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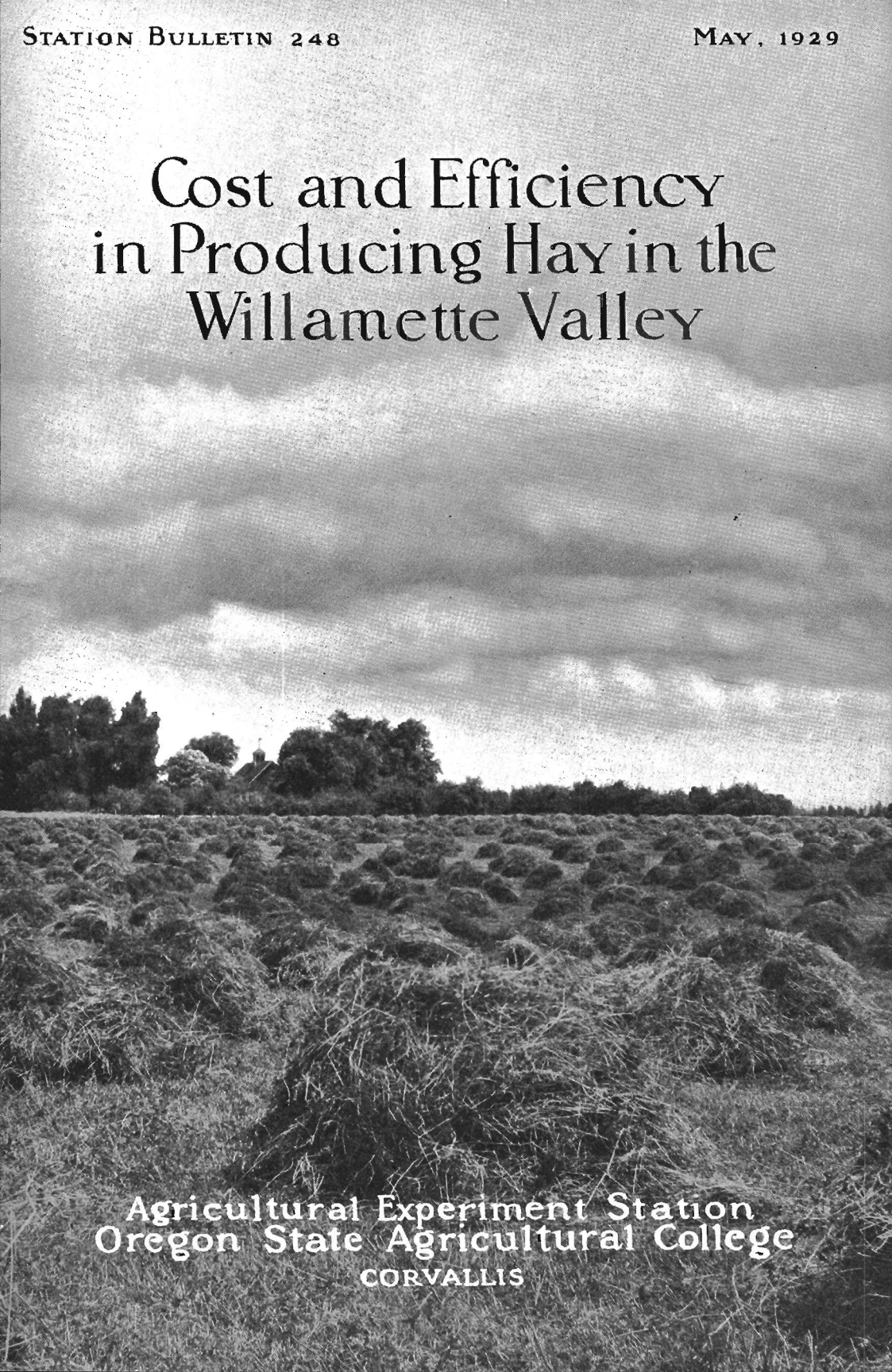
Cost and Efficiency in Producing Hay in the Willamette Valley



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HAY PRODUCTION IN THE WILLAMETTE VALLEY

Hay crops comprise a third of the total acreage of crops in the Willamette Valley. The annual production of hay amounts to half a million tons, with a value, at prices that have prevailed in recent years, of more than five million dollars.

* * *

The average cost of production for the three years 1925, 1926, and 1927, was $7.08 a ton for clover hay, $9.87 for vetch-and-oats, $7.93 for alfalfa, and $9.93 for cheat. These figures are based on 484 farm-survey records covering 10,146 acres of hay, with a production of 23,292 tons.

* * *

A reduction of 6 percent in the average cost of producing hay in the Willamette Valley would amount to more than a quarter of a million dollars annually. This study indicates that the principal factors that influence the cost, and that can be controlled to reduce it, are (1) harvesting efficiency, (2) yield, and (3) method of establishing a stand of clover.

CONTENTS

SUMMARY

1. This bulletin presents information upon the cost of producing hay in the Willamette Valley, the factors affecting the cost, and ways of reducing it. The bulletin has two objectives: (1) to establish facts and principles for the use of present and prospective hay growers, teachers and students of agriculture, and those concerned with public problems and policies; (2) to indicate to present hay growers possibilities of reducing their costs.

2. The facts presented were obtained in a state-wide study by the survey method of costs and practices in producing forage crops in Oregon during 1925, 1926, and 1927. This bulletin deals chiefly with the two major hay crops in the Willamette Valley, clover and vetch-and-oats, but also with the two principal minor hay crops, alfalfa and cheat.

3. The average cost of producing clover hay was $7.08 a ton; this is on a basis of 80 percent of the acreage seeded with grain and 20 percent seeded alone, which were the average proportions found; and the cost of establishing the stand has been divided equally between two years as the life of a clover stand. For vetch-and-oats hay the average cost was $9.87 per ton; for alfalfa, $7.93; and for cheat, $9.93 per ton.

4. In considering or using these cost figures, as well as the detailed figures given in the cost summaries, three points should be kept in mind: (1) They include non-cash as well as cash items of expense, and give the grower wages for his work and 5 percent interest on his investment. (2) They are averages of widely varying costs of individual growers, and consideration should be given to the range and variation in cost. (3) Cost of production is only one of several factors affecting the production of hay crops, all of which should be recognized when considering these crops.

5. For clover hay, cash items amounted to only 25 percent of the total cost; for vetch-and-oats, 43 percent; for alfalfa, 24 percent; and for cheat, 41 percent. The remainder of the total cost consisted of the unpaid labor of the grower and his family, depreciation, and interest.

6. There was little variation in the average cost of each crop in the different years, but considerable variation in costs on different farms in the same year, and in different years on the same farm. This variation in costs is caused partly by factors that the grower cannot control—for example, climatic conditions—and partly by management factors that he can control.

7. The factors affecting cost are classified and discussed in three groups, as follows:

(1) Harvesting Efficiency: With side-delivery rakes and hay-loaders harvesting required 4.2 man-hours and 4.7 horse-hours per ton, as compared with 4.9 man-hours and 4.4 horse-hours with ordinary methods.

A few cases of tractor mowing indicate that it is possible to mow more than twice as fast with a tractor as with a team (although not necessarily at half the cost.)

The labor for hauling hay from the field and chopping it into the barn with silage cutters was just the same as for ordinary methods—namely, 3.1 man-hours and 2.9 horse-hours a ton; hence there was no extra labor cost for chopping the hay.

Harvest labor per ton was less for the larger yields, up to a certain point; beyond that, the larger yields required more harvest labor.

For a difference in length of haul of 175 rods the difference in cost of hauling was 65c per ton.

There was wide variation in size and organization of the haying crews, but no greater efficiency was apparent for either large or small crews, or for crews with any particular organization.

(2) Yield: For both clover and vetch-and-oats there was a marked decrease in cost per ton with higher yields per acre. On the higher priced land, however, even though yields were higher, the cost of production also was higher.

Land-plaster on both clover and vetch-and-oats increased the yield and decreased the cost per ton.

The average yield of common vetch was 2.1 tons per acre; of Hungarian vetch, 2.5 tons per acre.

Yields of vetch-and-oats were the same on disked spring grain stubble as on ground that was plowed, and the cost of production was $1.77 per ton less on the disked ground.

Difference in date of fall seeding apparently had no effect on the yield of vetch-and-oats.

Using more vetch seed to the acre increased the yield and decreased the cost per ton.

(3) Cost of Seeding Clover: The average cost of seeding clover with grain was only $2.60 per acre as compared with $15.65 per acre for seeding alone.

For seeding with rape the cost was $12.35 per acre, when the pasture was valued at prevailing rates.

The difference in cost between seeding with grain and seeding alone will pay for a considerable amount of lime or fertilizer.

8. Data upon labor practices and requirements are given to show (1) the amount of each labor operation for each crop; (2) the average labor requirement for each operation; (3) the labor requirement for an acre of each operation on the average farm, on the more efficient farms, and on the less efficient farms; and (4) the seasonal distribution of the labor.

9. Because of the danger of depletion of fertility, uneven labor distribution, and the large acreage required, few Willamette Valley farms specialize on hay production. About three-fourths of the hay was fed by the growers and only about one-fourth was sold as a cash crop. Three of the important hay crops—clover, vetch, and alfalfa—are legumes and are important in crop rotation and in soil improvement.

10. The average return to the grower for hay that was sold was $9.70 per ton for clover and $11.62 for vetch-and-oats, as compared with the average costs of production of $7.08 and $9.87, respectively. With average yields of approximately two tons per acre, however, and average land values between $125 and $150 per acre, the percentage return on capital was not large, and an extensive acreage was necessary for a satisfactory income from hay alone.

Cost and Efficiency in Producing Hay in the Willamette Valley

By

H. E. Selby

INTRODUCTION

Hay crops comprise about one-third of the total acreage of crops in the Willamette Valley. The annual production of hay amounts to half a million tons, with a value at prices that have prevailed in recent years, of more than five million dollars. This bulletin presents information upon the cost of production, and factors affecting the cost, of this large part of the crops of this important agricultural region of Oregon.

With increasing attention to the business side of farming, and to the economics of agriculture, such information becomes increasingly important. It is needed (1) by both present and prospective farmers who are interested in either raising or feeding hay; (2) by teachers and students of agriculture; (3) by those concerned with public problems such as price control, land development, freight rates, and taxation, not only in the Willamette Valley but in the state as a whole. Especially important are any possibilities of reducing the cost, for with such extensive production a very small reduction in the average cost per ton would aggregate a large economic saving.

Method of study.* The facts presented have been obtained in a study by the survey method of costs and practices in producing forage crops in Oregon during 1925, 1926, and 1927.† Data were obtained in personal interviews with the operators of typical farms in important forage-producing regions of the state (Fig. 1). In the Willamette Valley a total of 207 farmers cooperated in the study, 76 for all three years, 72 for two years, and 59 for one year, an average of 143 farms per year.

The census classification of hay crops is rather unsatisfactory for the Willamette Valley. According to the 1925 Census about one-third of the total hay acreage was clover. Vetch-and-oats hay is not classified separately but probably also constitutes about one-third of the total hay acreage. The remaining third includes alfalfa, cheat, timothy, other tame grasses, grain, and wild hay. This bulletin deals chiefly with the two major hay

Acknowledgments. The author thanks the many farmers, county agents, and others whose willing cooperation has made this bulletin possible. Credit is due to numerous persons for helpful suggestions and assistance, particularly to Professor H. D. Scudder, under whose supervision the study has been conducted; to A. S. Burrier, E. B. Starkey, and C. D. Schoolcraft, who have assisted in the field work; and to Miss Helen Boyer for assistance in the tabulation. The departments of Animal Husbandry, Farm Crops, and Dairy Husbandry have given helpful cooperation in the study.

*For details of the methods used in the study see Appendix A.

†Other forage crops included in this study are discussed in Oregon Agricultural Experiment Station Bulletin 241, Cost and Efficiency in Producing Alfalfa Hay in Oregon, and in Station Bulletin 251, Cost of Producing Silage and Kale in the Willamette Valley.

crops, clover hay and vetch-and-oats hay, but data also were obtained on alfalfa hay and cheat hay, which are probably the most important of the minor hay crops. A total of 484 enterprise records was obtained upon these crops, covering 10,146 acres producing 23,292 tons.

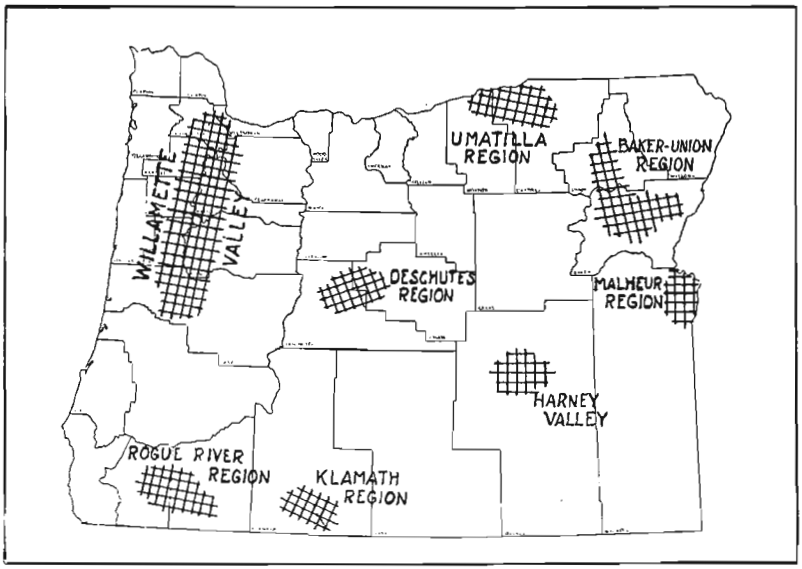


Fig. 1. Regions in which forage cost studies were made.

Climatic conditions. The average annual rainfall in the Willamette Valley, at Corvallis, based upon records for 40 years by the College Weather Station, is 42 inches; the average annual range in temperature is from 15° to 98° F.; and the average frost-free period is 181 days. During the winter of 1924-25 there was a period of unusually cold weather, which killed a considerable acreage of clover seeding and also some vetch. This condition, however, had no serious effect upon the results of this study; and aside from this one feature the three years apparently were quite representative of Willamette Valley climatic conditions.

THE COSTS OF PRODUCING WILLAMETTE VALLEY HAY CROPS

Cost summary. The itemized average costs per acre of producing clover hay, vetch-and-oats hay, alfalfa hay, and cheat hay, in the Willamette Valley, as determined by this study, are shown in Table I. The cost of the clover hay is shown (1) for clover from which both a seed crop and a hay crop were obtained, (2) for clover that was harvested only for hay, and (3) for these two types of clover-hay production combined. Corresponding costs *per ton* are given in Table XX, and the quantities of labor, seed, and fertilizer are given in Table XXI.

