9
Drying	.....	11.69	1.58	10.0
Gas and oil	.....	3.05	.41	2.6
Electricity, water, wood, office, supplies	.....	2.26	.30	1.9
Liability, fire, and motor insurance	.....	1.40	.19	1.2
Property taxes	.....	4.98	.67	4.3
Interest on cash required to operate	.....	6.00	.81	5.1
Total general expenses	.....	$ 33.33	4.50	28.5
Depreciation				
Buildings (not including operator's dwelling)	.....	$ 2.30	.31	2.0
Machinery	.....	6.44	.87	5.5
Total depreciation	.....	$ 8.74	1.18	7.5
Interest				
Buildings (at 5 per cent)	.....	$ 2.57	.35	2.2
Machinery (at 5 per cent)	.....	2.26	.30	1.9
Orchard (at 4 per cent)	.....	19.79	2.67	16.9
Total interest	.....	$ 24.62	3.32	21.0
TOTAL COSTS	45.5	$116.93	15.78	100 0

Depreciation

The depreciation on the machinery equipment chargeable to walnuts was $6.44 per acre and on the buildings, $2.30 per acre. No charge was made for any depreciation (or appreciation) of the plantings.

Interest

Interest averaged $24.62 per acre, or 3.3¢ per pound of walnuts. Interest (in lieu of rent) was computed as a cost at 4 per cent on the estimated value of the orchard. Five per cent interest was figured on the investment represented by the buildings and machinery used for walnuts. Interest on the cash required to operate during the year was charged at the rate of 5 per cent. This item of $6 per acre was included under General Expense.

Low investment per acre for machinery and buildings generally is achieved by utilizing equipment for a number of farm enterprises, by operating large crop acreages, by renting out the equipment owned, or by hiring custom work done.

Itemized cost on farm equipment

Costs on trucks averaged 10.5¢ per mile for 3,705 miles driven in 1949. Costs on pickups averaged 6.1¢ per mile for 6,959 miles used during the year. Costs on tractors averaged $1.04 per hour for 487 hours of use per tractor.

The detailed costs of all the equipment used in walnut production have been expressed as a ratio of the respective inventory values (Table 9). The data show that the year's cost on all machinery

Table 9. WALNUT FARM EQUIPMENT: COST OF USING, COMPUTED ON THE BASIS OF EACH $1,000 PRESENT VALUATION.[1]

(Oregon, 1949)

Item	Machinery					Buildings (22.2)[2]
	Pickup (5.9)[2]	Truck (6.6)[2]	Tractor (7.9)[2]	Other (7.5)[2]	Total (7.6)[2]	
Depreciation	$169	$152	$126	$134	$132	$ 45
Interest	50	50	50	50	50	50
Repair	47	71	89	97	86	11
Fuel and oil	125	105	128	4	105	....
License and insurance	55	55	.....	....	8	....
Total	$446	$433	$393	$285	$381	$106

[1]Data include costs on 55 trucks and pickup trucks, 172 tractors, and all the general equipment.

[2]Years remaining in life.

was $381 per $1,000 worth (inventory value) of all machinery used. This is 38 per cent of the present (depreciated) valuation. For the general farm machinery the ratio was only 28.5 per cent, while for all trucks it averaged about 44 per cent of the present (depreciated) value. These results serve as a basis for estimating costs or rates when desired.

Fixed and Variable Costs

Some items of cost are quite fixed regardless of the yield obtained. Other items vary somewhat with the size of the crop produced (Table 10). Any groupings of costs are necessarily somewhat arbitrary and therefore should be regarded only as rough approximations.

Table 10. WALNUTS: FIXED AND VARIABLE COSTS.
(Oregon, 1949)[1]

Item	Cost per acre	Cost per pound	Percentage of total cost
		Cents	*Per cent*
Fixed costs			
Depreciation, interest, taxes	$ 38	5.2	33
Semifixed costs			
Maintenance and miscellaneous	43	5.8	36
Variable costs			
Harvest labor and drying	36	4.8	31
Total cost	$117	15.8	100

[1]Average yield 741 pounds (orchard run, dried) per acre.

Fixed costs

Items designated as fixed costs amounted to $38 per acre, or 5.2¢ per pound of walnuts produced in 1949. As the planting, buildings, and machinery usually constitute an operating unit, such costs as depreciation, interest, and taxes cannot be readily shifted to some other enterprise in case of a poor crop.

Semifixed costs

These costs, including preharvest labor, fertilizers, farm motor fuels, repairs, and other miscellaneous items, amounted to $43 per acre, or 5.8¢ per pound of walnuts harvested in 1949. Such costs can be only partly postponed or shifted in case of crop failure. This is true either because they are incurred before crop prospects are evident or because some maintenance seems advisable for the sake of future production.

Variable costs

Variable costs include picking, drying, and other costs connected chiefly with harvesting. Much of these costs, amounting to $36 per acre or about one-third of all costs in 1949, would generally be eliminated during a year of crop failure.

Some growers know from experience how serious the fixed and semifixed costs are in case of crop failure. For example, in 1949 these costs totaled $79 per acre, or nearly 11¢ per pound with a yield of 741 pounds. If, however, a grower obtained only 200 pounds, his fixed and semifixed costs would increase to more than 31¢ per pound. If his yield were 1,200 pounds or more, these costs would be 8¢ per pound or less, exclusive of harvesting expense (see Table 15).

Major Items of Cost by Operations

Costs may also be expressed in terms of each major operation (Table 11). For example, the cost of $7.22 per acre for cultivating includes the wages for man labor and the charges for implements and power required for this work during the season.

Some costs vary widely from farm to farm and also from year to year. Not all of the operations are performed on every farm (see

Table 11. WALNUTS: COST OF LABOR, MATERIALS, AND OTHER EXPENSE ITEMS PER ACRE; BY FIELD OPERATIONS.[1]

(Oregon, 1949)

Item	Labor	Materials	Other expense	Total cost
Pruning	$ 1.56	.....	.....	$ 1.56
Brush removal	.89	.....	$ .65	1.54
Machine cultivating	2.76	.....	4.46	7.22
Cover cropping	.44	$ 3.22	.54	4.20
Fertilizing	.41	4.07	.31	4.79
Spraying, dusting	1.18	2.86	1.85	5.89
Picking	18.59	.....	1.86	20.45
Other harvesting	5.50	.....	.....	5.50
Supervision and miscellaneous	8.76	.....	4.82	13.58
Drying (custom basis)	.....	.....	11.69	11.69
Automobile and truck	.....	.....	4.30	4.30
Building expense	.....	.....	5.44	5.44
Property taxes	.....	.....	4.98	4.98
Interest on cash for operating	.....	.....	6.00	6.00
Interest on orchard investment at 4 per cent	.....	.....	19.79	19.79
Total cost per acre	$40.09	$10.15	$66.69	$116.93
Percentage of the cost	34.3%	8.7%	57.0%	100.0%

[1]Yields averaged 741 pounds per acre.

Table 12. WALNUTS: APPROXIMATE DISTRIBUTION OF LABOR FOR A 20-ACRE ORCHARD, BASED ON AVERAGE LABOR PROGRAM FOR 93 ORCHARDS STUDIED.

(Oregon, 1949)

Operation	Total labor per orchard	Monthly distribution of man hours per orchard											
		January	February	March	April	May	June	July	August	September	October	November	December
	Man hours												
Pruning and brush disposal	50	9	20	16	5	....	....	....	....	....	....	....	....
Machine cultivating	58	....	....	....	12	14	8	8	8	8	....	....	....
Cover cropping	8	....	....	....	....	....	....	....	1	5	2	....	....
Fertilizing	8	....	5	3	....	....	....	....	....	....	....	....	....
Spraying, dusting	24	....	....	....	4	15	3	....	2	....	....	....	....
Picking	490	....	....	....	....	....	....	....	....	45	400	45	....
Other harvesting	108	....	....	....	....	....	....	....	....	8	90	10	....
Indirect labor[1]	164	14	14	14	14	14	14	14	14	14	14	14	10
Total labor per planting (20 acres)[2]	910	23	39	33	35	43	25	22	25	80	506	69	10

[1]Indirect labor of the operator is the share of his general farm upkeep and maintenance work which was charged to walnuts. This labor is arbitrarily distributed over the whole year.