TABLE I. AVERAGE COST PER ACRE OF PRODUCING IMPORTANT WILLAMETTE VALLEY HAY CROPS, 1925-1927

	Clover hay*					
	With seed crop	No seed crop	All	Vetch-and-oats hay	Alfalfa hay	Cheat hay
Number of records	97	100	197	200	43	44
Number of acres	2478	1641	4119	4751	674	602
Number of tons	5343	3408	8751	11061	2540	940
Direct man labor	$3.34	$3.80	$3.65	$5.15	$7.49	$4.85
Overhead man labor	1.13	1.23	1.16	1.47	2.58	1.30
Horse labor	1.16	1.29	1.24	2.03	3.83	2.11
Tractor	.03	.02	.03	.89	.09	.39
Other machinery	.60	.82	.68	1.01	1.12	.71
Automobile	.11	.05	.07	.10	.07	.02
Fertilizer	.24	.31	.26	.13	.60	.49
Seed	.08†	.05†	.06†	3.03	.....	1.21
Depreciation of stand	1.30*	2.60*	1.90*	.....	4.28	.....
Taxes	.94	1.94	1.43	2.07	2.52	1.49
Interest on land	3.24	6.85	4.94	7.04	10.42	5.30
Total	$12.17	$18.97	$15.42	$22.92	$33.00	$17.87
Credit for pasture	.30	2.12	1.08	.17	3.23	.14
NET COST PER ACRE	$11.87	$16.85	$14.34	$22.75	$29.77	$17.73
TONS PER ACRE‡	1.9	2.0	2.0	2.3	3.8	1.8
COST PER TON	$6.20	$8.22	$7.08	$9.87	$7.93	$9.93

*The charges for depreciation of clover stand are based on 80 percent seeding with grain and 20 percent seeding alone, and on a two-year productive life for the clover. For discussion of other ways of computing this cost, see page 42.

†Seed used for thickening stand.

‡These yields are averages of the three annual average yields and therefore do not check with the total acres and tons at the top of the table.

For detailed explanation of cost items, see Appendix A.

In considering or using these figures three points should be kept in mind.

First, as will be discussed more fully, these figures represent the total cost of production, include non-cash as well as cash items, and give the grower wages for all of his work upon the crop and 5 percent interest on his capital investment.

Second, these figures are averages of many widely varying costs of individual growers, and consideration should be given to the range and variation in these costs. This also will be discussed more fully. The average figures do not indicate the possibilities, or what could be done, in raising the several crops, but rather what actually was done, on the average, during the three years studied.

Third, cost of production is only one of several factors affecting the production of these crops. Other factors, such as soil and climatic conditions, markets and prices, feeding values, maintenance of fertility, and utilization of surplus labor and equipment, must also be considered. Cost figures alone cannot be used to judge the comparative profitableness of the crops, nor to prove that on a given farm any one of them should be increased or decreased.

But while these limitations upon the use of average cost figures must be recognized and understood, there are many ways in which these figures are valuable and useful. They indicate the return that must be received to give the average grower wages for his work and pay 5 percent interest on present land values. They show the differences between the crops both in

total cost of production and in the amounts of the various items such as labor, fertilizer, machinery cost, and interest on land value. They indicate comparative advantages and disadvantages in the production of the several crops. By comparison with similar data from other regions and other states they make possible a comparison of hay production in the Willamette Valley with that of other parts of the country. And these facts, together with the information on other factors that have been mentioned, and amplified by the additional facts and details in the following pages, are important

Fig. 2. A 35-acre Willamette alfalfa field. Farm of A. I. Thomas, Yamhill county.

when considering the comparative profitableness of crops, probable trends of crop and livestock production, land values, land development or settlement, credit facilities, freight rates, taxation, and similar subjects.

Costs are not all cash expenditure. A strict classification of all cost items as to whether they are cash or non-cash is difficult to make, and any such classification must be arbitrary. The reason for this is that some items are cash in one sense and non-cash in another.

In Table II the items of the cost of producing the Willamette Valley hay crops have been classified into four groups. In the first group are the items commonly thought of as cash cost of production, such as hired labor, machinery repairs, and taxes. The items of board, horse feed, and seed, of course, consist partly of products raised on the farm; but their general nature is similar to the other strictly cash items. The credit for pasture has been deducted from these cash items since it brings a cash return either as pasture rent or as livestock or livestock products sold.

The second group of items includes the value, at prevailing wages, of the labor of the grower and members of his family that was not paid for in cash. These items are non-cash in the sense that no cash wages are paid for them. For this labor to be available, however, the grower and his family must incur certain living expenses, and in this sense it may be considered a cash cost.

The third group consists of items of depreciation. Depreciation is the purchase price of new machinery or equipment that is prorated as cost of production over the period of years that the piece of equipment lasts. For clover and alfalfa the cost of establishing the stand also is prorated as a

depreciation charge over the years of life of the stand. Theoretically the average annual cash expenditure for new equipment and replacements and for establishing new stands of clover and alfalfa should equal the average annual charges for depreciation.

The fourth and last group of items consists of interest charges on the capital investment in land and equipment used in producing the crop. Unless the grower is using borrowed money upon which he is paying interest, this is a strictly non-cash cost.

How much should the returns be? Table II shows that on the average the cash costs of clover hay amounted to only 25 percent of the total cost, and those of vetch hay to only 43 percent of the total. Some people think of this cash cost as cost of production. Returns sufficient to cover only this part of the cost, however, would give the grower no wages for his labor, no allowance for equipment worn out in producing the crop, and no return on his capital investment.

TABLE II. CASH AND NON-CASH COSTS PER ACRE OF PRODUCING IMPORTANT WILLAMETTE VALLEY HAY CROPS, 1925-1927

	Clover hay		Vetch hay		Alfalfa hay		Cheat hay	
	Amount	Percent of total	Amount	Percent of total	Amount	Percent of total	Amount	Percent of total
		%		%		%		%
Hired labor	$ 1.35		$ 1.78		$ 3.68		$ 1.69	
Board	.50		.47		.25		.61	
Horse feed and maintenance	.88		1.47		2.79		1.54	
Horse labor hired	.04		.03		.02		.01	
Tractor repairs	.....		.10		.01		.04	
Tractor fuel and oil	.02		.46		.02		.19	
Tractor hire	.....		.04		.04		.....	
Other machinery repairs	.10		.16		.24		.10	
Other machinery hired	.01		.02		.03		.....	
Automobile operating expense	.07		.10		.07		.02	
Fertilizer	.26		.13		.60		.49	
Seed	.06		3.03		.....		1.21	
Taxes	1.43		2.07		2.52		1.49	
Total	4.72		9.86		10.27		7.39	
Credit for pasture	1.08		.17		3.23		.14	
NET TOTAL CASH COST	3.64	25	9.69	43	7.04	24	7.25	41
Operator's direct labor	1.62		2.50		3.48		2.36	
Overhead labor	1.16		1.47		2.58		1.30	
Unpaid family labor	.18		.40		.08		.19	
TOTAL OPERATOR'S AND UNPAID FAMILY LABOR	2.96	21	4.37	19	6.14	20	3.85	22
Depreciation of horses, barn and harness	.22		.37		.71		.39	
Depreciation of machinery	.40		.59		.58		.44	
Depreciation of tractor	.01		.23		.01		.12	
Depreciation of stand	1.90		.....		4.28		.....	
TOTAL DEPRECIATION	2.53	18	1.19	5	5.58	19	.95	5
Interest on horses, barn and harness	.10		.16		.31		.17	
Interest on machinery	.17		.24		.27		.17	
Interest on tractor	.....		.06		.01		.04	
Interest on land	4.94		7.04		10.42		5.30	
TOTAL INTEREST	5.21	36	7.50	33	11.01	37	5.68	32
TOTAL COST PER ACRE	$14.34	100	$22.75	100	$29.77	100	$17.73	100

Adding to the cash costs the value of the operator's and unpaid family labor makes 46 percent of the total cost for clover hay, and 62 percent of the total for vetch. With his living expenses to pay, the grower must get this much to cover his cash outgo, or as is commonly said, to "keep from going behind." He still will have no return to use for replacing worn-out equipment and no return on his capital. To obtain prevailing wages for his labor, allowance for depreciation, and 5 percent interest on his capital, he must get a return equal to the total cost of production.

Fig. 3. Most Willamette Valley hay is cured in loosely-built medium-sized hay-cocks such as these.

Now, it is possible that some farmers may be willing to raise hay for a return of less than prevailing wages for their labor. They may have no way to get a better return and may prefer to have some return rather than none at all. It is possible that some equipment used for hay may be necessary on the farm for other purposes. The use of it on hay may involve no extra cost, and perhaps the hay should therefore not be charged for the use of it. It is possible that land values may be too high for a return of 5 percent on capital to be expected; or it is possible that owners may be satisfied with a return of less than 5 percent on the value of their land.

Making allowance for possible differences, such as these, in attitude toward cost of production is facilitated by the classification of cost items in Table II since any part or parts of the cost may be considered as desired. Thus those who object to including a charge for use of land as part of the cost of production, on the ground that profits determine land values instead of land values determining costs and thus profits, can easily deduct the charge for interest upon the value of the land.

It is thought that, in general, returns of much less than the total costs of production as they have been computed will tend either to reduce the acreage of these crops or to decrease land values, and that much greater returns will tend either to stimulate hay production or to increase land values.

Costs are different on every farm. The annual average costs per acre of each crop were quite consistent, those of the two principal crops, clover

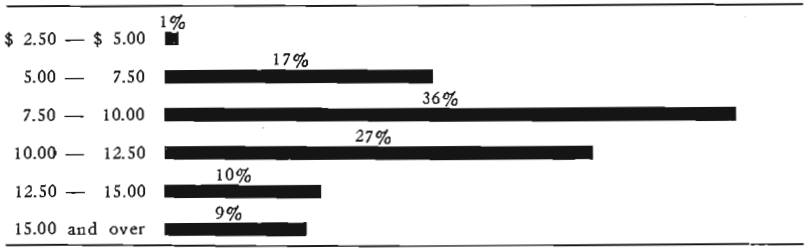
and vetch, all being within 10 percent of the three-year average (Table III). The average annual costs per ton, however, show greater variation, because of differences in yield from year to year with different seasonal conditions. The variation in both acre and ton costs was greater, of course, for the alfalfa hay and cheat hay, because of the smaller numbers of records that were taken.

TABLE III. VARIATION FROM YEAR TO YEAR IN AVERAGE COST PER ACRE AND PER TON OF IMPORTANT WILLAMETTE VALLEY HAY CROPS

	Average cost per acre				Average cost per ton			
	1925	1926	1927	Ave.	1925	1926	1927	Ave.
Clover hay: with seed crop	$10.76	$12.27	$12.57	$11.87	$ 8.13	$ 6.16	$ 5.18	$ 6.20
Clover hay: no seed crop	17.40	15.72	17.43	16.85	9.17	8.36	7.35	8.22
Clover hay: all	15.32	13.49	14.22	14.34	8.92	6.91	5.90	7.08
Vetch-and-oats hay	24.51	21.55	22.21	22.75	10.63	9.95	9.06	9.87
Alfalfa hay	35.69	27.75	25.83	29.77	9.62	7.36	6.83	7.93
Cheat hay	19.62	16.06	17.53	17.73	8.30	9.24	13.94	9.93

As with all farm cost data, there was wide variation in costs on individual farms in the same year (Table IV). This variation is caused by differences in a large number of factors that affect costs. These factors are of two types. The first type consists of conditions, such as kind of soil, prevalence of crop pests, and value of land, most of which cannot be changed or controlled by the grower to influence his costs, except by changing his location. The second type consists of management factors such as the acreage of the crop; methods of seeding, cultivating, fertilizing, and harvesting; efficiency in the use of labor; and kind of equipment used; most of which are under the control of the grower.

TABLE IV. VARIATION IN COST OF VETCH-AND-OATS HAY ON DIFFERENT FARMS



For similar data for the other crops see Table XXII.

The cost of production also changed from year to year on individual farms. This variation is caused by changes in different years in both the condition and management factors that have been mentioned. Certain farms in one year get more rain at a critical time than others, and in another year they get less; crop pests are worse on different farms in different years. Growers also change their management practices from year to year—they change their acreage—they change their practice in cultivating and fertilizing—they adopt new equipment or methods—and these changes affect their costs from year to year.

In the following pages are discussed a number of the individual factors causing the variations in cost that have been noted.

FACTORS AFFECTING THE COST OF WILLAMETTE VALLEY HAY CROPS

Because of the large number of factors affecting farm costs, and the many complicated combinations of them, different on every farm and in every year, it is difficult to analyze farm cost data and determine the effect and importance of individual factors. There are a number of factors, however, that in this study have discernible effects upon the costs of Willamette Valley hay crops. Some of these are conditions that the established grower cannot change, but their importance and effect will be of interest to prospective growers; others are factors that can be controlled by the grower to increase his efficiency and reduce his costs. These factors have been classified, and will be discussed, under three main headings, as follows: (1) Factors Affecting Harvesting Efficiency. (2) Yield and the Factors that Influence It. (3) Cost of Establishing a Stand of Clover.

An average reduction in the cost of producing hay in the Willamette Valley of a fraction of a cent per ton would pay big dividends on this investigation. It is hoped that many growers will obtain suggestions that will enable them to reduce their cost by dollars per ton.

1. FACTORS AFFECTING HARVESTING EFFICIENCY*

The percentage of the acreage of each crop upon which each harvesting operation was performed is shown in Table XV. Most of the mowing and raking was done with the 5-foot mower and the 2-horse, 10-foot sulky dump rake. There were a few exceptions of wider and narrower sizes of these implements, and sometimes only one horse was used on the smaller hayrakes. In the aggregate 5 percent of the growers used side-delivery rakes, and about two-thirds of these also used hay-loaders. Practically all of the hay was cocked by hand from the windrow, except that handled with the hay-loaders.

Twelve percent of the growers baled all or part of their hay from the field. Excepting this, practically all of the hay was hauled to the barn with wagons, most of it being pitched on to the wagons by hand and unloaded with forks or slings. A few growers used slips and buckrakes in baling from the field.

The average cost of harvesting was found to be $3.36 per ton. This covers mowing, raking, cocking, and hauling to the barn, and is based upon 332 records covering the harvesting of 13,745 tons of clover hay and vetch-

*A multiple correlation analysis was made of the 197 clover records for the three years, using cost per ton as the dependent factor and (1) man-hours of harvesting labor per ton, (2) yield per acre, and (3) land value per acre, as independent factors. The coefficient of multiple correlation was .773 $\pm$ .011. The coefficients of determination were .198, .293, and .107 for the three independent factors respectively, indicating that the amount of harvesting labor accounts for about a fifth of the variation in cost, yield for nearly a third and land value for about a tenth. As the relationships are not strictly linear these values can be taken as only roughly indicative.

and-oats hay during the three years. The items making up the total cost are:

Direct man labor	$1.94
Horse labor	0.46
Overhead man labor	0.58
Interest, depreciation and repairs of machinery	0.34
Use of automobile	0.04

Records involving baling from the field or any exceptional haying methods have been omitted from this tabulation.

Exceptions to the common haying methods that warrant special consideration are: (1) the use of side-delivery rakes and hay-loaders; (2) mowing with tractors; (3) chopping hay into the barn; (4) baling from the field; (5) the use of power hay hoists.

Side-delivery rakes and hay-loaders. Seventeen records covering the use of side-delivery rakes and hay-loaders gave average labor requirements

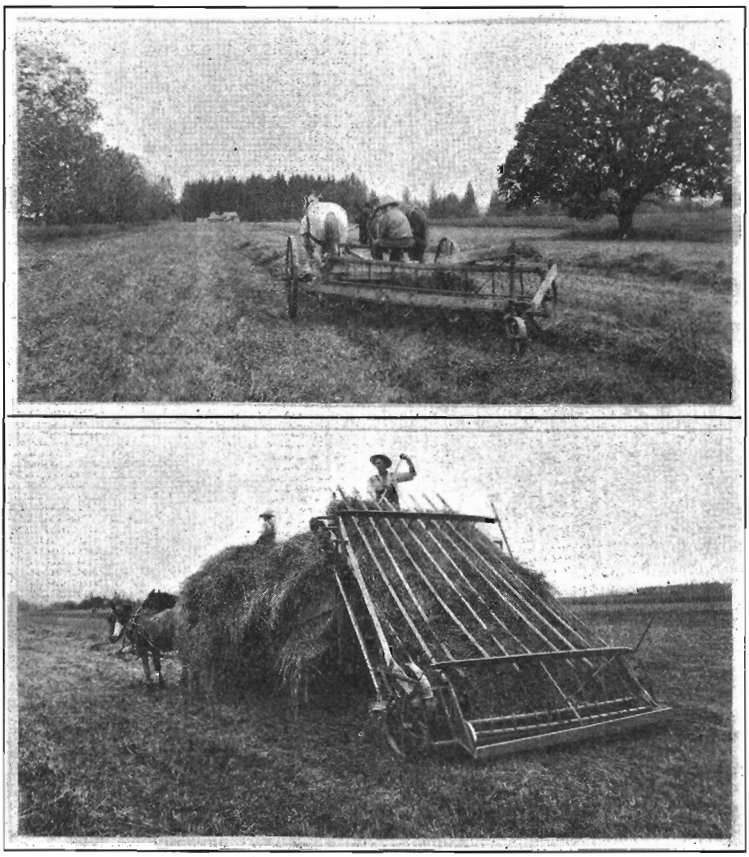


Fig. 4. Advantages of side-delivery rakes and hay-loaders are better curing of the hay and elimination of cocking by hand.

for harvesting a ton of hay as 4.2 man-hours and 4.7 horse-hours, as compared with 4.9 man-hours and 4.4 horse-hours with ordinary methods. Although the number of records is small, this comparison indicates that side-delivery rakes and hay-loaders have some labor-saving advantages.

Side-delivery rakes also offer some advantage in curing hay more quickly and evenly. The hay can be rolled into a loose windrow with the leaves in the center where they are protected, and with the butts of the stalks on the outside where they will cure most rapidly. The rake can be used ad-

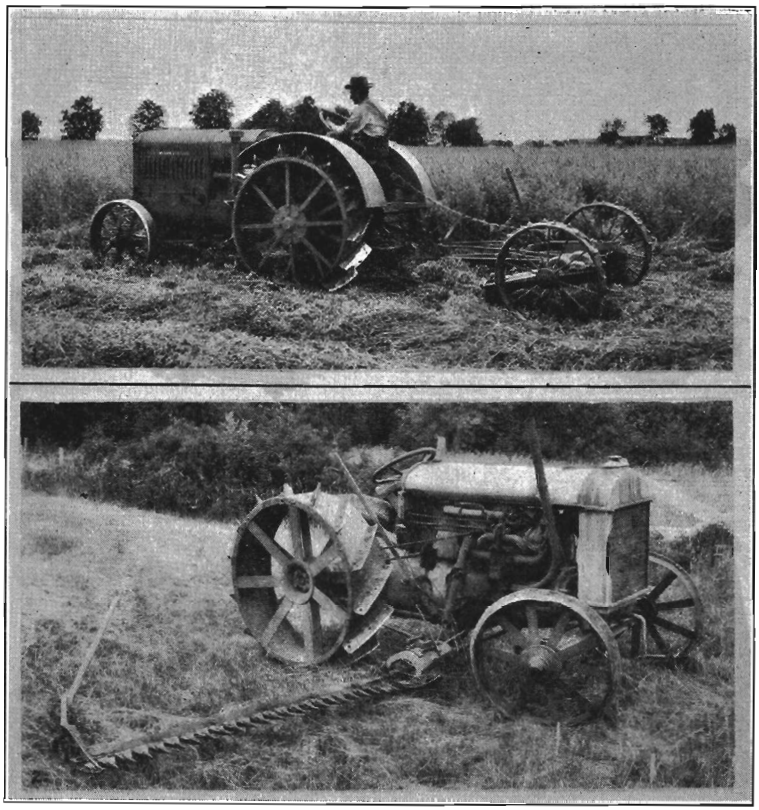


Fig. 5. The use of tractors for mowing is increasing. (1) Traction tractor mower used by W. J. Wilcox, Washington county. (2) Mower attachment used by Ed Jensen, Lane county.

vantageously in turning windrows after a rain, and some models can be used for tedding by reversing the cylinder.

Despite these advantages, however, side-delivery rakes and hay-loaders were used on only 5 percent of the farms included in the study, as has been stated. The biggest obstacle to their more general use seems to be the comparatively high price of the implements, an investment that is not justified by the amount of hay on most Willamette Valley farms. Cooper-

ative ownership of the equipment by neighbors is a possibility in meeting this difficulty.

Mowing with tractors. Mowing hay with tractors is still quite exceptional in Oregon. Several cases were found, however, that indicate the possibilities of this practice.

In each of the three years of this study, W. J. Wilcox, near Reedville, mowed 100 or more acres of hay with a tractor. The hay was mostly vetch-and-oats. He uses a tractor mower with a 7-foot cut (Fig. 5). This

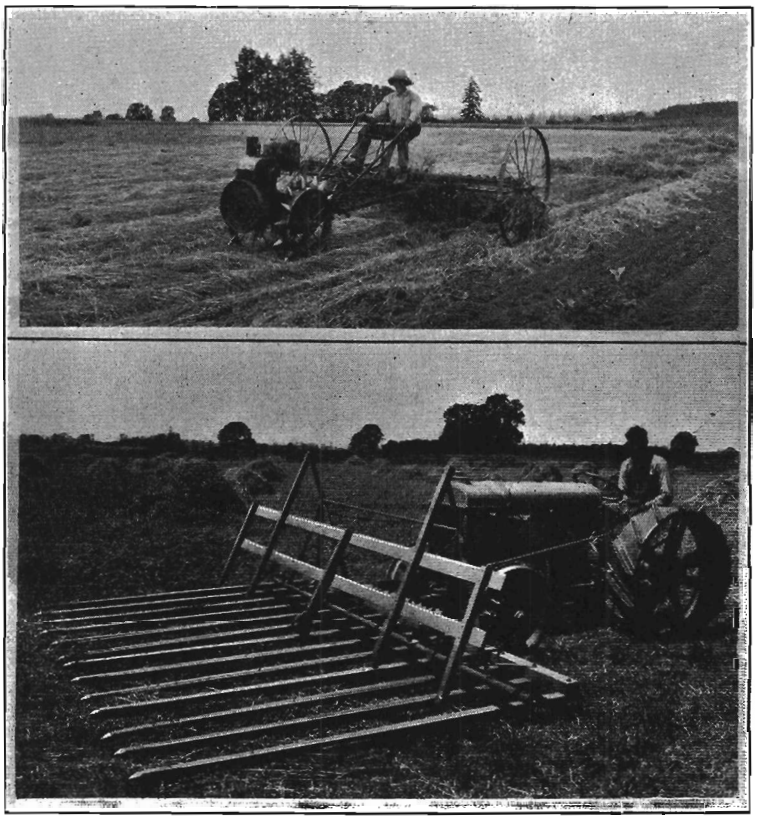


Fig. 6. Exceptional uses of tractors in haying. (1) No team being available for raking, the idle garden tractor was hitched up. (2) This tractor buckrake hauls thirty tons a day to the baler, the work of two men with teams. (Farm of W. J. Wilcox, Washington county.)

mower is pulled by the tractor and is traction-driven, but has two speeds so that it can be speeded up in heavy hay. It is controlled from the driver's seat of the tractor. Mr. Wilcox cuts as much as 20 acres a day with this outfit.

Ed Jensen, near Eugene, in 1927 mowed 255 acres of vetch hay and cheat hay in 11 days with a 6-foot mower attachment. A horse mower was used to mow out headings and irregular corners.

Several cases similar to these indicate that it is possible to mow more than twice as fast with a tractor than with a team—although not necessarily at half the cost; and it is to be expected that as tractor mowing equipment is improved and perfected the use of it will increase. In the past, with mower attachments driven directly from the tractor there has been considerable breakage, and traction mowers pulled by the tractor have not been entirely satisfactory because of clogging and difficulty of operating without an extra man on the mower. On many farms, of course, tractors will not be used for mowing because horses that otherwise would be idle are available for this operation.

Chopping hay into the barn. Perhaps the most interesting development in hay harvesting methods in the Willamette Valley, and a practice that seems to be increasing, is chopping hay into barns directly from the field. Feeding trials show extra value for chopped hay, and chopping greatly increases the storage capacity of the hay mow. In the three years, 22 records covering this practice were obtained. (See Fig. 7, back cover.)

The hay is thoroughly cured in the field and is chopped and blown into the barn with an ensilage cutter. Hauling the hay from the field and chopping it into the barn required an average of 3.1 man-hours and 2.9 horse-hours per ton, just the same labor requirements as for hauling hay and putting it in the barn with forks and slings. With the blower it is not necessary to have men in the mow, and this saving apparently makes up for the extra work of putting the hay through the cutter. The only extra cost of chopping, then, is for the use of the cutter and tractor, which is small if the farm already has this equipment, as many Willamette Valley farms have. A small electric motor could be used advantageously for this operation. There can be little question as to the value of chopping hay if it can be done in this way for practically nothing, as these data indicate.

No trouble from heating of the hay was experienced by any of the growers who followed this practice, although several said that they had been afraid of heating. To be on the safe side they allowed their hay to become quite dry, and there is some question, of course, as to the effect of this upon the quality of the hay. Precautions should be taken against dust explosions.

Baling from the field. Most hay that is baled in the Willamette Valley is baled directly from the field at time of harvest. Forty-two records covering this practice were obtained during the three years. In these records the labor of hauling the hay and pitching it on to the baling table was included in place of the labor of hauling to the barn. The hauling to the baler required an average of 1.7 man-hours and 1.7 horse-hours a ton. The average length of haul to the balers for the 1926 and 1927 records was 32 rods, as compared with an average haul to barns of 107 rods. Wagons were used for hauling in 11 of the 42 records, slips in 25, and buckrakes in 6.

Baling from the field eliminates the work of putting the hay into the stack or mow. Offsetting this advantage, however, is the disadvantage that the hay does not go through the stack sweat, which is desirable in producing hay of high quality. Hay baled from the field is often of poor quality because it becomes too dry before baling or because it is baled when too damp and becomes musty or mouldy. The value of stack-

ing the hay before baling should be seriously considered by growers interested in producing high-quality hay.*

Power hay hoists. No power hay hoists were found on the farms included in this study. Tests of electric power hoists that have been made by the Agricultural Engineering and Animal Husbandry departments of the Experiment Station indicate that on many farms a hoist will make a worthwhile saving in labor and cost by taking the place of a man and one or two horses.†

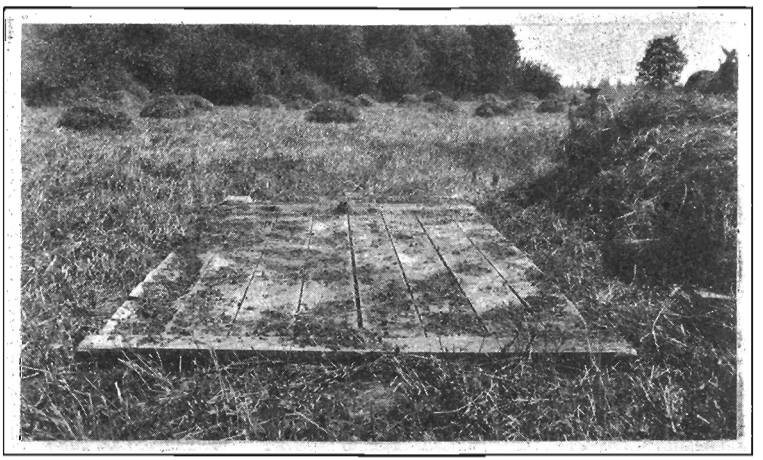


Fig. 8. Hay slip. This simple home-made device is used in the Willamette Valley chiefly for hauling hay to the baler.

Forks vs. slings. In the irrigated regions of Oregon it was found that slings had a definite labor-saving advantage in stacking alfalfa hay as compared with forks. In putting hay in the mow in the Willamette Valley, however, slings do not seem to have this advantage. This is probably because most Willamette Valley hay hangs together better than alfalfa when forks are used, and because many barn doors are so small that they interfere with the use of slings.

Slings were used in 44 records; forks in 370. Hauling the hay and putting it in the barn required 3.3 man-hours and 3.1 horse-hours per ton with the slings as compared with 3.0 man-hours and 2.8 horse-hours with the forks.

The fork most commonly used was the double harpoon, but there were a few single harpoons, grapple forks, and Jackson forks; and several growers used two double harpoons chained together.