[2]Fifty of the 93 tracts in this study were between 10 and 30 acres in size.

Table 13). Some things are done in alternate years or only in occasional years as circumstances happen to dictate. Some growers will experiment regarding the use of practices such as cover cropping, fertilizing, dusting and spraying, rather than adopting a rigid policy. Among those practices, therefore, the cost per acre actually covered would be correspondingly greater than the data in the study indicate on the basis of total acreage in orchards (see Tables 18 and 19).

Seasonal Distribution of Man Labor

More than half of the man labor for walnut production in 1949 was used in October (Table 12). Most of this labor came in harvesting and most of it was hired.

During the other 11 months of the year, the man labor totaled about 20 hours per acre. Since the majority of the plantings in the study (50 out of 93), ranged from 10 to 30 acres in size, a 20-acre orchard was considered here as a typical unit, thus the man labor, exclusive of the harvest work in October, totaled about 400 hours on 20 acres (Figure 3). If a grower could distribute his work on 20 acres of walnuts uniformly he would have less than five 8-hour days of employment per month for 11 months in addition to full-time em-

Table 13. WALNUTS: AVERAGE NUMBER OF TIMES OVER AND THE MAN LABOR REQUIREMENTS OF DIFFERENT OPERATIONS USED IN PRODUCTION.

(Oregon, 1949)

Operation	Times over orchard for acreage covered	Labor required per acre once over	Total labor required per acre	Percentage of total acres covered
		Man hours	*Man hours*	*Per cent*
Pruning and brush disposal	[1]	[1]	2.5	100
Disking cover crop	2.0	.5	1.0	80
Disk cultivation	4.0	.5	2.0	57
Other cultivation	4.0	.3	1.2	80
Cover cropping	1.0	.5	.5	83
Fertilizing	1.0	.7	.7	45
Manuring	1.0	3.2	3.2	3
Dusting	2.8	.2	.6	37
Spraying	2.4	1.0	2.4	44
Picking	[1]	[1]	26.2	93
Other harvest labor	[1]	[1]	5.8	93
Miscellaneous and supervision	[1]	[1]	8.2	100

[1]Items which were estimated only in terms of total amounts for the entire orchards during the year.

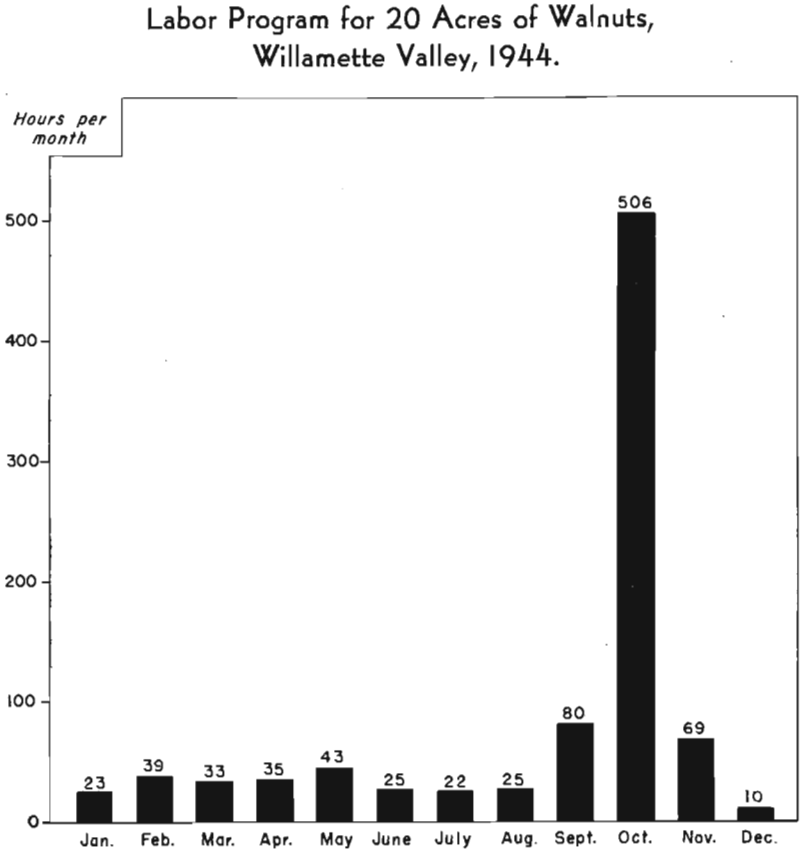


Figure 3. The man labor required in producing walnuts in 1949 was recorded by type of work and its approximate distribution by months. On the basis of the average labor annually required per acre of bearing walnuts, the estimated total labor requirement for a 20-acre orchard would be 910 hours. Assuming twenty-five 8-hour days (200 hours) per month as a full-time job for one man, a 20-acre walnut orchard would then provide full-time work for the operator during only one month of the year (see Table 12).

ployment during October. The weather, of course, plays an important role in determining if and when some of the jobs are done.

Some diversification was generally found on the farms studied. A number of the growers, however, devoted their full time to the walnut enterprise. For the group as a whole, the operators averaged 476 hours of labor per bearing orchard (37.5 acres), or less than

2.5 months of the year. Unpaid family labor averaged an additional 39 hours per orchard. Thus the combined labor of the operator and family comprised about 30 per cent of all labor as compared with 70 per cent hired labor.

The total man labor required for operations (such as cultivation and dusting per average acre) was also computed on the basis of labor required per acre for each time over the orchard (Table 13). Picking, although shown as one operation, obviously may be repeated a number of times during the harvest season which may extend over several weeks. Since there are many variations in the way jobs are handled, ranging from hand labor to dusting by airplane and shaking

Table 14. WALNUTS: VARIATIONS IN COST PER ACRE AND PER POUND ON THE ONE-THIRD LOW-COST AND THE ONE-THIRD HIGH-COST ORCHARDS.

(Oregon, 1949)

Item	Total study	Low-cost orchards	Your farm	High-cost orchards
Number of orchards	93	31		31
Number of acres	37.5	44.5		43.1
Pounds of walnuts	741	1,180		226
Estimated value of orchard	$495	$457		$442
Cost per acre				
Pruning	$ 1.56	$ 1.66		$ 1.17
Brush disposal	1.54	1.95		.82
Cultivating	7.22	6.47		6.36
Cover cropping	4.20	4.87		3.18
Fertilizing	4.79	5.35		2.27
Dusting, spraying	5.89	6.98		4.25
Automobile and truck	4.30	4.73		2.95
Buildings	5.44	5.09		4.16
Property taxes	4.98	5.17		4.44
Interest on cash for operating	6.00	6.00		6.00
Miscellaneous labor and expense	13.58	14.35		9.62
Interest on orchard investment at 4 per cent	19.79	18.29		17.67
Total preharvest cost	$ 79.29	$ 80.91		$62.89
Harvest and drying cost	37.64	54.61		15.04
Total cost per acre	$116.93	$135.52		$77.93
Cost per pound				
Preharvest	10.70¢	6.86¢		27.84¢
Harvest and drying	5.07	4.62		6.66
Total cost per pound	15.77¢	11.48¢		34.50¢

the trees with a mechanical shaker, these data are presented as the average performance of all the growers rather than as standards of good management.

Variations in Costs of Production

The cost of walnut production in 1949 on the group of 31 orchards (one-third of the total studied) with the highest costs per pound was 34.5¢ or three times the 11.5¢ cost per pound on the low-cost group (Table 14). Most preharvest costs per acre varied only moderately, and there was very little difference in the average size of tracts, in age of trees, or in value of plantings. The big difference was chiefly that the high-cost orchards produced only 226 pounds of walnuts per acre compared to 1,180 pounds for the low-cost group.

Some Major Factors Influencing Costs

The grower is concerned with the study of major factors responsible for the variations in cost, and how he can improve his situation. In this analysis of conditions associated with low-cost production, yield per acre is a dominant factor.

The effect of yield on cost

The yield of walnuts per acre varied widely from farm to farm (Table 15). Twenty-six orchards or 28 per cent of the entire group

Table 15. WALNUTS: RELATION OF YIELD TO COST IN 1949; WITH COMPARABLE YIELD DATA FOR 1946-49.