*For discussion of desirable methods and practices in producing hay of high quality see "Haymaking, Baling and Loading Practices Essential to the Marketing of High-Grade Hay," U. S. Dept. of Agric. Circular 326, pages 13-21.

For methods of stacking and plans for a desirable type of hay derrick see Cost and Efficiency in Producing Alfalfa Hay in Oregon, Oregon Agricultural Experiment Station Bulletin 241.

†A bulletin giving the results of these tests will be issued in the near future.

Yield. That the labor requirements for harvesting a ton of hay are less with higher yields is shown in Table V. As the yield becomes greater there is a decrease of nearly two hours per ton in the man labor for harvesting. The increase in the highest yield group, however, indicates that when the yield becomes too heavy the difficulty of mowing and curing offsets the advantage of the higher yield.

TABLE V. IT TAKES LESS WORK PER TON TO HARVEST A LARGER YIELD—UP TO A CERTAIN POINT

200 records — Vetch-and-Oats hay — 1925-1927

Tons per acre	Man-hours to harvest a ton
Less than 1.50	5.8
1.50 — 1.99	5.3
2.00 — 2.49	4.6
2.50 — 2.99	4.5
3.00 — 3.49	3.9
3.50 and over	4.7

For additional data see Table XXIV.

It is to be expected, of course, that this relationship between yield and harvesting labor requirements should exist. It takes just about as long to mow and rake an acre yielding a ton as an acre yielding a ton and a half; the time required per ton, therefore, is about 50 percent greater. Even the operations of cocking and hauling to the barn require less time to the ton, since less ground need be covered for the same amount of hay. While this principle is well understood by most farmers, many do not appreciate its importance.

There will be further discussion of yield as a factor affecting total cost of production.

Length of haul. There is considerable variation in the distances that hay is hauled from the field to the barn in the Willamette Valley, and this has a definite relation to the labor requirements in hauling hay (Table VI). The difference in average length of haul between the shortest and longest haul groups is 175 rods, which is 350 rods, or more than a mile, in the round trip to the field. For this extra haul there was a difference of 1.4 horse-hours, which is .7 hour for a two-horse team, indicating an average rate of travel of between 1½ and 2 miles per hour. The corresponding difference of 1.2 man-hours results from two men riding back and forth on the wagon on most farms. At 40 cents an hour for man labor, 12½ cents for horse labor, and ignoring the extra wear and tear on the wagons, the cost of the extra haul of a little more than a half mile would be 65 cents a ton.

On many farms the cost of producing hay can be reduced materially by planning a good field layout that will reduce the length of haul.

Size and organization of haying crews. There is great variation in the size and organization of haying crews. On the 148 farms that produced

clover hay or vetch hay in 1927, 34 different combinations of men and horses were used for hauling the hay to the barn (Table VII).

It appears that certain combinations of men and horses for hay-hauling crews should be more efficient than others. The data obtained in this study, however, give no conclusive evidence that any particular crew is

TABLE VI. THE LONG HAUL INCREASES THE COST

Clover hay and vetch-and-oats hay, 1926-1927*

Length of haul	Number of records	Average haul	Hauling labor per ton		Hay per acre
			Man-hours	Horse-hours	
rods		*rods*			*tons*
Under 80	113	34	2.3	2.1	2.3
80—159	124	90	2.9	2.6	2.3
160 and over	87	209	3.5	3.5	2.2

*Length of haul was obtained only for 1926 and 1927.

TABLE VII. VARIATION IN SIZE AND ORGANIZATION OF HAY HAULING CREWS USED FOR CLOVER HAY AND VETCH HAY IN 1927

Haying crew		Number of farms using each crew	
No. of men	No. of horses	Clover hay (87 farms)	Vetch hay (85 farms)
2	2	16	12
2	3	5	4
3	2	11	16
3	3	6	4
3	4	4	7
4	4	9	5
4	5	1	4
5	4	3	4
5	5	5	4
6	6	3	6
7	5	5	3
23 other combinations		29	20

more efficient on the average than any other. If anything, slightly less labor was required on the average where the hay was hauled by two men with one wagon and one 2-horse team.

That the crew combinations vary so greatly, in itself indicates that there are no particularly efficient combinations, for if there were, more farmers would have discovered and adopted them. Apparently the only advantage of large crews is completing the haying more quickly.

It is thought that most men who have had experience in haying will heartily agree that the next factor to be mentioned—the kind of men in the crew—is far more important than the number of men.

Kind of men, management of crew, condition of equipment, and weather. These factors probably affect efficiency in haying as much as any that have been discussed, except yield. Unfortunately, it is difficult, if not impossible, to measure these influences numerically, or to determine their effect by a statistical study of this kind.

A haying crew composed of hard-working, experienced help will turn out more work, of course, other things being equal, than one composed of inexperienced help. This factor is largely beyond the control of the grow-

er; he must use the best help available. Many growers complain that it is increasingly difficult to obtain satisfactory labor for haying, and it is notable that as a consequence many are adopting labor-saving methods and equipment.

Fig. 9. Even the motor truck is being used in haying. This is sometimes economical on a long haul.

One man will get more work out of a haying crew than another, other things being equal, simply because of better management—because he is a better boss. This factor depends upon the ability of each individual man; it deserves careful study and consideration.

Equipment that does not work well or that is constantly breaking down or getting out of order is a frequent cause of lost time and efficiency in haying. This factor is entirely within the control of the grower. Equipment should be in good order and repair before haying is begun; repairs or replacements should be on hand for any possible breakdowns, so that delay will be minimized.

A shower of rain at the wrong time greatly increases the work and cost of haying by necessitating turning the hay or even spreading it out to dry after it has been cocked. The haying season in the Willamette Valley is exceptionally favorable as there is very little summer rainfall. Rain is bothersome chiefly with clover hay that is cut early so as to obtain a seed crop, and with the first cutting of alfalfa.

2. YIELD AND THE FACTORS THAT INFLUENCE IT

Yield is usually the chief factor affecting the cost per unit of any farm product, cost per unit meaning cost per ton, per bushel, and so on. Accordingly, we find that yield per acre has a marked relationship to the cost per ton of Willamette Valley hay crops* (Fig. 10). Low yields are associated with high costs per ton, and high yields with low costs.

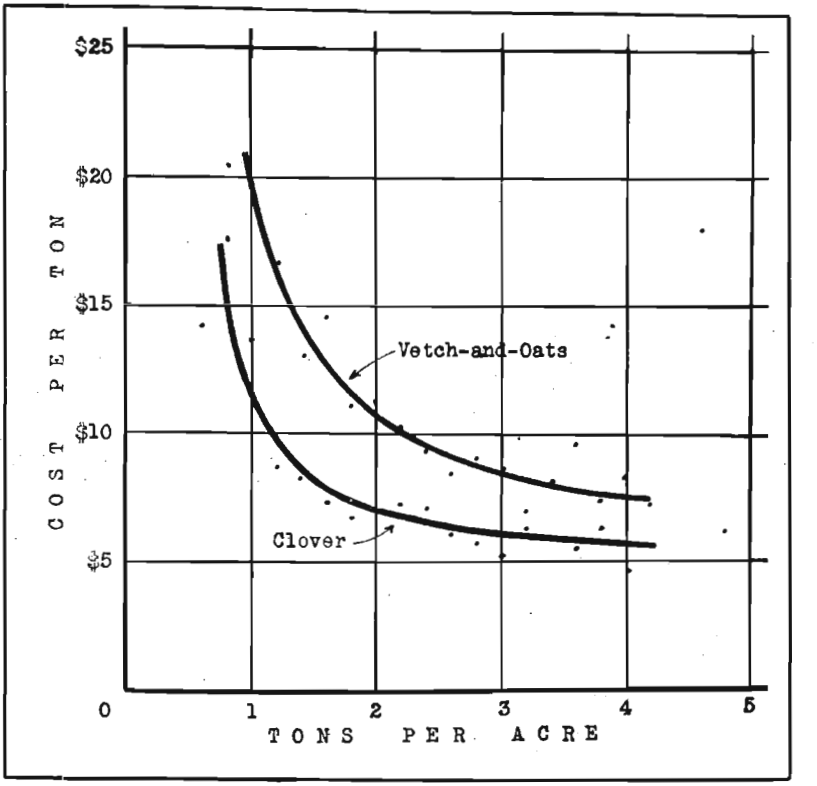


Fig. 10. The cost comes down as the yield increases. For tabular presentation of this relationship see Table XXIII, page 45. The equations for the curves, computed by the method of least squares, are: vetch-and-oats, $Y=(4.893x+7.761)\div(x-.375)$; clover, $Y=(4.718x+1.636)\div(x-.441)$.

*See footnote page 14 for multiple correlation results.

The reason for this relationship between yield and cost is that a large part of the cost is a fixed amount per acre and is the same whether the yield is high or low. For example, the work of plowing the land is just the same whether a large or small crop is obtained, taxes and interest on the land remain constant, and there is the same investment in machinery. With a high yield, then, the cost of these items per ton will be less than with a low yield. More work is necessary, of course, for harvesting a larger crop; but we have already seen that even harvesting labor is less per ton with larger yields. (Page 20.)

TABLE VIII. AVERAGE YIELD OF EACH CROP IN EACH YEAR

Crop	Tons per acre			
	1925	1926	1927	Average
Clover hay: with seed crop	1.3	2.0	2.4	1.9
Clover hay: no seed crop	1.9	1.9	2.4	2.0
Clover hay: all	1.7	1.9	2.4	2.0
Vetch-and-oats hay	2.3	2.2	2.4	2.3
Alfalfa hay*	3.7	3.8	3.8	3.8
Cheat hay	2.4	1.7	1.3	1.8

*2.7 cuttings.

The yield of hay in the Willamette Valley is determined by many things. Some of the things that have the greatest effect upon it the grower cannot control; for example, climatic and soil conditions, and the prevalence of insect pests or crop diseases. Other things—notably the various cultural practices—he can control, to a certain extent, to influence his yield and thus influence his cost of production.

Value of land. The average value of the land used for clover hay was $135 per acre; for vetch hay, $141; for alfalfa, $208; and for cheat, $106. There was considerable variation, of course, in land values on different farms. Table IX shows that in general yields were higher on the higher-priced land. Evidently, however, they were not enough higher to justify the higher land values, because the cost per ton of producing the hay was also higher. Many of the higher land values are based on location, roads, and other factors, more than on the productiveness of the land. The cheaper land appears more economical on the average for hay production.

TABLE IX. ON THE HIGHER-PRICED LAND THE YIELD IS HIGHER—AND ALSO THE COST

197 records — Clover hay — 1925-1927

Value of land per acre	Tons per acre	Cost per ton
Less than $100	1.7	$6.09
$100 — 149	1.9	$6.83
150 — 199	2.2	$7.50
200 — 249	2.3	$8.98
250 and over	2.4	$9.67

For additional data see Table XXIV.

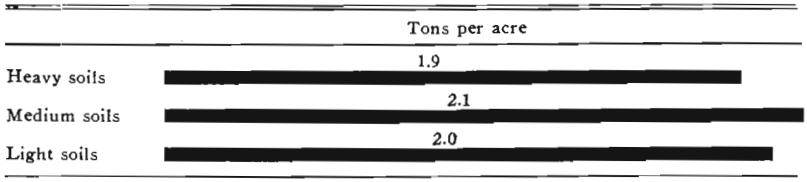
These relationships, of course, are generalities based on averages of rather large groups of farms. In many individual cases high-priced land is cheap, and low-priced land is dear, when judged by its production of hay.

Kind of soil. The soils upon which Willamette Valley hay crops are raised vary from sandy soils to heavy clay, with clay loams predominating. Most of the alfalfa hay, however, was raised on sandy and silt loams.

Only a very brief description of the soil was obtained from the growers. Based on these descriptions the records were divided into groups of heavy, medium, and light soils (Table X). In general, this division also means poorly-drained, fairly-well-drained, and well-drained soils.

TABLE X. THE MEDIUM SOILS GAVE THE BEST YIELD

197 records — Clover hay — 1925-1927



For additional data see Table XXV.

Yields and land values were highest by a small margin, for the medium soils, and were lowest for the heavy soils. The differences in cost of the hay do not appear to be significant; the effect of the difference in yield apparently is about offset by the corresponding difference in land values.

Fertilization. Practically the only fertilizer used on both clover hay and vetch hay was land-plaster, or calcium sulfate. Of the clover growers 70 percent used an average of 66 pounds per acre, and thirty percent of the vetch growers used 64 pounds per acre. The prevailing price was $14.00 a ton.

Comparisons between the farms that used land-plaster and those that did not are shown in Table XI. Apparently the use of this fertilizer, or amendment, is a profitable practice. With vetch hay there is some danger of stimulating a growth that is too rank, making the hay coarse and giving trouble in harvesting.

TABLE XI. EFFECT OF LAND-PLASTER ON CLOVER HAY AND VETCH-AND-OATS HAY, 1925-1927

	Clover hay		Vetch hay	
	Farms using land-plaster	Farms not using land-plaster	Farms using land-plaster	Farms not using land-plaster
Number of farms	141	56	60	140
Yield per acre (tons)	2.1	1.9	3.1	2.0
Value of land per acre	$136	$134	$159	$135
Cost of hay per ton	$6.89	$7.93	$8.56	$10.86
Percent of farms obtaining seed crop	47%	36%	.....	.....

Size of acreage. On the average, yield and cost of production were higher for the smaller acreages. In general, however, land values also were higher for the smaller acreages. The variation in yield and cost undoubt-

edly should be associated with this variation in land values rather than with the variation in size of acreage.

Production of clover seed. In 1925, 31 percent of the acreage of clover hay that was studied produced a seed crop in addition to the hay; in 1926, 65 percent produced seed; and in 1927, 66 percent.* The figures for 1926 and 1927 undoubtedly represent the more normal conditions. The average yield of the hay with seed was 1.9 tons per acre, and of the hay alone, 2.0 tons per acre.

Fig. 11. It pays to fertilize. The streaks through this clover field are where the fertilizer spreader was clogged up for one round of the field in applying superphosphate. Farm of Hawkins and Roberts, Polk county.

When seed was obtained, the charges for fertilizer, taxes, interest, and depreciation of stand, and the credit for pasture, were divided equally between the hay crop and the seed crop. This makes the cost of clover hay with a seed crop considerably less than that of clover hay alone, even though the hay alone receives a much larger credit for pasture (Table I). Undoubtedly, however, it is the better and more vigorous stands that produce seed crops. If these stands were harvested for hay only, the hay yield would doubtless exceed 2.0 tons per acre, and because of this heavier production the cost per ton might be no greater than it is for the hay in combination with a seed crop. In other words, the lower cost per ton might reasonably be expected from the part of the clover acreage that produces the seed crop, whether the seed were produced or not, simply because it is the more productive part of the acreage.

Other methods of dividing the joint costs between the hay crop and seed crop are possible, of course, and doubtless under certain conditions would be more logical than the method that has been used. Some growers consider the seed crop a by-product of their hay; others consider the hay the by-product. It is thought that for most growers the method that has been used is most logical.

For the total acreage producing seed in addition to the hay crop the average yield of cleaned seed per acre was 78 pounds, with a value of $20.07. Of the seed acreage 11 percent was not harvested, however, chiefly because of rain damage. For the acreage actually harvested the yield per acre was

*An acreage of clover averaging 25 percent of the clover hay acreage was harvested as seed only, no hay being produced.

92 pounds, with a value of $23.61. The average price received was 28 cents a pound in 1925 and 1926, and 23 cents in 1927.

The data did not indicate that the production of seed was influenced by the location in the Valley, by the method of seeding the clover, or by whether the clover was first- or second-year crop.

Life of clover stand. Of the growers 56 percent, with 62 percent of the acreage, said that they usually harvest hay crops from their clover for two years; 44 percent said that they usually harvest only one crop. From this it would be expected that about 31 percent of the acreage should be second-year crop, since half of the 62 percent should be second-year crop each year. This checks closely with the average for 1926 and 1927 of 33 percent second-year clover; but in 1925, because of extensive killing out of new clover the previous winter, 56 percent of the acreage was two years old.

Poorer second-year crops of clover hay are caused by increased weediness, or by thinning of the stand by root-borer injury, diseases, or unfavorable soil conditions, or by a combination of these causes. The data that were obtained do not indicate that the obtaining of a second-year crop is influenced by method of seeding, location in the Valley, or harvesting of seed. Judgment as to whether a crop is satisfactory varies, of course, with individuals. Many growers who do not cut the second-year crop could get a better crop than many others who do cut it.

Some growers who do not cut a second-year hay crop keep their second-year clover for pasture; others plow it under. Some keep it over and cut it for hay if it looks promising or use it for pasture if it does not.

Growers who plan normally to cut only one crop often cut the second-year crop when their clover seeding fails, or under other conditions that make a poor crop better than none at all.

The difference in yield between first- and second-year crops was less than might be expected, the average yields per acre being 2.05 and 1.92 tons respectively. The second-year hay is of poorer quality, however, because of thinner stands and more weeds and grass.

Possible differences in charging depreciation of stand are suggested by these data upon the life of clover stands. When only one crop is harvested the entire cost of establishing the stand might be charged to the one year's crop. Considerable justification is possible, however, for charging part of it to the pasture crop the second year, or even to the stand that is plowed under for soil improvement; many of the stands that are plowed under are better than others that are saved for a second-year crop. A larger charge might be made against the first-year than against the second-year crop, but, as has been shown, the difference in yield was small and there is no measure of the difference in quality.

It is thought that the data obtained in this study do not afford a definite enough basis for charging depreciation of stand other than to consider that clover is normally productive for two years, as hay, pasture, or green-manure crop, and to divide the cost of the stand equally between the two years. In order to charge the cost of the stand to one year only, the charge for depreciation of stand may be doubled and the total costs per acre and per ton adjusted accordingly; or similar adjustments may be made for any other basis of charging depreciation of stand that may be desired.

Common vs. Hungarian vetch. For the three years, 67 percent of the acreage of vetch hay was Common vetch, 19 percent was Hungarian vetch, 13 percent a mixture of Common and Hungarian, and 1 percent other varieties. The percentage of Hungarian vetch increased, however, from 13 percent in 1925 to 28 percent in 1927. Gray winter oats were used almost exclusively for seeding with the vetch.

The average yield of Hungarian vetch was 2.5 tons per acre as compared with 2.1 tons for Common vetch. The average land values were $124 and $140 per acre, respectively, indicating that the Hungarian was grown on the poorer land.

Plowing vs. disking for vetch. The ground was plowed for about two-thirds of the vetch hay; for the other third it was only disked. The disked ground, of course, was mostly ground that had been plowed the previous spring. The average yield was the same, 2.3 tons per acre, for both methods, even though the value of the land that was disked averaged only $121 an acre, as compared with $153 for the land that was plowed. The average cost of production of the hay on disked ground was $8.71 a ton, as compared with $10.48 a ton for the hay on plowed ground.

Effect of cultivated crop preceding vetch-and-oats. During the three years 19 records were obtained of vetch hay on land that had been in cultivated crop the preceding year. The average yield was two-tenths ton above average, even though the land was $30 below average in value. The cultivated crop was mostly corn.

Date of seeding vetch. Disregarding a few cases of spring planting, 23 percent of the vetch hay was planted in September, 66 percent in October, and 11 percent in November. No difference in yield between the early and late fall seeding was apparent.

Rate of seeding vetch. The average rate of seeding vetch-and-oats was 38 pounds of vetch seed and 62 pounds of oats per acre. The average value of the vetch seed was 4.9 cents a pound and of the oats, 1.7 cents.

TABLE XII. IT PAYS TO USE PLENTY OF VETCH SEED

200 records — Vetch-and-oats hay — 1925-1927

Pounds vetch seed per acre	Tons hay per acre	Cost per ton
Less than 40	2.1	$10.50
40 — 49	2.3	$9.16
50 and over	2.9	$8.24

For additional data see Table XXVI.

There was considerable variation in the amounts of seed used by different growers. Table XII indicates that larger proportions of vetch in the mixture of seed gave considerably larger yields and cheaper production per ton.

3. COST OF SEEDING CLOVER

An important item in the cost of producing clover hay is the cost of establishing the stand of clover. This item has been shown in the cost

summaries as depreciation of stand. Unfortunately, for many of the crops of clover hay that were studied it was impossible to obtain reliable data upon the cost of establishing the stand because two or three years had elapsed since the clover was planted. This item has been determined, therefore, on the basis of costs of establishing new stands of clover during 1925, 1926, and 1927.

As we have seen, several ways of computing the charge for depreciation of clover stand are possible, depending on whether a seed crop is produced and whether hay is produced for one year or for two. The most important factor influencing the cost of the stand, however, is the method of seeding.

Methods of seeding. Several ways of seeding clover are used in the Willamette Valley, but these may be grouped into two general methods: first, seeding alone, or "summer-fallowing-in"; and second, seeding with grain. Of the clover acreage that was studied 20 percent was seeded alone and 80 percent was seeded with grain. The proportion of seeding alone was considerably higher, however, on the west than on the east side of the Valley.

Clover that is seeded alone is sown in spring or early summer, mostly in May. Except for the pasture obtained, the land is used for no other purpose during the year than to start the clover. On 23 percent of the acreage of seeding alone rape was sown with the clover to increase the amount of pasture.

In seeding with grain a stand of clover is established on land that also produces a crop of threshed grain or of grain hay during the year. Three methods are used: first, sowing on fall grain in early spring, mostly in February; second, sowing with fall grain, mostly in October; and third, sowing with spring grain, mostly in April and May. Clover sown in the fall usually does not produce a crop until the second following summer, so that it comes into production at the same time as clover sown the following spring rather than with that sown the preceding spring.

Of the clover that was seeded with grain 78 percent was sown in early spring, usually February, on grain that was sown the previous fall; 11 percent was sown in the fall with fall grain; and 11 percent was sown in the spring with spring grain.

Of the seeding on fall grain in early spring, 72 percent was on wheat, 20 percent on oats, 5 percent on vetch and oats, and 3 percent on barley. The seeding with fall grain was mostly with wheat or with vetch-and-oats; and the seeding with spring grain was mostly with wheat or with oats.

Varieties sown. Of the acreage of clover seeding 92 percent was red clover, 5 percent was alsike and 3 percent was red and alsike mixed.

Cost of seeding by each method. The cost of seeding clover alone is much higher than for seeding with grain (Table XIII). This is because in seeding alone the clover must be charged with all of the labor, and with the taxes and interest on the land for the year; whereas in seeding with grain, the taxes and interest, and most of the labor, are chargeable to the grain crop. Apparently there was no reduction in the grain crops because of seeding clover with them; the clover therefore was not charged with any costs that would have been necessary for the grain had the clover not been sown. Any extra labor because of sowing the clover in the grain, such as

for seeding or for extra harrowing or rolling, was charged entirely to the clover.

TABLE XIII. COST PER ACRE OF SEEDING CLOVER ALONE AND WITH GRAIN, 1925-1927

Items	Seeding alone	Seeding with grain
Total number of records	54	121
Total number of acres	1269	3360
Direct man labor	$ 2.45	$ .21
Overhead man labor	.70	.07
Horse labor	1.93	.06
Tractor	1.66	.....
Other machinery	.35	.03
Clover seed	2.41	2.41
Other seed	.07	.....
Fertilizer	.....	.06
Taxes	2.02	.....
Interest on land (5 percent)	5.93	.....
Total	$17.52	$ 2.84
Credit for pasture	1.87	.24
TOTAL NET COST PER ACRE	$15.65	$ 2.60

An average of 8.4 pounds of seed was used in seeding alone and 8.5 pounds in seeding with grain. The item "Other Seed," under seeding alone, covers rape and grain seed sown with the clover for pasture. The item "Fertilizer" covers land-plaster and manure used in a few exceptional cases.

It will be noted that credit has been given for the value of pasture obtained. This is much larger for the seeding alone, as would be expected, but far from offsets the additional cost of this method.

TABLE XIV. LABOR PRACTICES AND REQUIREMENTS FOR CLOVER SEEDING ALONE AND WITH GRAIN, 1925-1927

	Seeding alone					Seeding with grain*			
	Percent of acres covered	Times over	Hours of labor per acre Man	Horse	Tractor	Percent af acres covered	Times over	Hours of labor per acre Man	Horse
	%					%			
Plowing	99	1.0	2.2	3.9	1.1	....	....	....	....
Disking	60	1.8	.7	1.2	.4	....	....	....	....
Rolling	98	2.9	1.4	3.9	.3	5	1.1	.0	.1
Spike harrowing	84	2.9	1.1	3.5	.2	18	1.1	.1	.3
Acme harrowing	7	3.5	.2	.6	....	....	....	....	....
Spring-toothing	47	2.4	.4	.2	.3	....	....	....	....
Floating	38	2.9	.6	1.6	.2	....	....	....	....
Seeding	100	1.0	.4	.3	....	98	1.0	.4	.0
Miscellaneous	.....	....	.1	.2	.0	....	....	.1	.1
TOTAL	.....	....	7.1	15.4	2.5	....	....	.6	.5

*Only labor charged to the clover is shown.

The labor practices and requirements in seeding clover are shown in Table XIV. Most of the seeding was done with hand seeders. Of the acreage seeded alone, 83 percent was sown with hand seeders, 14 percent with drills, and 3 percent with endgate seeders; of the seeding with grain 97 percent was with hand seeders and 3 percent was drilled.

Seeding with rape. Seeding with rape has been included in the general method of seeding alone, but warrants additional consideration. As has

been stated, rape was sown on 23 percent of the acreage of clover seeded alone. The average amount of rape seed used was 1.4 pounds per acre.

The average value of the pasture from the clover sown with rape was $3.82 an acre as compared with $1.28 for that sown without rape, or nearly three times as great. The pasture was valued at prevailing rates, which were usually from ½ cent to 1 cent per head per day for sheep and from 5 cents to 10 cents per head per day for cattle.

After crediting the $3.82 an acre, however, the net cost of establishing a stand of clover by seeding with rape was still $12.35 an acre, as contrasted with only $2.60 an acre by seeding with grain. It is evident, therefore, that when valued at prevailing rates the value of rape pasture does not offset the extra cost of seeding alone, and the cost of establishing a stand of clover by this method is much closer to that of seeding alone than to that of seeding with grain. Farmers who need summer pasture should consider carefully whether it could be furnished more cheaply by some other crop than rape.

The pasture was used mostly for sheep, but also for cattle and hogs. The pasture season was generally from July to November. On five farms that pastured exclusively with sheep, an average of 4.2 head an acre were carried for an average of 83 days. This seems to be about a normal carrying capacity in the opinion of most growers with experience in pasturing sheep on rape.

A few growers make a practice of fattening late feeder lambs, shipped in from other parts of the state, on their rape pasture, and realize satisfactory returns. Hawkins and Roberts, of Salem, in 1927 carried 700 feeder lambs for three months on 160 acres of rape and clover seeding with an increase in value of the lambs that amounted to about $15 per acre. Fred Auer of Rickreall carried 300 feeder lambs for three months on 80 acres, with an increase in value amounting to more than $10 per acre, and with considerable pasture for ewes in addition. All of the returns from this practice, however, cannot be credited to the rape and clover, as there are other expenses, management, and risks involved. It is a practice, moreover, that seems to be limited to rather large operators and to men with special experience and skill. It is probably not practicable for the average farmer, unless perhaps it could be developed gradually by a group of farmers on a cooperative basis.

It is probable that sheepmen who seriously need rape for pasture in the late summer could afford to figure it worth more than a cent a day per head. If the rape pasture is figured at two or three cents a day, the larger credit reduces the cost of the clover seeding to a point where it is not prohibitive, perhaps, for land that needs a legume crop but is not in condition to produce clover by seeding with grain. To justify as large a charge as this, however, rape pasture must be used for fattening or for pure-bred lambs.

Soil conditions are important. Most growers who seed clover alone do so simply because they cannot get a stand by seeding with grain, or because they have too large a proportion of failures in trying to do so. There are few who claim that they can get a stand with grain, but think that by seeding alone their stands are enough cleaner and better to justify the extra cost.

Success in seeding with grain varies from year to year with seasonal conditions. But over a period of years the most important factor affecting it is unquestionably the condition of the soil. Just what soil condition it is that makes difficult the obtaining of a stand of clover is not so apparent. In many cases it is sour or acid soil; in other cases it is more likely a general run-down condition or lack of fertility. In most cases it is probably a combination of both of these conditions.

The significant point is that both conditions can be corrected—acidity with lime, and lack of fertility with manure, fertilizers, and green-manure crops—and a difference in cost of $13.05 per acre between seeding with grain and seeding alone will pay for considerable lime and manure. Furthermore, the saving in the cost of establishing a stand of clover is not the only return to be considered, for improving the soil should increase the yield, value, and profitableness of both the grain crop and the clover crop. From 3,255 acres of clover hay that was seeded with grain an average yield per acre of 2.1 tons was obtained, as compared with 1.8 tons from 364 acres seeded alone, a difference of a third of a ton more hay per acre in favor of the soil conditions that made possible the seeding with grain.