(Oregon)

Yield group	Yield per acre		Number of orchards	Total cost per pound	Cost up to harvest	
	Average 1949	4-year average 1946-49			Per pound	Per acre
	Pounds	*Pounds*		*Cents*	*Cents*	
Less than 400 pounds per acre	183	319	26	37.9	31.3	$ 57
400 to 799 pounds per acre	665	640	25	16.0	10.4	69
800 to 1,199 pounds per acre	1,026	968	15	14.5	9.7	100
1,200 to 1,599 pounds per acre	1,384	1,236	18	12.8	8.1	112
1,600 or more pounds per acre	1,884	1,462	9	10.5	6.0	112
All orchards	741	739	93	15.8	10.7	$ 79

studied had yields of less than 400 pounds, averaging 183 pounds, in 1949. Nine orchards had yields of more than 1,600 pounds, averaging 1,884 pounds per acre. The cost on the low-yielding orchards averaged 37.9¢ per pound, while the cost on the high-yielding orchards averaged only 10.5¢ per pound. If the yield is small, each pound must bear a proportionately larger share of the overhead or fixed costs than if the yield is large.

Yields appeared to vary in direct proportion to the cost input for the different orchard-yield groups. The data indicate that the same variations in yields were found for the 4-year period 1946-49, as for the 1 year studied.

Many factors combine to affect the yield. Some of these factors appear in the following discussion of such items as age of the trees, kind of soil, use of fertilizers, and efforts to control pests and diseases.

► AGE OF ORCHARD: The study, designed to represent the entire bearing walnut acreage in Oregon, included some plantings of all ages over 11 years (Table 16). Some entire plantings had been set out in one year, while others contained trees of various ages. Fourteen orchards classed as less than 20 years old averaged 17 years in 1949. They produced 635 pounds per acre and the cost was about 18¢ per pound. The next group, averaging 22 years, had reached more nearly full production with 993 pounds per acre. Their cost of 15.7¢ was almost exactly identical to the 15.8¢ cost for the entire study. The oldest age-group of orchards, averaging 44 years, produced 518 pounds at a cost of 18.6¢ per pound or slightly more than the average cost of the youngest orchards studied (see Figure 11).

Table 16. WALNUTS: RELATION OF AGE OF ORCHARD TO COST IN 1949; WITH COMPARABLE YIELD DATA FOR 1946-1949.

(Oregon)

Orchard group	Average age	Number of orchards	Yield per acre		Cost of pruning per acre	Total cost per pound
			1949	1946-49		
	Years		*Pounds*	*Pounds*		*Cents*
Less than 20 years ..	17	14	635	771	$3.07	18.3
20 to 24 years	22	27	993	914	5.99	15.7
25 to 29 years	26	22	936	875	3.84	14.3
30 to 39 years	33	21	564	574	1.68	16.4
40 years or more	44	9	518	582	1.07	18.6
All orchards	27	93	741	739	$3.10	15.8

The data show that the cost of pruning was highest for the group between 20 and 25 years of age. However, as some of the older orchards which originally had been planted less than 50 feet apart began to suffer from crowding they have required additional expense for thinning.

► SOILS: The group of bottomland orchards had the highest yields for each of the three years, 1947-49. This group had next to the lowest cost per pound in 1949 (Table 17). The group of hill

Table 17. WALNUTS: COMPARISON OF BOTTOM LAND, VALLEY LAND, AND HILL LAND ORCHARDS.

(Oregon, 1949)

Item	Bottom land orchards	Valley land orchards	Hill orchards	
			Under 26 years old	26 years or older
Number of orchards	20	18	25	30
Acres per orchard	18	24	29	65
Approximate age of trees, 1949	25	25	22	34
Valuation of orchard per acre, 1949	$817	$626	$539	$390
Cost of producing per pound, 1949	15.3¢	18.4¢	14.0¢	16.4¢
	Pounds	*Pounds*	*Pounds*	*Pounds*
Production per acre				
1947 crop	867	661	764	421
1948 crop	1,466	957	1,071	646
Cost of producing per pound, 1949 crop	1,072	776	1,071	549
Average yield 1947-49	1,135	798	969	539

orchards under 26 years of age had the lowest cost per pound and equalled the bottomland orchard yield in 1949. Yields on the valley land soils probably are affected adversely at times by excessive moisture or poor drainage. The productivity of hill orchards depends largely on whether they have adequate depth of soil along with sufficient organic matter to hold the necessary moisture for maturing the crop, particularly as the trees reach maturity of growth.

Practically no irrigating was done on the walnut orchards in the study. Usually such irrigation as occurred was minor in extent or of an experimental nature. In other words, a few growers applied a limited amount of water to their walnuts from a system used chiefly for vegetables or other crops rather than for their walnuts.

► SOIL MAINTENANCE: Nine out of every 10 growers in 1949 had some cover crop in their orchard (Table 18). The 11 orchards

Table 18. WALNUTS: EXTENT AND COST OF FERTILIZING PRACTICES.
(Oregon, 1949)

Item	1949 season		
	No fertilizer	Cover crop	Cover crop and fertilizer
Number of orchards	11	24	57
Walnut yield per acre[1]	552 pounds	738 pounds	885 pounds
Estimated cost per pound	22¢	14¢	15¢
Cost of fertilizing per acre	.....	$5	$14

[1]Average yield over the 4-year period 1946-49.

with no fertility practice during that year averaged 552 pounds of walnuts per acre for the 4-year period 1946-49. Of the 81 orchards seeded to cover crop in 1949, 57 also received one or more applications of fertilizers.

While the abovementioned groupings do not necessarily signify that the respective growers have regularly followed those programs, the study would indicate that quite generally the practices found there in 1949 were their normal practices.

Actually very few growers would intentionally omit the cover crop. Because of rains, some growers fail to get the crop sowed if they wait until after the walnuts are harvested. Some sow a cover crop only in alternate years. Only a few rely solely on volunteer growth. Growers should use a cover crop that is recommended for their particular conditions. They should obtain sufficient seed to allow a good coverage. Merely drilling the seed into the soil is no assurance of getting a satisfactory cover crop growth. The time of seeding, the growing conditions, and the severity of the winter season affect the stand. The application of commercial fertilizers helps the cover crop withstand some of the adverse weather conditions, thus producing a heavy growth of green manure. Organic matter protects the soil from erosion and leaching and enhances its water-holding capacity as well as its plant food content (Figure 4).

The low cost per pound of walnuts produced strongly indicates that expending from $5 to $14 per acre on a fertility program amply repaid the growers for their additional outlay.

The vetches were the most commonly used seeds for cover crops, either singly or mixed and sowed either alone or as a mixture with winter oats or other winter grains. Austrian winter field peas ranked second, followed by crimson clover and rye (Figure 5).

Photo courtesy U. S. Department of Agriculture

Figure 4. Substantial growth of cover crop shown on April 28. Fertilizer was applied on March 25.

Nitrogen fertilizers, chiefly ammonium phosphate and ammonium sulfate, ranked first with the walnut growers. Following in the order of their frequency in 1949 were boron, mixed fertilizers, superphosphate, and lime.

▶ DUSTING AND SPRAYING: The main concern of the growers who dusted or sprayed their orchards was to control walnut blight. Some orchards have suffered little or no apparent infection. In

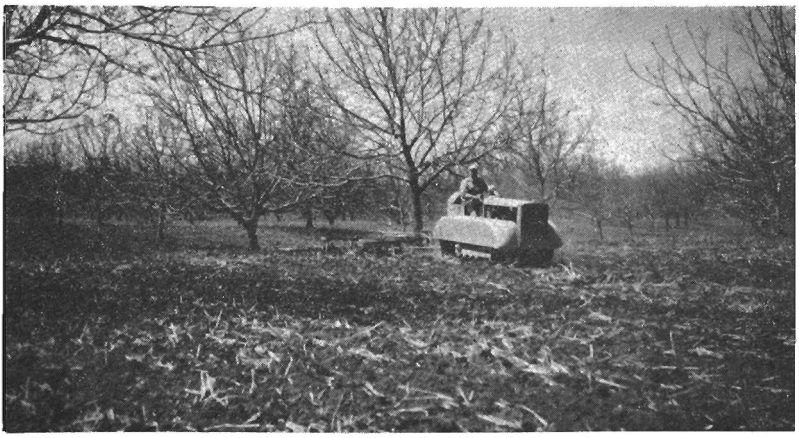


Photo courtesy D. L. Rasmussen

Figure 5. Using a 10-foot disk to knock down the cover crop (May 8). This operator disks three times. A mixture of 30 pounds Austrian winter field peas and 70 pounds Abruzzi rye per acre was broadcast with end-gate seeder in late September. Two swaths, each 25-30 feet wide, get the seed close to the trunks (50 x 50 feet) even though the branches touch the ground. Seed is lightly covered with a ring-type drag. Seeder covers about 30 acres per hour.

years such as 1950 blight was not serious because there was no rain during the critical period for infection. But if wet weather occurs during the blooming and early post-blooming periods, blight is a serious factor where no control program has been followed. Advice regarding materials and their application was furnished to growers by Oregon State College.

Twenty-two of the 93 orchards in this study were neither dusted nor sprayed in 1949 (Table 19). Twenty-six orchards were dusted, 37 were sprayed, and 8 were both dusted and sprayed. While these growers differed widely in their opinions regarding the need of blight control measures, the records indicate that those who were dusting or spraying had better yields and their costs per pound were lower than those on orchards using no controls, despite the extra outlay of $9.09 per acre for dusting and $7.64 per acre for spraying. A grower who had kept records of his dusting operation for 6 years reported: "As five applications per year are normally required for efficient control of blight, my costs for dusting averaged $9.40 per acre. Therefore, if we receive 16¢ per pound for our walnuts, it will only take 60 pounds saved from blight per acre to pay all dusting costs. A 6-year average of our orchard gives us a 33 per cent yearly

Table 19. WALNUTS: EXTENT AND COST OF DUSTING AND SPRAYING.
(Oregon, 1949)

Item	1949 season			
	No dusting or spraying	Dusted	Sprayed	Dusted and sprayed
Number of orchards	22	26	37	8
Pounds of walnuts per acre	357	865	809	1,282
Cost per pound	21¢	15¢	16¢	13¢
Cost of treatment per acre				
Labor	.....	$ .71	$2.33	$2.07
Equipment	.....	1.55	3.35	3.04
Materials	.....	6.83	1.96	4.02
Total cost of treatment[1]	.....	$9.09	$7.64	$9.13

[1]Costs refer to covering the acreage dusted 3.6 times over and the acreage sprayed 2.2 times over while the costs for the acreage receiving both dust and spray includes dusting once and spraying 3 times during the year.

additional yield of marketable nuts. The additional walnuts saved by dusting, from only two trees per acre, bear the complete cost of our entire dust program."

► VARIETY OF TREES: Four-fifths of the walnut trees in Oregon were Franquettes, according to the nut tree survey made in 1949.[1] Seedlings (producing soft-shelled nuts) comprised nearly 10 per cent and Mayettes a little more than 5 per cent of the total trees at that time.

The proportion of the Franquette trees has continued to increase as more and more of seedling trees have been grafted to this variety.

Effect of the orchard investment on cost

Interest at 4 per cent on the estimated value of $495 per acre on the bearing orchard accounted for about 17 per cent of the cost of producing walnuts in 1949. The study indicates that this value is conservative in terms of the estimated current cost of $1,176 per acre for establishing a new planting on similarly-priced land (see Table 22). Valuation of the orchard is not a major factor affecting the cost of producing walnuts inasmuch as the valuations are closely in line with yields (Table 20).

Efficient operation lowers cost of production

Usually the larger farm enterprises show a lower unit cost for equipment and labor expended than do the smaller enterprises. This

[1]Excerpt from Oregon Extension Bulletin 708: *Oregon-Washington Nut-Tree Survey, 1949.*

Table 20. WALNUTS: VARIATION IN VALUE OF ORCHARD PER ACRE, SHOWING RELATION OF INVESTMENT TO YIELD AND COST.

(Oregon, 1949)

Orchard group	Average value per acre	Number of orchards	Cost per pound	Production per acre	
				1949	1946-49
			Cents	*Pounds*	*Pounds*
Less than $500 per acre	$ 348	30	16.0	548	552
$500 to $599 per acre	501	24	14.8	835	907
$600 to $999 per acre	680	22	16.6	984	1,029
$1,000 or more per acre	1,149	17	15.2	1,375	1,367
All plantings	$ 495	93	15.8	741	739

was true of the walnut orchards studied (Table 21). Some growers performed the various operations much more economically than others. For example, the tillage operations ranged from practically nil for a few orchards having a sod cover to one cultivation of some kind nearly every week throughout the summer. The actual coverage for all the orchards averaged about eight times over during the season including leveling the ground for harvesting. Efficient work is usually the result of the operator's careful study of his jobs whereby he develops practical and rapid methods (see Figure 5).

► HARVESTING: Harvesting concerns the walnut grower from the standpoints of the cost and the seasonal aspects. The total cost of harvesting and delivering the walnut crop to the drier averaged

Table 21. WALNUTS: RELATIONS BETWEEN SIZE OF ORCHARDS, LABOR AND MACHINERY COST, YIELD, AND TOTAL COST PER POUND.

(Oregon, 1949)

Orchard group	Average orchard	Number of orchards	Labor and machinery cost per acre	Yield per acre[1]	Total cost per pound
	Acres			*Pounds*	*Cents*
Less than 10 acres	6.7	12	$82	827	15.2
10 to 19.9 acres	12.8	28	88	1,007	17.9
20 to 39.9 acres	25.0	29	73	795	17.4
40 or more acres	97.0	24	53	686	14.8
All orchards	37.6	93	$61	739	15.8

[1]Average of four years, 1946-49.

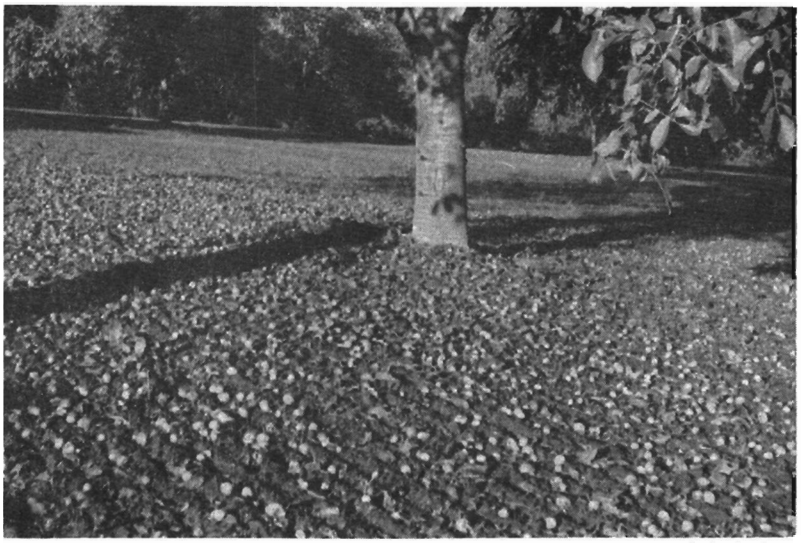


Photo courtesy U. S. Department of Agriculture

Figure 6. Picking up walnuts in Oregon has been mainly a hand operation. A mechanical shaker was used in this orchard.

3.5¢ per pound dry weight in 1949. This was 22 per cent of the total production cost (Figure 6).

Walnuts are harvested in the late fall, usually just in time to reach the market for the holidays. It is necessary, therefore, to ship the bulk of the nuts as speedily as possible by rail, as the largest markets are on the eastern seaboard. Most growers recognize that the harvesting should be done as early as practicable, in keeping with the factors of cost and yield. The harvest season naturally would extend over several weeks. But inasmuch as going over the orchard repeatedly adds to the cost per acre, the tendency is to shorten the picking period as much as possible.