It must be admitted, of course, that liming is too expensive for renters when they can not be sure of receiving the long-time benefits from it. Owners and renters should give more attention to arranging between themselves an intelligent program of soil improvement.

Quality of stand obtained. Estimates of the quality of stand secured were obtained only for 1926 and 1927. In 1926, an unfavorable year for clover seeding, growers who seeded alone estimated that their stands were 82 percent perfect; while those who seeded with grain estimated theirs at only 63 percent. In 1927, a favorable year, seeding alone was estimated at 88 percent and seeding with grain at 94 percent. It should be remembered that in general the seeding alone is on the less favorable soils.

Amount of failure. Estimates were obtained from the growers as to the amount of failure in getting a stand that they expect. Three-fourths of the growers seeding alone expected no failure, but only one-fourth of those seeding with grain felt as sure of success. The average expected percentage of failure for all seeding alone was only 4 percent; while for seeding with grain it was 20 percent, and individual estimates ranged up to 50 percent. It is apparent, therefore, that there is more risk in seeding with grain, and if failure to get a stand would be of serious consequence seeding alone might be justified for this reason alone.

But most growers seem to worry very little about the occasional failure. A practice followed by many when their clover stands seem to be too thin, and if the clover is needed for hay, is to disk vetch-and-oats into it in the fall. In the following year, then, the vetch-and-oats replaces the clover in the cropping system and furnishes the hay required. From the standpoint of cost, even with an average failure of 20 percent, or a failure once in five years, seeding with grain is still much cheaper than seeding alone, and the difference in cost will still buy a considerable amount of lime.

LABOR PRACTICES AND REQUIREMENTS FOR WILLAMETTE VALLEY HAY CROPS

A number of the labor operations upon Willamette Valley hay crops have been discussed to some extent in the preceding pages. All of the operations will now be summarized and considered in greater detail. Four phases will be considered: (1) the amount of each operation used for each crop; (2) the relative importance of the various operations; (3) labor requirements, or duty of labor, for each operation; and (4) seasonal distribution of the operations.

Amount of each operation. In Table XV is summarized the percentage of the acreage covered and the number of times over, for each operation upon each crop. This shows the practices that are used in producing each of the four hay crops.

TABLE XV. PERCENTAGE OF ACREAGE COVERED, AND NUMBER OF TIMES OVER, FOR EACH OPERATION, 1925-1927

Operations	Clover hay		Vetch hay		Alfalfa hay		Cheat hay	
	Percent covered	Times over	Percent covered	Times over	Percent covered	Times over	Percent covered	Times over
	%		%		%		%	
Fertilizing	70	1.0	28	1.0	48	1.0	.....	....
Manuring	.....	....	2	1.0	11	1.0	9	1.0
Plowing	.....	....	53	1.0	.....	....	42	1.0
Disking	.....	....	48	1.3	.....	....	45	1.4
Rolling	.....	....	4	1.4	.....	....	.....	....
Spike harrowing	3	1.0	55	1.6	.....	....	60	1.4
Spring-toothing	.....	....	11	1.3	58†	2.7	3	1.0
Floating	.....	....	4	1.3	.....	....	4	1.0
Drilling	2*	1.0	92	1.0	.....	....	73	1.0
Broadcast seeding	2*	1.0	8	1.0	.....	....	27	1.0
Ditching	2	1.0	15	1.1	.....	....	41	1.0
Mowing	100	1.0	100	1.0	100	2.7	100	1.0
Dump raking	96	1.0	95	1.0	89	2.3	100	1.0
Side-delivery raking	4	1.0	5	1.0	29	2.0	.....	....
Tedding	6	1.0	2	1.0	11	1.0	.....	....
Bunching with rake	5	1.0	3	1.0	6	2.0	3	1.0
Cocking by hand	92	1.0	98	1.0	82	2.3	100	1.0
Turning	5	1.1	4	1.0	8	3.4	10	1.0
Hauling	100	1.0	100	1.0	100	2.6	100	1.0

*Seeding clover seed, or vetch and oats, to thicken stand.
†Special alfalfa cultivators also were used to cultivate 12 percent of the alfalfa acreage 5.6 times.

Relative importance of operations. In Table XVI are summarized the amounts of man and horse labor upon an average acre of crop for the various operations. This shows for each crop the relative importance of each operation in amount of labor required.

Variations in practice between individual farms in the same region cause considerable variation in individual costs. Growers should consider carefully whether, under their conditions, it would be profitable to increase or decrease the amount of any operation.

Labor requirements for each operation. Table XVII shows the amount of each operation accomplished in a day on the average farm, on the 10 percent of the farms that did the most in a day, and on the 10 percent of the farms that did the least in a day. This table also shows several

general comparisons of different ways of doing certain operations, such as the use of manure-spreaders as compared with wagons or sleds; for several operations the use of horses as compared with tractors; and the use of dump-rakes as compared with side-delivery rakes. For some of these comparisons the number of records is small and the conditions probably were not strictly comparable, but the figures may be considered as roughly indicative.

TABLE XVI. TOTAL HOURS OF MAN, HORSE AND TRACTOR LABOR PER AVERAGE ACRE OF CROP, FOR EACH OPERATION, 1925-1927*

	Clover hay			Vetch hay			Alfalfa hay			Cheat hay		
	Man-hours	Horse-hours	Tractor-hours	Man-hours	Horse-hours	Tractor-hours	Man-hours	Horse-hours	Tractor-hours	Man-hours	Horse-hours	Tractor-hours
Fertilizing	.3	.4	....	.2	.3	....	.3	.4	....	....	....	....
Manuring	....	....	....	.2	.3	....	1.3	2.5	....	.8	1.6	....
Plowing	....	....	....	1.2	1.8	.6	....	....	....	1.4	4.1	.1
Disking	....	....	....	.5	.8	.3	....	....	....	.4	.5	.3
Spike harrowing	....	....	....	.4	1.4	.1	....	....	....	.6	1.7	....
Spring-toothing	....	....	....	.1	.2	.0	2.6†	7.0†	.1†	....	....	....
Seeding	....	....	....	.8	2.1	.1	....	....	....	.8	1.4	.1
Ditching	....	....	....	.1	.1	....	....	....	....	.1	.1	....
Miscellaneous	.1	.1	....	.1	.2	....	.1	.1	....	.1	.2	....
TOTAL EXCEPT HARVEST	.4	.5	....	3.6	7.2	1.1	4.3	10.0	.1	4.2	9.6	.5
Mowing	1.1	2.2	....	1.3	2.4	.1	3.5	7.1	....	1.0	2.0	.1
Raking	.5	1.1	....	.6	1.1	....	1.5	3.0	....	.5	1.0	....
Cocking by hand	2.0	....	....	2.5	....	....	3.4	....	....	1.9	....	....
Tedding and turning	.1	.1	....	....	....	....	.2	.4	....	....	....	....
Hauling	6.1	6.0	.1	6.4	5.7	.2	10.5	10.2	....	5.0	4.3	.0
TOTAL HARVEST	9.8	9.4	.1	10.8	9.2	.3	19.1	20.7	....	8.4	7.3	.1
TOTAL	10.2	9.9	.1	14.4	16.4	1.4	23.4	30.7	.1	12.6	16.9	.6

*The amounts of labor in this table are not for an acre once over of each operation, but for the amount of each operation upon an average acre of crop, which may be more or less than for an acre once over of the operation. For labor for an acre once over see Table XXVII.

†Including cultivation other than spring-toothing.

The variation in amount of work accomplished on different farms is caused partly by differences in conditions such as kind of soil or shape of the field, and partly by the efficiency with which the work is performed. The efficiency with which the work is performed is determined by such things as the kind and size of equipment used; size and condition of the horses, or of the tractor; and the energy and skill of the man doing the work. Growers who would reduce their cost of production, or keep it at a minimum, must keep their labor requirements as low as possible. Their aim should be the maximum efficiency indicated in the table in so far as their conditions permit.

Seasonal distribution of operations. Labor on hay crops is characterized by a very uneven distribution during the year, because of the high peak-labor requirements for harvesting. This is shown graphically for Willamette Valley hay crops in Fig. 12. These diagrams are necessarily rather arbitrary, as there are countless variations from them on individual

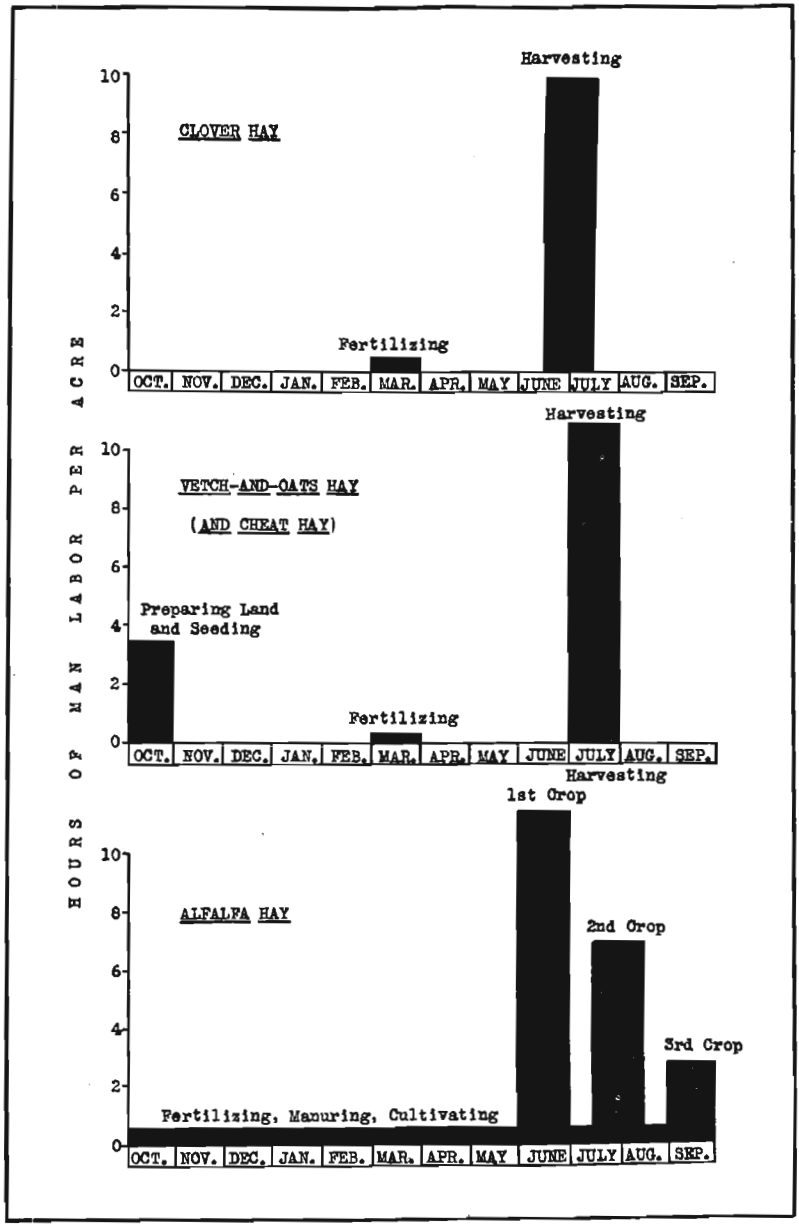


Fig. 12. Seasonal distribution of labor on Willamette Valley hay crops.

TABLE XVII. HOW MANY ACRES IS A DAY'S WORK?

Operations	Acres covered per man in ten hours		
	Average all farms	Ten percent of farms covering the most acres	Ten percent of farms covering the fewest acres
Fertilizing with spreader	17.8	32.3	10.0
Fertilizing by hand	12.7	33.3	8.2
Manuring with spreader	.9	2.5	.4
Manuring with wagon or sled	.6	1.1	.3
Plowing for vetch and oats, horses	2.2	5.5	1.3
Plowing for vetch and oats, tractor	5.9	9.5	4.3
All plowing, horses	2.1	3.7	1.3
All plowing, tractor	5.6	9.3	3.4
Disking, horses	6.9	14.9	3.8
Disking, tractor	14.1	25.0	8.7
Rolling, horses	12.3	21.8	8.1
Rolling, tractor	20.0	34.5	9.8
Spike harrowing, horses	17.6	33.3	10.5
Spike harrowing, tractor	21.8	45.4	12.4
Spring-toothing, horses	9.0	18.5	5.9
Spring-toothing, tractor	14.9	32.3	8.4
Floating, horses	13.5	26.3	9.3
Floating, tractor	16.7	23.8	12.0
Drilling, horses	11.5	18.5	7.7
Drilling, tractor	19.6	62.5	9.8
Cultivating alfalfa with spring-tooth	8.3	14.1	5.6
Cultivating with alfalfa cultivator	9.3	25.0	5.3
Mowing clover hay	8.5	12.0	5.4
Mowing vetch-and-oats	7.2	10.9	3.7
All mowing	7.9	11.4	4.6
Raking with dump rake	18.2	28.6	12.4
Raking with side-delivery	12.4	15.9	8.9
Tedding hay	20.0	25.0	17.2
Cocking hay	4.2	10.3	2.2
Hauling hay	1.5	3.8	.7

For number of records and man and horse hours per acre for each operation, see Table XXVII.

farms and in different seasons. They represent in a general way, however, the most typical seasonal distribution for each crop.

Nearly all of the operations upon Willamette Valley hay crops must be done at a rather definite time, according to the season. The principal exceptions to this are cultivating, fertilizing, and manuring of alfalfa hay, for which considerable latitude in time of performance is possible, as indicated in the chart.

Because of the high peak-labor requirements for harvesting, it is necessary for growers with more than a few acres to have extra help for haying, as is of course well known. Satisfactory help is often difficult to obtain, and many growers limit their acreage of hay for this reason. Neighboring growers, if their acreages of hay are not too large, commonly solve their labor problem by exchanging work.

PLACE OF HAY CROPS IN THE WILLAMETTE VALLEY FARM BUSINESS

Hay crops have an important place in the farm business of the Willamette Valley, comprising, as they do, a third of the total acreage of crops. The most important hay crops, moreover, are legumes, which are of fundamental importance in crop rotation and soil improvement.

Type of farming. Tables XVIII and XIX show the crop and livestock enterprises on the farms included in this study. It is apparent that a great many different enterprises are possible under Willamette Valley conditions, and that the farming business is widely diversified.