► PREPARING FOR PICKING: Unlike the wide interest among the filbert growers in using mechanical pickers, there has been comparatively little actual picking of walnuts with machinery in Oregon. One grower who uses mechanical means to harvest his filberts said: "As far as walnuts are concerned, I have not seen or heard of a mechanical walnut picker which interests me. However, a good rolling after cover crop planting will not hurt the cover crop and will greatly assist you to get a cleaner job of picking. If you have a good clean, well-rolled orchard, you should be able to attract pickers

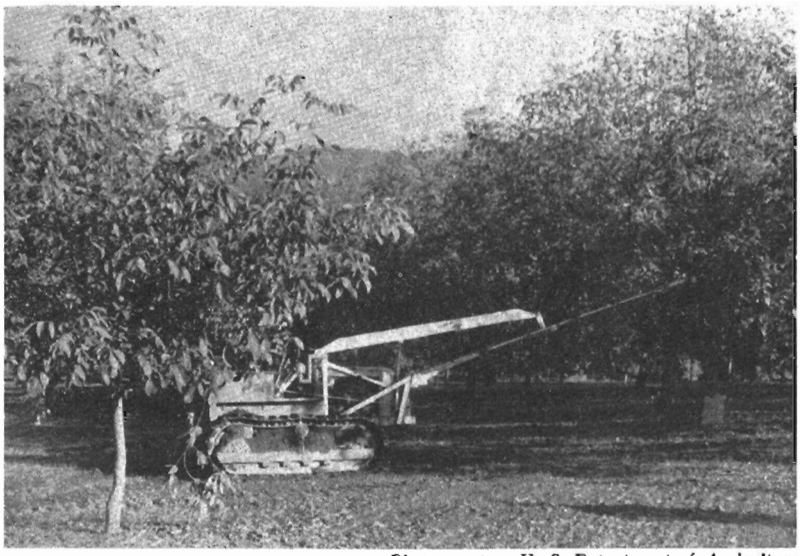


Photo courtesy U. S. Department of Agriculture

Figure 7. Many of the growers used a power shaker, either owning one or hiring this work done.

at a lower rate. On fairly steep land we must concede that rolling would not be the thing to do on account of the danger of soil erosion."

► SHAKING, PICKING, AND HUSKING: Most growers shook their trees either by hand or with power shakers (Figure 7). Several growers said, "Avoid the mistake of shaking too soon. It takes extra work to sort the stick-tight nuts. We put in one of those so-called huskers, and the machine won't knock the husks off them. The husk should be cracked when you shake them down. We cleaned the ground first without shaking. Then the next week when we started shaking a lot of the nuts fell out of the husks, but a lot of them didn't. But when they came through the husker it knocked them off in pretty good shape. We would accumulate 1 to 1½ sacks full of stick tights per day. The first of these were not much good, but the later ones turned out all right.

"The advantage of having a husker is that you do not have to delay your harvest until a good rain enables you to pick up the clean nuts. This way you get started a little bit earlier, and you can keep going.

"The shaker is hydraulic and mounted on a crawler tractor with a power takeoff at the front end. It should be built a little stronger to shake a 20- to 30-year-old tree. We shook 100 trees per hour.

"We gained several things through the use of shaker and huller. First, we start at least two weeks earlier, thus often avoiding the rain. We don't have to wash the nuts after hulling. We get better nuts. They do not lie on the ground. We have whiter meats and better grades. Our nuts go on the market earlier, which is the thing we are fighting for all the time. By spreading the season we take the load off the driers, of which there is always a shortage in our territory."

Drying

Walnuts are first washed and dried after picking, either by the grower or at a neighborhood drier. In this process the walnuts lose an average of about 35 per cent of the original weight. Since the prevailing practice was to have the nuts dried commercially, all drying expense was figured on the custom basis. The charge for this service averaged $20 per ton green basis or $31 per ton dried (orchard run) basis.

Importance of quality

Experienced growers agreed in their convictions that *growers must produce quality walnuts in order to enable processors to market them under their high-grade brands.* Quality is the result of having desirable varieties, favorable soil and climatic conditions, and proper management—including the control of diseases and pests.

Those who produce few culls and a high proportion of large sizes normally receive more for their crop than growers who produce many culls or small nuts. The estimated cullage in Oregon over the six-year period 1945-1950 has averaged around 20 per cent, varying from about 13 up to 37 per cent of the crop. Practically all of this cullage was shelled and then marketed.[1]

Hazards and problems

Various kinds of hazards have been encountered by walnut growers during a period of years. Growers report that sometimes frost in the spring has reduced the set of nuts on their trees. They frequently have had rains during harvesting which impaired operations, and occasionally ruined part or all of their crop as happened on some tracts in 1950 when flood waters covered the ground. Heavy snowfalls and near-zero weather early in 1950 and again a

[1] *Tree Nuts*, Crop Reporting Board, Bureau of Agricultural Economics, U. S. Department of Agriculture. August 1951 and previous editions.

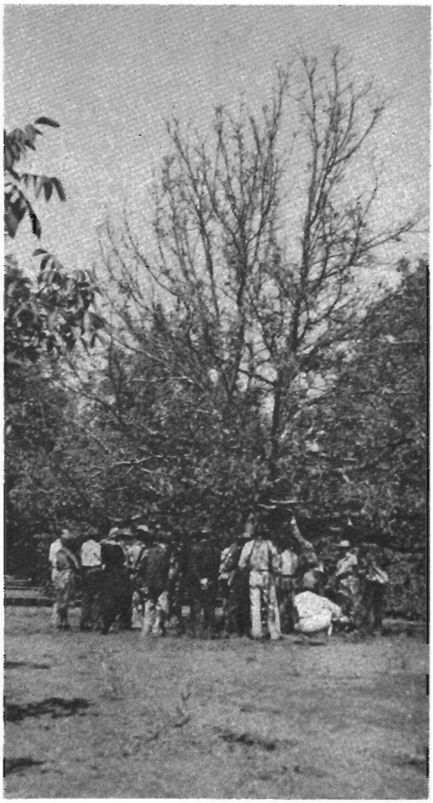


Figure 8. Horticultural specialist points out black-line on graft of a dying walnut tree.

year later caused considerable tree breakage and severe freeze damage to some walnut trees. In some cases the entire trees have been killed to the ground level by adverse weather. Many of the growers now recognize blight as a threat and often serious but generally controllable as already mentioned.

Walnut girdle (black-line) and crown rot are two outstanding causes of decline in walnut orchards, ranging from one or two trees per year in some orchards to much more extensive damage in others. Of these two disorders, black-line is the more serious by far. Its cause is still unknown and the only preventative measure known to date is to use a root stock other than black walnut.[1]

With respect to crown rot where the crown rot is not associated with black-line as is sometimes the case, pending more definite information, the following suggestions are offered by Rawlings[2] to prevent and alleviate the disorder.

1. Avoid cutting bark on the trunk with disk or other tools.
2. Plant walnuts on well-drained soil.
3. Farm the land in a way such that there are no depressions around the trunks to hold water during the winter.
4. If irrigating, apply water so that it does not stand around the trunks.
5. Where crown rot has started, remove soil from the base of the trunk and adjoining roots during the late spring exposing

[1]Miller, Rawlings and Painter. *Forty-third Annual Report*, Oregon State Horticultural Society, 1951, pp. 183-185.
[2]C. O. Rawlings. Extension Horticulturist, Oregon State College.

crown and injured area to air during the summer. Fill back in before winter rains set in.

Walnut shrivel has been designated by Painter as the number one problem of the walnut growers of Oregon.[1] He found that nearly everyone has an idea as to the cause of shrivel. Some said it was too much water; some said not enough water. Some said it was too little sunshine and heat; others said too much sunshine and heat, causing sunburn. Some said it was caused by aphis injury; others were equally sure it wasn't. Some thought it was due to lack of some minor element in the soil; some said we were using too much borax. Painter points out that shrivel is not new, for C. E. Schuster, former U. S. Department of Agriculture horticulturist, reported in 1935 considerable trouble with shrivel. This fact is important because growers had not gone into heavy borax applications at that time. Painter mentions the following factors that may have worked together to cause the severe trouble in 1948:

- Heavy crop. Many trees carried more nuts than they could fill.
- Lack of adequate soil moisture at the critical period during which the kernels were developing.
- Lack of adequate moisture and the excessive heat caused sunburn and premature defoliation.

The effect of heat at a critical time of the year; that is, late in the season during filling of the nuts, unquestionably causes shrivel in addition to a darkening of the kernel.

Recent experimental work on irrigation of walnuts has given substantial evidence that lack of adequate water during the growing season is the principal cause of shrivel.[2] Under controlled conditions irrigation eliminated tip shrivel completely; reduced quarter shrivel from 14 per cent to 2 per cent; half shrivel from 8 per cent to 4 per cent; three-quarter shrivel from 14 per cent to 4 per cent, and increased the number of shrivel-free kernels from 46 per cent to 90 per cent (Figure 9).