TABLE XVIII. KINDS AND AMOUNTS OF CROPS RAISED ON THE WILLAMETTE VALLEY FARMS FROM WHICH DATA WERE OBTAINED
(430 farm records — 1925-1927)

Crop	Acres per farm (all farms)	Percent of farms growing each crop	Acres per farm growing the crop
	acres	*%*	*acres*
Wheat	31.0	82	37.9
Oats	28.2	85	33.3
Barley	5.5	36	15.3
Clover hay	12.0	57	21.1
Clover seed	3.0	10	30.7
Clover seeding	3.4	15	23.2
Vetch-and-oats hay	13.3	67	20.0
Alfalfa hay	2.6	24	10.5
Cheat hay	2.8	23	12.2
Grain hay	.3	2	14.0
Timothy hay	.5	3	15.1
Rye-grass hay	.8	4	18.6
Wild oats hay	.7	2	29.3
Mixed, wild, and volunteer hay	.9	7	13.2
Corn silage	5.9	56	10.5
Corn, other uses	2.7	31	8.9
Vetch and oats silage	.3	7	4.0
Vetch seed	5.2	20	26.7
Rye-grass seed	2.1	3	77.6
Kale	.6	23	2.5
Potatoes	1.2	34	3.5
Vegetables	.8	18	4.4
Small fruits	.2	5	3.6
Orchard	1.7	14	12.2
Other crops	1.4	11	13.1
Total crops	127.0	100	127.0
Pasture	65.3	88	74.5
Fallow	2.7	12	21.8
Farmstead and waste	23.6	100	23.6
TOTAL FARM ACREAGE	218.6	100	218.6

Few farms specialize on hay production. Obstacles in the way of specialized hay production are: (1) the necessity of rotating other crops with the hay crops in order to control weeds and maintain desirable soil conditions; (2) the uneven labor distributions of the hay crops; (3) the large acreage required for an adequate family income from hay alone; (4) the depletion of fertility by continued selling of hay instead of feeding it and putting the manure back on the land. Because of these difficulties, hay is raised chiefly in connection with the livestock enterprises, principally dairying and sheep raising, and as a minor cash crop.

Nature of the hay enterprises. The four principal hay crops—clover, vetch-and-oats, alfalfa, and cheat—are quite different in their nature and in the places that they occupy in the farm business. Clover, a biennial legume, is almost indispensable in crop rotation and in soil improvement. In its widespread utility as a soil builder it has little competition from other crops at the present time. Many Willamette Valley farmers say that they could not farm without clover. In addition to its usefulness as forage, moreover, it is one of the outstanding cash crops of the Valley when grown for seed.

TABLE XIX. KINDS AND AMOUNTS OF LIVESTOCK KEPT ON THE WILLAMETTE VALLEY FARMS FROM WHICH DATA WERE OBTAINED

(430 farm records — 1925-1927)

Kind of livestock	Number head per farm (All farms)	Percentage of farms keeping each kind of stock	Number head per farm keeping each kind of stock
		%	
Horses	4	98	4
Milk cows	12	98	12
Other cattle	8	79	10
Sheep	29	37	78
Goats	4	12	35
Hogs	22	68	32
Chickens	134	95	141
Turkeys	7	18	41

Vetch-and-oats hay occupies much the same place in the cropping system as a straight grain crop. While the vetch is an annual legume, its root system is smaller than that of either clover or alfalfa and hence there is less nitrogen fixation. Like clover, in addition to its value as forage, it is one of the important cash crops when grown for seed, and the vetch straw, like clover straw, has high fertility value when returned to the soil. Many growers raise vetch-and-oats primarily as a cash seed-crop, and simply cut the edges and irregular corners of the field for whatever hay they need.

Alfalfa raising has increased considerably in the past few years, but the total acreage is still small. There are many demonstrations that alfalfa can be grown successfully on the bench and upland soils. As yet, however, there are comparatively few large acreages of the crop except on the more favorable soils, which are the river-bottom sandy loams. With its heavy yield of high-quality hay, its long life of stand, and its value as a soil builder, this crop in the future should take an increasingly important place in the cropping systems of the Valley.

Cheat hay is raised mostly on land that is too wet to produce other hay. Often it is raised on wet swales that run through fields of other crops. Its chief value is its adaptability to this type of soil, and as the amount of tile drainage increases less of it will be raised.

Amounts of hay fed and sold. About three-fourths of the hay in the Willamette Valley is fed by the growers and about one-fourth is sold as a cash crop. During the three years, 75 percent of the clover hay that was studied was fed by the growers, 6 percent was sold loose from the field, 17 percent was baled from the field, and 2 percent was baled from the barn or stack. Of the vetch-and-oats 71 percent was fed, 2 percent was sold loose from the field, 1 percent loose from the barn, 25 percent baled from

the field, and 1 percent baled from the barn or stack. The hay that is sold goes chiefly to local dairymen and to dairymen of the Coast regions.

Prices and profits. A net return to the grower of $9.70 a ton for clover hay delivered to the baler or stored in the barn is shown by 37 reports obtained during the three years covering sales of 1,360 tons of clover hay. For vetch-and-oats hay the net return was $11.62 a ton, according to 32 reports covering sales of 2,673 tons. The most common charges for baling from the field were $2.25 a ton when the grower delivered the hay to the baler, and $3.75 a ton when the hauling of the hay was included with the baling.

These average prices, when compared with the costs of production that have been given, indicate a margin of profit of two or three dollars a ton. This seems rather large in proportion to the average cost of production per ton. But with average yields approximately two tons an acre, and average land values between $125 and $150 an acre, it is evident that this seemingly large margin of profit is a rather small percentage upon the capital investment involved. Even adding this profit to the return for his labor and 5 percent interest on his investment that has been included in the cost of production, the grower must have a large acreage and a large capital investment to make a satisfactory income, or else combine other enterprises with his hay production.

Appendix A

DETAILS OF METHODS USED IN THE STUDY

Considerable difference of opinion is possible on many practices in computing and analyzing farm costs. In this study effort has been made to conform in general with commonly accepted procedure, such as there is, in studies of this kind; but the primary aim has been to accomplish the objectives of the study and any procedure that has promised to facilitate this has been adopted. It is thought that such defensible differences in procedure as might be suggested would have no appreciable effect upon the validity of the conclusions that have been drawn.

Sampling. With the assistance of county agents and others familiar with local conditions, representative farms were selected in each county from the different sets of conditions and different types of hay production in the county. Effort was made to avoid too large a proportion of either the larger or smaller farms, or the better or poorer farms or farmers. It is the judgment of those associated with the work that representative cross-sections have been obtained of the production of the several crops, although for clover the number of records was somewhat inadequate.* With the number of records that could be taken, and the variation that exists in conditions and types of production, the samples are probably as reliable as could be obtained by any other method of sampling.

The same farms were included each year as much as possible, but a few were dropped and others added in the second and third years in order to obtain more representative farms; or because of absence or illness of the operators, or other conditions that prevented including all of the farms.

The number of farms was also increased or decreased from year to year in some of the regions in accordance with the relative importance of the region as brought out by the continued study. In the entire forage study, a total of 549 farms cooperated, 217 for all three years, 133 for two years, and 199 for one year. The number of farms averaged 143 per year in the Willamette Valley, and 36 per region per year in the other regions.

During the three years, 1,505 enterprise records of individual crops of forage were obtained. These covered in the aggregate 49,547 acres producing 146,805 tons of forage. In addition there were 400 records upon the cost of seeding alfalfa and clover; and 196 records of the cost of horse labor were obtained in a supplemental study in 1926.†

*The cost of clover hay may be affected materially by whether it is seeded alone or with grain, whether one or two years' crops are obtained, and whether a seed crop is harvested or only hay. These important factors occur in several different combinations, with consequent variation in effect on cost. Because of the variation in the combinations of these factors, the number of clover records obtained was not large enough to give more than an indication of the relationships between these factors and cost of production. A more comprehensive and detailed study of the entire clover enterprise in the Willamette Valley, covering several times as many farms, would be very desirable. Such a study undoubtedly would modify some of the present conclusions, and would bring to light additional valuable and useful facts about this crop, which is of fundamental importance in Willamette Valley agriculture.

†The costs of horse labor are presented in Oregon Agricultural Experiment Station Bulletin 250.

Method of analysis. The data have been analyzed chiefly by the method of grouping and cross-tabulating. It was thought that the modifications of conclusions, or additional conclusions, that might be reached by mathematical correlation methods would hardly justify the procedure involved, especially since the data on several of the factors are not adapted to such methods. In studying a given causal factor effort has been made to tabulate with it any other factors that might be correlated with it and to consider any correlation thus indicated when drawing conclusions.

Discarding and omitting records. Records of farms with unquestionably abnormal conditions and records that for any reason appeared unreliable were discarded. Except for such records, however, all records for the crop concerned have been included in all of the tabulations, unless otherwise definitely indicated.

Averaging. The general principle has been followed of averaging values per acre rather than values per farm or per ton. In averaging together tabulations for different years, the general principle has been to average the groups for each year separately and then average together the unweighted annual averages for each group, in order to avoid undue weighting from irregularity of numbers of records in individual groups. In a few tabulations, however, in which the number of records was too small to give reliable group averages, the aggregate average has been used.

Cost in barn or delivered to baler. The cost of the hay is figured up to and including putting it into the barn or stack or delivering it to the baling table if baled from the field. In a few cases where a small part of the crop was sold standing, or in the cock, the hay thus sold was included in the cost record by estimating the labor for the omitted operations according to the labor requirements for the balance of the hay that was put in the barn.

Renters figured as owners. Most of the cooperators were owners. In all cases of rented land, to make the records comparable, the cost was computed as though the land were owned by the grower, charging the taxes and interest on the value of the land instead of the cash or share rent paid.

Direct man labor. This is all of the man labor expended directly upon the crop, including the work of the grower himself, members of his family, and hired labor, valued at prevailing wages for farm labor. If board was furnished in addition to wages its value has also been included. The average total cost per hour for direct man labor for all of the Willamette Valley forage crops that were studied was 35c in 1925, 36c in 1926, and 36c in 1927. These figures cover both hired and operator's labor, and silage and kale as well as the hay crops.

Overhead man labor. This is the amount chargeable to the crop for indirect and overhead labor such as general repairing and upkeep, general supervision, and attending to general farm business matters. A careful estimate was made of the proportions of each grower's total year's work that were chargeable to his various farm enterprises. The overhead labor is the difference between the amount of labor thus charged and the grower's direct labor upon the crop. For the Willamette Valley hay crops it amounts on the average to 7 percent of the total net cost.

Horse labor. The work of the grower's own horses was charged in the Willamette Valley at 12.5 cents a horse-hour. This rate is supported by the supplementary study of the cost of horse labor that was made in 1926. A small amount of work by horses that were hired is charged at the actual price paid.

Machinery, tractor, and automobile. Estimates were obtained of the proportions chargeable to each crop of the fuel and oil, repairs, depreciation, and interest, for each piece of equipment. Depreciation is based upon the original cost and total life of the implement or machine. Interest is computed at 5 percent upon the present value of the machine. The cost of rented machinery is included at the actual price paid.

Fertilizer. Commercial fertilizers are charged at the actual cost to the grower. Manure is charged at the value placed upon it by the grower. Most of the growers figured manure as worth only the labor of putting it upon the field, which is included under man and horse labor. In some places, however, manure has well established cash values, and these values have been charged in such localities.

Seed. The cost of seed was charged at prevailing market value on the farm. For clover and alfalfa the seed for establishing the stand is covered by the charge for depreciation of stand.

Taxes. The charge for taxes is the total state and county tax paid upon the land used for the crop as determined from the reports of the growers and assessors' records.

Interest on land value. Interest at 5 percent is charged on the value of the land used for the crop, as given by the growers. The value that the growers were asked to give was the present asking price in the locality for land of comparable value.

Depreciation of stand. The cost of establishing stands of clover and alfalfa were computed separately from the cost of producing hay from the established stands. The average costs of establishing the stands were then charged uniformly to the hay crops as annual charges for depreciation of stand based upon the average life of the crop. The costs were computed in this way because of the difficulty of obtaining reliable data upon the cost of much of the seeding that had been done two or more years previously, and also because there are advantages in analyzing the data in using a uniform average charge for depreciation of stand rather than a different cost for every farm.

For cost of establishing a stand of clover see page 28. The charge for depreciation of clover stand that has been used in the cost summaries and tabulations is based upon the average of 80 percent seeding with grain and 20 percent seeding alone, and upon a two-year productive life for the clover, the cost of establishing the stand being divided equally between the two years. For separate average costs for seeding with grain or seeding alone, upon a two-year basis, the costs in Table I should be changed as follows:

	Items	With seed crop	No seed crop	All
Seeding with grain	Depreciation of stand	$ 0.65	$ 1.30	$ 0.95
	Total net cost per acre	11.22	15.55	13.39
	Total cost per ton	5.87	7.58	6.59
Seeding alone	Depreciation of stand	$ 3.91	$ 7.83	$ 5.72
	Total net cost per acre	14.48	22.08	18.16
	Total cost per ton	7.58	10.77	8.96

To charge the cost of the stand to one year only, the charges for depreciation of stand should be doubled and the total costs adjusted accordingly.

For cost of establishing a stand of alfalfa in the Willamette Valley see Appendix B.

Credit for pasture. This is a credit for the value of the pasture that was obtained in spring or fall in addition to the hay crop, valued at the price received, if sold, or as estimated by the grower if used by him.

Yield. Except where the hay was baled and the actual weight obtained, yields are based upon the growers' estimates. This is an item upon which the estimate of the grower is quite reliable, however, as it is of particular interest to him and he gives it much consideration.

Appendix B

SUPPLEMENTARY AND DETAILED TABLES

TABLE XX. AVERAGE COST PER TON OF PRODUCING IMPORTANT WILLAMETTE VALLEY HAY CROPS, 1925-1927

	Clover hay†					
	With seed crop	No seed crop	All	Vetch-and-oats hay	Alfalfa hay	Cheat hay
Direct man labor	$1.74	$1.86	$1.80	$2.23	$2.00	$2.71
Overhead man labor	.59	.60	.59	.64	.69	.73
Horse labor	.61	.63	.61	.88	1.02	1.18
Tractor	.02	.01	.01	.39	.02	.22
Other machinery	.31	.40	.34	.44	.30	.40
Automobile	.06	.02	.03	.04	.02	.01
Fertilizer	.13	.15	.13	.06	.16	.27
Seed	.04*	.03*	.03*	1.31	.....	.68
Depreciation of stand	.68†	1.27†	.94†	.....	1.14	.....
Taxes	.49	.95	.70	.90	.67	.84
Interest on land	1.69	3.34	2.43	3.05	2.77	2.96
Total	$6.36	$9.26	$7.61	$9.94	$8.79	$10.00
Credit for pasture	.16	1.04	.53	.07	.86	.07
NET COST PER TON	$6.20	$8.22	$7.08	$9.87	$7.93	$9.93
TONS PER ACRE	1.9	2.0	2.0	2.3	3.8	1.8

*Seed used for thickening stand.