How serious this matter of walnut shrivel and other conditions can be, is indicated in the following excerpts taken from a report on the situation that prevailed in 1948.[3]

" . . . At the time the 1948 walnut crop was being harvested this office (Northwest Nut Growers) advised all growers that the best they could hope for was pretty much of a salvage operation and that is approxi-

[1]John H. Painter, Horticulturist, U. S. Department of Agriculture.
[2]Painter, John H. *Ann. Proc.* Nut Growers Soc., Ore. & Wash., 1951, pp. 195-197.
[3]John E. Trunk. "1948 Walnut Crop Big Disappointment," *Northwest Nut Bowl, No. 5.* Published by Northwest Nut Growers, Dundee, Oregon.

Photo courtesy William B. Parker

Figure 9. Supplemental irrigation is good insurance in case of extremely dry or hot weather. It also permits use of a permanent cover crop.

mately the way it has turned out. Our advice to many growers at the time was that they should not harvest their low-quality crops, but they couldn't see these big crops go to waste, even if they were of extremely low quality.

"Harvesting was brought on somewhat earlier than expected but again it was delayed because of very heavy rains and some lack of harvesting labor. Filberts were later than usual and both crops came together—thus causing the worst congestion so far as washing and drying facilities were concerned. Shrinkage in weight at the driers ran from 45 to 60 per cent, the heaviest ever known. In many cases drying took three times as long as in an ordinary season.

"Quality-wise, the crop ran as follows: 8.7 per cent were First Quality Blue Pirate, 34.9 per cent were Second Quality Cascade, 54.4 per cent Third Quality Omegas, and 2 per cent were varieties such as Mayettes and Fords which were not marketable in the shell.

"Sizes, too, were nothing to brag about. There were 8.8 per cent Jumbo, 24.3 per cent Large, 40.3 per cent Medium, and 26.6 per cent Baby. There was an utter lack of demand for Baby size. There was great resistance to Third Quality packed under our Omega brand.

"Practically the entire crop was processed after November 1st and a very large percentage of it after the middle of November. Buyers who had placed orders even for the grades we had to offer cancelled them when they found out we couldn't make delivery in time for holiday distribution. In the spring it took some price concessions and other inducements to get the buyers to take on these nuts.

"Besides having so many shriveled kernels, we also started running into another situation which proved to be actually worse and that was the thin shells and the poor sealing of the shells. In many of our shipments from 10 to 25 per cent, and in a few instances even more, of the shells popped open and deliveries were a mess. In most instances our claims were settled for around 10 to 15 per cent, but in others we had to allow up to 25 per cent and in a few cases we were forced to hand sort or ship to other markets.

"Only 55 per cent of the total tonnage was of merchantable quality. The other 45 per cent was either culls from processing operations or orchard-run lots that went directly to the shelling plant. Under the Walnut Marketing Agreement and Order in effect the surplus percentage of the crop was set up at 10 per cent and the saleable at 90 per cent. As has been the usual experience, the 10 per cent surplus brought about 50 per cent as much as would have been the case had these nuts been marketed in the shell."

Fortunately such a calamitous combination of circumstances is rare, but on the other hand, each one of the various aspects described has occurred occasionally.

Cost of Establishing Walnuts

The estimated cost of growing a walnut orchard to bearing age (based on the 1950 price level) was $960 per acre exclusive of the land (Table 22).[1] The estimated values at which the growers in this study appraised their "walnut" land averaged $216 per acre. Thus the total cost of establishing walnuts, including the investment in land, the accrued growing costs, and interest compounded annually on the costs, amounted to $1,176 per acre (Figure 10).

Costs by years

Besides the value of the land committed to the use of walnuts, a cost of $155 per acre or 16 per cent of the total growing cost was incurred during the first year. Costs averaged $80 per acre annually during the following 10 years, based on charging the use of the land exclusively to the walnut trees.

[1] An understanding of the method of computing the average cost of items is essential to a proper interpretation of these figures. Costs were determined on the basis of the entire walnut acreage studied. The entire input or cost of an item was divided by the total acreage to obtain the cost per acre. Hence the average per-acre costs as herein presented represent a composite of all items to the extent used, and do not always show what the cost would be if any particular item or practice—such as fertilizing—were followed out on the entire acreage. Neither was any consideration given to the net effect of intercropping or of walnuts produced during the 11-year period of establishing.

Table 22. ESTIMATED COST PER ACRE FOR BRINGING A WALNUT PLANTING TO BEARING AGE (TWELVE YEARS).[1]

Item	Cost per acre		
	First year	Average, second to eleventh year	Total for 11 years
Man labor per acre at $1 per hour			
Plowing	$ 2.00	.....	$ 2.00
Planting trees	18.00	.....	18.00
Cultivating	2.90	$ 2.90	31.90
Cover cropping	.40	.40	4.40
Fertilizing	.40	.40	4.40
Pruning	2.50	2.50	27.50
Miscellaneous and supervision	8.20	8.20	90.20
Total labor	$ 34.40	$14.40	$ 178.40
Materials			
Trees, 27 @ $2.50[2]	$ 67.50	.....	$ 67.50
Stakes, ties, tree replacement	4.04	$ .20	6.04
Cover crop seed	3.22	3.22	35.42
Fertilizers	4.07	4.07	44.77
Total materials	$ 78.83	$ 7.49	$ 153.73
General expense			
Buildings	$ 5.44	$ 5.44	$ 59.84
Machinery	11.85	9.05	102.35
Auto, truck	4.31	4.31	47.41
Electricity, insurance, supplies	1.95	1.95	21.45
Property taxes	4.98	4.98	54.78
Interest on accrued growing costs	5.00	24.20	247.00
Interest on land, 4 per cent on $216 value	8.64	8.64	95.04
Total general expense	$ 42.17	$58.57	$ 627.87
Total growing cost	$155.40	$80.46	$ 960.00
Value per acre of unplanted land	.....	.....	$ 216.00
TOTAL COST PER ACRE	.....	.....	$1,176.00

[1]Based on the 1950 cost level. No consideration was given to the effect of intercropping or of walnuts produced prior to the twelfth year.

[2]Requires 27 trees per acre when set 40 feet apart on the square plan. In effect, close planting is comparable to intercropping.

Man labor

The total cost of man labor for the 11-year period of establishing walnuts, computed at $1 per hour, was $178 per acre or about one-fifth of the total growing cost. Planting the trees accounted for about half of the 34 man hours required during the first year. The total amounts of other labor were similar for each of the 11 years.

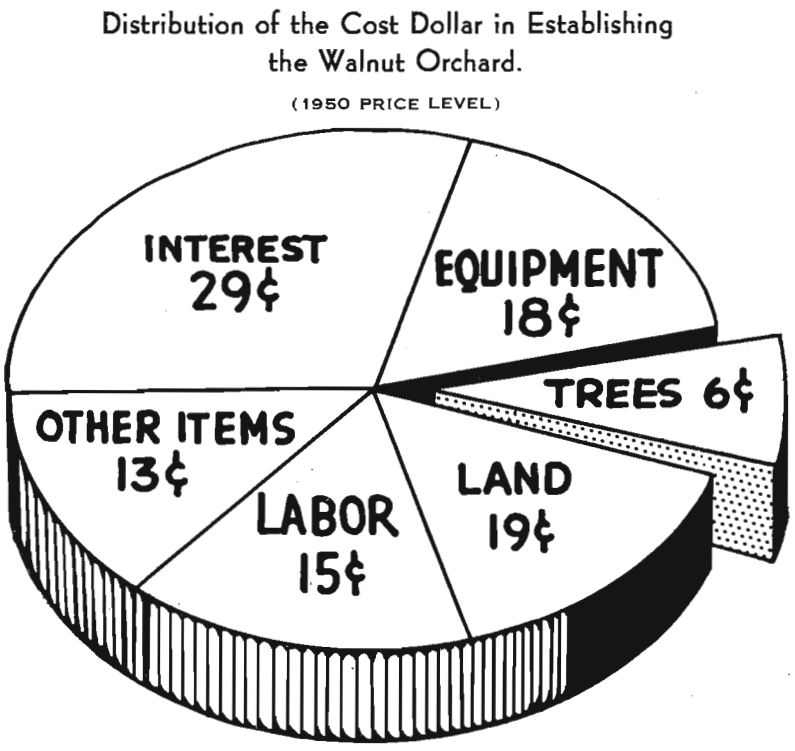


Figure 10. The estimated cost of $1,176 per acre for growing a walnut planting during 11 years was computed with no consideration given to intercropping.

Materials

The cost of trees (based on 40-foot spacings) constituted 43 per cent of the first year's growing expense. This item varies with the number of trees set per acre and with the price per tree. (Cull trees seldom make a successful orchard, yet growers are often tempted by the low prices to purchase such stock.)

Outlays for stakes and tree replacements varied greatly, and the per-acre costs for cover crop seed and fertilizers were lower than if the entire acreage had been treated each year.

General expense

The general expense, which was $42 per acre for the first year, increased gradually during the ensuing 10 years as the interest on the accrued costs was added. Interest computed on costs and on

the value of land (in lieu of rent) comprised 29 per cent of the total cost, and 36 per cent of the growing cost exclusive of the land investment.

Yield and the Age of Plantings

Certain physical factors such as type, depth, and fertility of soil; varieties planted; quality of stock planted; skill used in planting; amount and character of intercropping; general care of the orchard; and disease and insect infestation have a determining effect upon the age at which a young walnut orchard will pay all of the annual costs. Equally important in their effects are such economic factors as number of trees per acre; the cost of trees, land, labor, machinery operation, taxes; and the rate used in figuring interest on land investment and cumulative costs during the establishing period.

That a walnut orchard would reach commercial production during its twelfth year was indicated in this study as in an earlier one

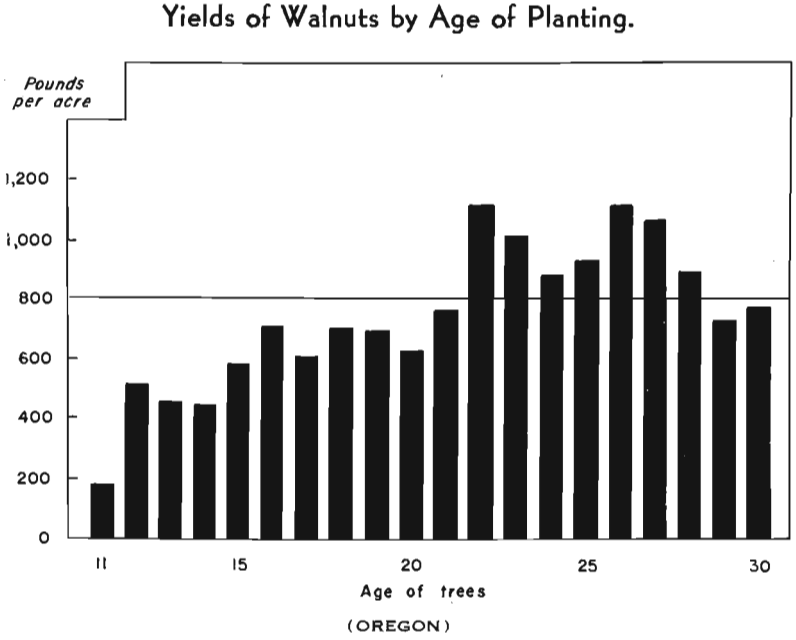


Figure 11. Data are based on 258 orchard records embracing 5,131 acres producing four million pounds of walnuts during 20 years.

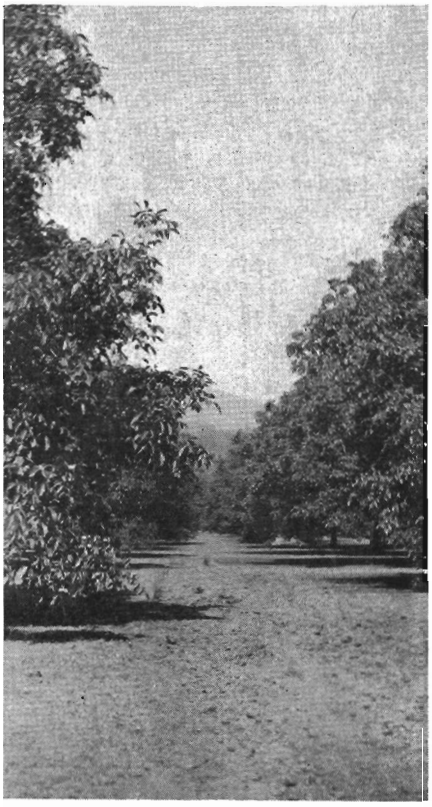


Figure 12. This 40 x 40 foot orchard was 25 years old when it was thinned on the diagonal plan, allowing 56 feet between trees. The subsequent growth of healthy, low limbs is evident.

(1919-29).[1] This previous study, based on data from 54 orchards, revealed that a total of 513 pounds of walnuts per acre had been produced from the fifth to the eleventh year.

In the present study of 49 orchards the yields during the eleventh year averaged 185 pounds (dried) nuts per acre (Figure 11). Orchards during the twelfth year averaged 523 pounds, the thirteenth year 461 pounds, the fourteenth year 454 pounds, and the fifteenth year 591 pounds. During the next 6 years (16th-21st) the average of the annual yields was 685 pounds, ranging from 607 to 765 pounds per acre. This was followed with a 7-year peak production period (22nd-28th) averaging 1,000 pounds per acre. Usable data on older plantings were too limited to include here, but yields tend to decline as trees become crowded. Some plantings have responded to thinning and rehabilitation which may extend the life span of those orchards for many years (Figure 12).

Major Factors Affecting Costs

The planting system and the value of the land are two of the major factors in their effect on cost of establishing an orchard. Intercropping may also be an important factor affecting the cost and the subsequent productivity of the orchard.

[1]Oregon Station Bulletin 315: *Costs and Practices in Establishing Walnut Orchards in Oregon.*

Planting systems

The square planting system predominated in the walnut orchards studied (Table 23). Of the 81 tracts planted on the square, 22 had trees spaced 40 feet apart, 25 had trees 50 feet apart and 19 had trees 60 feet apart. There was no indication in the various age groups of any marked trend in the choice of planting systems over the 40 years represented by these plantings.

The subject of tree spacing brings up the co-subject of thinning. Most growers using spacings of 40 feet or less expected to thin the trees when crowding commenced. The chief argument used in favor of close planting is that returns during the early years are much greater, as there are more trees per acre. In effect, close planting is comparable to intercropping.

The chief arguments against close planting are, first, that it is a rather costly method of using the land not required by the permanent trees, and secondly, that many growers will not remove the extra trees before they crowd and injure the permanent planting.

The estimated cost of planting a walnut tree in 1950, including the tree cost, amounted to about $3.00. The per-acre planting cost for a 30-foot spacing planted on the square, therefore, would be $152, while the same item of cost for a 60-foot planting on the square would be only $38. Obviously, close planting adds materially to the cost of establishing the orchard. Whether subsequent returns will justify this cost was not determined from this study.

Table 23. PLANTING ARRANGEMENT AND SPACING OF WALNUT TREES, SHOWING THE DISTRIBUTION OF ORCHARD BLOCKS ON THE FARMS STUDIED.

(Oregon, 1949)

Square plan		Other plans	
Dimensions	Number	Dimensions	Number
34 feet	1	33 x 40 feet	1
40 feet	22	40 x 70 feet	1
45 feet	3	40 x 80 feet	1
46 feet	1	50 x 60 feet	1
48 feet	4	50 x 94 feet	1
50 feet	25	60 x 65 feet	1
55 feet	1	Diagonal:	
57½ feet	1	40 feet	1
59 feet	1	45 feet	1
60 feet	19	48 feet	1
72 feet	1	50 feet	2
80 feet	1	56 feet	1
93 feet	1		
Total	81	Total	12

Land

Land has both productivity value and location value, but location value is of minor importance for a tract of walnuts since the nuts are not bulky and are easily delivered to market. For this reason land with a high location value adds an undue amount to the cost of producing walnuts.

In this study, for instance, some of the high values for unplanted land were from bottomland areas or from semi-suburban districts where part-time farmers live on small tracts and work off the farm for part of their living. Such high-valued unplanted walnut land may be a distinct handicap to establishing an orchard at low cost or to producing walnuts at low cost after the orchard attains bearing age. Even if the high value is based on productivity the prospective grower should assure himself that the land is productive specifically for walnuts.