†The charges for depreciation of clover stand are based upon 80 percent seeding with grain and 20 percent seeding alone, and upon a two-year productive life for the clover. For other ways of computing the cost see page 42.

For detailed explanation of cost items, see Appendix A.

TABLE XXI. QUANTITY COSTS PER ACRE FOR IMPORTANT WILLAMETTE VALLEY HAY CROPS, 1925-1927

Item	Clover hay	Vetch-and-oats hay	Alfalfa hay	Cheat hay
Direct man labor (hrs.)	10.2	14.4	23.4	12.6
Horse labor (hrs.)	9.9	16.4	30.7	16.9
Tractor work (hrs.)	.1	1.4	.1	.6
Seed (lbs.)	8.5*	100†	9.2*	74
Land-plaster (lbs.)	47	19	52	.....
Other fertilizer (lbs.)	.8	.....	5.3	.....
Manure (loads)	.....	.2	.8	.5

*Seed used in establishing stand.

†Vetch seed, 38 lbs.; oats, 62 lbs.

TABLE XXII. PERCENTAGE OF FARMS GROWING EACH KIND OF HAY AT GIVEN COSTS PER TON, 1925-1927

Cost per ton	Clover hay	Vetch hay	Alfalfa hay	Cheat hay
	%	%	%	%
$ 2.50—$ 5.00	15	1	12	....
5.00— 7.49	43	17	35	11
7.50— 9.99	27	36	32	32
10.00— 12.49	7	27	14	27
12.50— 14.99	5	10	....	16
15.00 and over	3	9	7	14
Total	100	100	100	100

TABLE XXIII. RELATION OF YIELD PER ACRE TO COST AND LABOR REQUIREMENTS OF CLOVER HAY AND VETCH HAY 1925-1927

	Yield per acre	Number of records	Average yield	Total cost Per acre	Total cost Per ton	Hours man-labor harvesting Per acre	Hours man-labor harvesting Per ton
	tons		*tons*				
Clover hay	Less than 1.50	28	1.1	$11.92	$11.16	5.9	5.5
	1.50—1.99	37	1.7	12.31	7.41	9.0	5.4
	2.00—2.49	60	2.1	15.02	7.06	10.8	5.1
	2.50—2.99	39	2.6	16.12	6.22	11.0	4.3
	3.00—3.49	27	3.1	20.08	6.39	14.2	4.6
	3.50 and over	6	3.9	20.35	5.16	18.5	4.7
	Average	197	2.0	$14.34	$7.08	9.8	4.9
Vetch hay	Less than 1.50	12	1.1	19.20	18.01	6.2	5.8
	1.50—1.99	23	1.6	19.95	12.32	8.6	5.3
	2.00—2.49	69	2.1	23.14	11.10	9.6	4.6
	2.50—2.99	32	2.6	23.87	9.06	11.8	4.5
	3.00—3.49	36	3.1	25.02	7.85	12.1	3.9
	3.50 and over	28	4.2	29.81	7.15	19.8	4.7
	Average	200	2.3	$22.75	$9.87	10.8	4.7

TABLE XXIV. RELATION OF VALUE OF LAND TO YIELD AND COST OF CLOVER HAY AND VETCH HAY, 1925-1927

	Value of land per acre	Number of records	Average value of land per acre	Yield per acre	Total cost Per acre	Total cost Per ton
				tons		
Clover hay	Less than $100	19	$ 74	1.7	$10.51	$ 6.09
	100—149	78	111	1.9	12.91	6.83
	150—199	53	152	2.2	15.42	7.50
	200—249	36	200	2.3	20.87	8.98
	250 and over	11	278	2.4	23.02	9.67
	Average	197	$135	2.0	$14.34	$ 7.08
Vetch hay	Less than $100	23	71	2.3	17.90	7.69
	100—149	77	105	2.0	19.69	9.72
	150—199	51	159	2.6	25.31	9.61
	200—249	37	205	2.7	27.90	10.45
	250 and over	12	284	2.7	32.43	12.58
	Average	200	$141	2.3	$22.75	$ 9.87

TABLE XXV. RELATION OF KIND OF SOIL TO YIELD, VALUE OF LAND, AND COST OF HAY, FOR CLOVER HAY AND VETCH HAY, 1925-1927

	Kind of soil	Number of records	Yield per acre	Value of land per acre	Cost of hay per ton
			tons		
Clover hay	Heavy	40	1.9	$116	$ 7.11
	Medium	131	2.1	144	7.50
	Light	26	2.0	137	6.93
	Average	197	2.0	$135	$ 7.08
Vetch hay	Heavy	40	2.0	$119	$10.23
	Medium	123	2.5	149	9.56
	Light	37	2.4	148	10.71
	Average	200	2.3	$141	$ 9.87

TABLE XXVI. RELATION OF AMOUNT OF VETCH SEED SOWN PER ACRE TO YIELD AND COST, 1926-1927*

Vetch seed per acre	Number of records	Average pounds seed per acre		Yield per acre	Cost per ton	Value land per acre
		Vetch	Oats			
lbs.		*lbs.*	*lbs.*	*tons*		
Less than 40	76	29	70	2.1	$10.50	$149
40—49	50	41	54	2.3	9.16	116
50 and over	32	56	46	2.9	8.24	134

*1925 omitted from this tabulation because of unusual amount of winter-killing.

TABLE XXVII. HOURS OF LABOR PER ACRE ONCE OVER ON ALL FARMS PERFORMING OPERATION, ON 10 PERCENT OF FARMS WITH LOWEST LABOR REQUIREMENTS, AND ON 10 PERCENT OF FARMS WITH HIGHEST LABOR REQUIREMENTS, 1925-1927

Operations	Number of records of operation	All farms		Lowest 10 percent		Highest 10 percent	
		Man-hours	Horse-hours	Man-hours	Horse-hours	Man-hours	Horse-hours
Fertilizing with spreader	169	.6	1.1	.3	.6	1.0	1.9
Fertilizing by hand	54	.8	.4	.3	.2	1.2	.2
Manuring with spreader	143	11.2	19.8	4.1	8.8	24.1	31.3
Manuring with wagon or sled	31	15.4	26.6	9.8	19.6	31.4	47.8
Plowing for vetch and oats, horses	52	4.5	12.8	1.8	8.0	8.0	17.9
Plowing for vetch and oats, tractor	93	1.7	.....	1.1	.....	2.3	.....
All plowing, horses	202	4.8	13.5	2.7	9.5	7.6	17.4
All plowing, tractor	229	1.8	.....	1.1	.....	2.9	.....
Disking, horses	142	1.4	4.7	.7	2.5	2.6	7.0
Disking, tractor	232	.7	.....	.4	.....	1.2	.....
Rolling, horses	150	.8	2.3	.5	1.7	1.2	2.9
Rolling, tractor	26	.5	.....	.3	.....	1.0	.....
Spike harrowing, horses	341	.6	1.7	.3	1.1	1.0	2.4
Spike harrowing, tractor	31	.5	.....	.2	.....	.8	.....
Spring-toothing, horses	69	1.1	3.4	.5	2.5	1.7	3.8
Spring-toothing, tractor	54	.7	.....	.3	.....	1.2	.....
Floating, horses	49	.7	2.1	.4	.9	1.1	3.0
Floating, tractor	8	.6	.....	.4	.....	.8	.....
Drilling, horses	237	.9	2.6	.5	1.8	1.3	3.2
Drilling, tractor	15	.5	.....	.2	.....	1.0	.....
Cultivating alfalfa with spring-tooth	14	1.2	4.1	.7	2.1	1.8	7.2
Cultivating with alfalfa cultivator	6	1.1	2.7	.4	1.6	1.9	3.8
Mowing clover hay	197	1.2	2.3	.8	1.6	1.9	3.5
Mowing vetch-and-oats	193	1.4	2.6	.9	1.8	2.7	4.2
All mowing	476	1.3	2.5	.9	1.8	2.2	3.8
Raking with dump rake	453	.6	1.1	.4	.7	.8	1.6
Raking with side delivery	25	.8	1.6	.6	1.2	1.1	2.2
Tedding hay	10	.5	.9	.4	.8	.6	1.2
Cocking hay	458	2.4	.....	1.0	.....	4.6	.....
Hauling hay	471	6.8	5.9	2.6	2.9	13.5	10.8

The figures for each operation are based upon the total number of records of the operation upon all of the Willamette Valley forage crops that were studied, including corn silage, vetch silage and kale as well as the hay crops.

Appendix C

COST OF ESTABLISHING A STAND OF ALFALFA

In Table XXVIII is shown the average cost of establishing a stand of alfalfa in the Willamette Valley, based upon 47 records covering 436 acres of alfalfa seeding. Table XXIX shows the labor operations that were performed and the average labor requirements.

TABLE XXVIII. AVERAGE COST OF ESTABLISHING A STAND OF ALFALFA IN THE WILLAMETTE VALLEY, 1925-1927

(47 records — 436 acres)

Item	Amount per acre	Cost per acre
Direct man labor	15.5 hrs.	$5.22
Overhead man labor	.....	1.96
Horse labor	32.9 hrs.	4.12
Tractor	2.5 hrs.	1.88
Other machinery	.....	.97
Lime	330 lbs.	1.20
Seed	9.2 lbs.	4.21
Inoculation	.....	.01
Taxes	.....	2.65
Interest on land (5%)	.....	10.08
Total	.....	$32.30
Credit for pasture	.....	.98
Credit for clippings	.....	1.37
TOTAL NET COST PER ACRE	.....	$29.95

Most of the seeding was done in May. Grimm alfalfa was sown almost exclusively.

The average cost per acre of $29.95 has been divided by an estimated life of seven years to get the annual depreciation charge of $4.28 that has been used in the cost summaries. Continued experience with this crop in the Willamette Valley may show the average life of a stand to be more, or less, than seven years, which of course would change this charge for depreciation of stand.

TABLE XXIX. PERCENTAGE OF ACREAGE COVERED, TIMES OVER, AND HOURS OF LABOR PER ACRE FOR OPERATIONS ON ALFALFA SEEDING IN THE WILLAMETTE VALLEY, 1925-1927

	Percentage of acreage covered	Times over	Labor per average acre of crop		
			Man-hours	Horse-hours	Tractor-hours
	%				
Fertilizing (lime)	32	1.0	.4	.5	.....
Manuring	5	1.0	.7	1.2	.....
Plowing	95	1.0	3.0	6.7	.8
Disking	69	3.1	2.5	6.2	.6
Rolling	72	3.6	1.6	3.5	.4
Spike harrowing*	90	4.7	2.2	5.5	.3
Spring-toothing	58	3.9	2.0	4.5	.3
Floating	31	2.1	.3	.6	.1
Seeding with horses	57	1.0	.6	1.3	.....
Seeding by hand	43	1.0	.3	.....	.....
Pulling weeds	6	1.0	.4	.....	.....
Clipping	67	1.4	.9	1.8	.....
Rake and haul clipping	30	1.4	.6	1.1	.....
TOTAL	....	.....	15.5	32.9	2.5

*Including cultivation with spike harrows of 10.6 percent of the average 4.9 times.

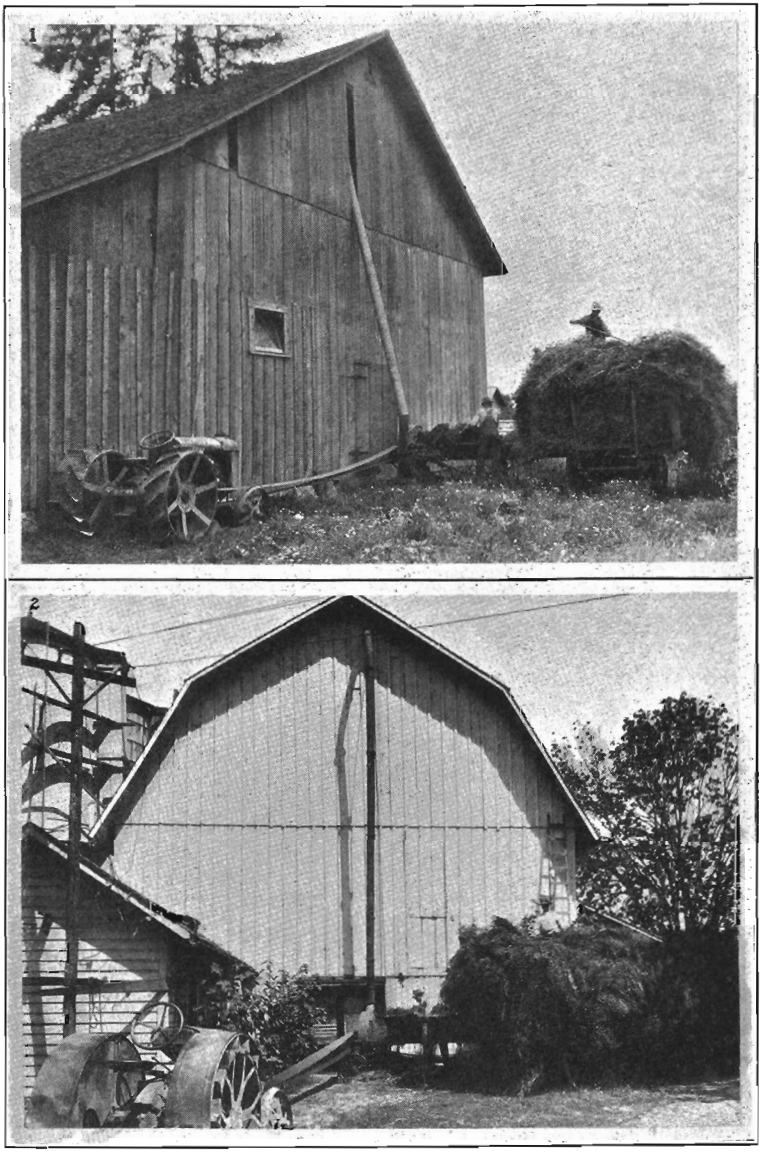


Fig. 7. Chopping hay into the barn. (1) Farm of A. E. Holmes, Benton county. (2) Farm of J. W. Gentle, Polk county. For discussion see page 18.