Intercropping

The utilization of land not occupied by the roots of the young trees has always been a problem. Some growers have met this problem by close planting or by interplanting with comparatively short-lived trees (filberts, prunes, etc.) with the intention of thinning the trees when they crowd. Others have grown berries or annual crops between the tree rows. Most of the growers have preferred not to intercrop at all. Some growers have found that intercropping attracts gophers, which then cause damage to young trees.

Interplanting also presents some problems in regard to cost and possible injury to plants from the use of dusts and sprays required during the season. For example, in order to control the cherry fruit fly it is advisable to dust or spray the walnut trees as well as the interplanted cherry trees, thereby increasing these costs. Moreover, materials which are apt to drift across the rows may be toxic to some plants in the various stages of growth.

Computing costs on a basis whereby the intercrop would carry all costs incidental to its production, including interest and taxes on the land actually occupied, materially reduces the cost of establishing the walnuts. For example, if intercropping were charged with half of the overhead items (Table 22), the growing cost of establishing walnuts would be only $576. The total cost, including land at $216, would be $792 per acre. Much of this reduction in the cost of growing is in items such as interest and taxes, since only one-fourth or one-third of the soil area is used by the walnut trees as compared to a full utilization in the case of the nonintercropped orchards. The basic principle to observe is *do not allow the intercrop roots to compete with the walnut roots for plant food and moisture.*

Estimated Returns from Walnuts

What have been the average returns from walnut production over a period of years with the fluctuations that occur in yields, costs, and prices?

The estimated prices paid to growers for their 1949 crop averaged 11¢ per pound, compared to the average cost of 15.8¢ shown in the study. Growers, therefore, recovered only 70 per cent of their total costs that season (Table 24). In 1947 the small crop of 463 pounds per acre brought the growers 15.5¢ per pound, although the estimated cost was 22¢ that year. This means that the growers again recovered only 70 per cent of their total costs. In 1948 the yield of 752 pounds per acre brought the growers 12¢. With an estimated cost of 15.8¢ the growers got back 76 per cent of their total costs.

With those three bad years (1947-1949) in succession following the war, it is apparent why many of the growers valued their orchards so conservatively in terms of investment. For the 11-year period from 1940 to 1950 the price of walnuts averaged 16.3¢ while the estimated costs averaged 16¢ per pound. The growers' price, therefore, was 102 per cent of the estimated costs during that period.

Table 24. WALNUTS: ESTIMATED COST AND THE SEASONAL AVERAGE PRICE.

(Oregon)[1]

Year	Yield per acre	Estimated cost per acre				Cost per pound	Price per pound	Percentage price is of cost
		Labor		Other costs	Total cost			
		Harvest	Other					
	Pounds					*Cents*	*Cents*	*Per cent*
1940	400	$ 4	$ 5	$ 39	$ 48	12.0	10.0	83
1941	622	7	6	42	55	8.8	12.0	136
1942	314	6	9	48	63	20.1	14.3	71
1943	455	11	12	51	74	16.3	21.0	129
1944	574	16	13	53	82	14.3	22.5	157
1945	575	17	14	55	86	15.0	23.0	153
1946	735	22	15	61	98	13.3	22.0	165
1947	463	14	15	73	102	22.0	15.5	70
1948	752	25	16	78	119	15.8	12.0	76
1949	741	24	16	77	117	15.8	11.0	70
1950	500	16	16	80	112	22.4	16.0	71
Average 1940-50	557	....	....	....	....	16.0	16.3	102

[1]Prices and yields are based on Oregon Extension Bulletin 700: *Oregon's Tree Fruits and Nuts*, and on other data prepared cooperatively by the Oregon State College Extension Service, Agricultural Economics Section, and the Bureau of Agricultural Economics.

A Look Ahead

What are the prospects for a grower to continue in business if his costs are higher than his walnut prices? First, he realizes that the term cost includes a charge for *all* his items of input. It refers not only to the cash expenditures for commercial fertilizers, sprays, taxes, interest, and hired labor; but also to the value of items such as farm manure applied to the orchard, depreciation on equipment, interest for the investment value of the equipment and orchard, and work done by the operator and his family. Obviously, to the extent that a grower holds equity in his equipment and orchard and does his own work the cost represented by such items is noncash and thus deferable to some extent. Many, of course, have had better-than-average results. Others, perhaps, have had little or no return on their investment, and only small returns for the use of their equipment and labor.

Managerial ability becomes an increasingly large factor as mechanization increases and as labor becomes more costly. Orchard management is a long-term undertaking. Unfortunately, in some cases, during a period of poor returns less attention is given to management, thus causing deterioration both in value of the planting and in the quality of walnuts produced.

The primary concern of the individual grower is to strive for efficient production in terms of high yield and good quality of walnuts, which in turn reduces his cost per pound and assures him the maximum price for his crop. Rigid adherence to this policy will enable him to compete most advantageously with other growers.

Good farm management practice suggests that specialization is not advisable for most farmers. The farmer with a diversified production program is able to employ his farm machinery, power equipment, and his own and family labor more advantageously over the entire year than the specialized farmer with a one-crop system.

When adverse conditions arise in the walnut enterprise, moreover, the diversified farmer, with a relatively small acreage in walnuts along with some other enterprises, is able to retrench more effectively with regard to cash expenditures. These include labor, where his family is able to substitute in a large part for the hired labor ordinarily employed.

The large-scale operator, on the other hand, is much more concerned about the necessity of obtaining a sufficient cash income. He is largely, if not entirely, dependent on his receipts from walnuts to pay the operating expense, which often represents a considerable short-term obligation for money borrowed. Consequently, he may

face a serious situation whenever his crop yield is small or the price unusually low. If he has no other resource to draw upon until the next crop is harvested, the financing of future operations following a disastrous year or two is often difficult for him and sometimes impossible.

Findings in this study, by pointing out the importance of good yields of high-quality walnuts produced at a reasonably low cost per pound, should be helpful to the individual grower interested in improving his business. Having the data in terms of physical requirements, such as the hours of labor and machinery used per acre, the approximate cost of production for any other period may be estimated by simply adjusting for any changes in the scale of wages and other items of cost.

APPENDIX

Methods of Obtaining, Compiling, and Analyzing Data

The data for this study were collected by the survey method. Each cooperating grower was visited at the end of the year for the purpose of obtaining a complete business record on the bearing walnut acreage. Analysis of the data was made chiefly by grouping and cross-tabulating. Many of the details on the schedule were the growers' carefully checked estimates. Sufficient time was spent with each grower to work out thoroughly all the facts pertaining to the year's operations.

▶ JOINT COSTS: Those farm expenses that were incurred only in part for the walnut enterprise were charged to it in proportion to the benefits received. The investment in machinery and buildings used jointly was likewise apportioned according to use.

▶ RENT: A few growers rented land, buildings, or equipment. The renter was treated as an owner and was charged interest, taxes, and depreciation in lieu of rent, in order to make all farms comparable on an investment basis.

▶ LABOR: A very complete form was used to compile the various labor operations performed in walnut production. The enumerator recorded for each operation the farmer's estimate of the work done by himself, members of his family, and hired labor. The wage rate for family labor was gauged by wages paid to hired labor for comparable work.

In addition to the time that the farmer spends at specified jobs he generally puts in considerable time that should be charged as overhead against his enterprises. Each cooperator was asked to apportion his total year's time among his enterprises. From his estimate for the walnut enterprise, the actual time he had spent on direct orchard work was deducted, and the remainder was entered as supervision and miscellaneous work.

▶ CONTRACT LABOR: Expenditures for contract work were divided between wages for the man labor involved and rental value of the equipment furnished.

▶ INTEREST: The present investment or inventory value of orchard and equipment was estimated, and interest was charged uniformly at 4 per cent on the orchard and at 5 per cent on the equipment.

▶ DEPRECIATION: Depreciation on buildings and equipment was obtained by dividing the present (depreciated) value by the remaining years of usefulness. No depreciation was calculated on the trees. Appreciation on young trees would partly offset depreciation on older plantings in this study.

▶ MACHINERY OPERATION COST: Total machinery cost may be obtained by adding together the operating costs, interest, and depreciation.