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WORK OF THE UMATILLA FIELD STATION IN 1923, 1924, AND 1925[1]

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CONTENTS

CONDITIONS ON THE PROJECT

The Umatilla reclamation project, located in north-central Oregon along the Columbia River, is typical of a number of irrigation projects adjacent to that river in Oregon and Washington. The soils are light and the topography somewhat rough. The estimated irrigated area in these projects is 150,000 acres, and in addition the area is representative of several hundred thousand acres of desert land which may be brought under irrigation in the future. Of the 28,300 acres on the Umatilla project, 12,512 acres were cropped in 1925.

During the period covered by this report (1923–1925) a very unsettled condition prevailed on the project. This feeling among the farmers was partially due to the general agricultural depression and partly to lack of a settled policy with regard to repayments of the building charge and of the charge for operation and maintenance of the irrigation works. Development and improvement on the farms has been at a standstill. Table 1 gives the acreages and the average

[1] The Umatilla Field Station is located on the Umatilla reclamation project, about 2 miles north of Hermiston, Oreg. The farm contains 40 acres of land withdrawn from entry in 1908 by the Department of the Interior for use as an experiment farm. It is maintained and operated by the Oregon Agricultural Experiment Station in cooperation with the Bureau of Plant Industry, United States Department of Agriculture, under a cooperative agreement. Operations were begun in 1909. The buildings used were constructed by the United States Reclamation Bureau and by the Oregon Agricultural Experiment Station. The expenses of the farm are shared equally by the Oregon station and the Office of Western Irrigation Agriculture of the Bureau of Plant Industry. The investigational work is under the immediate supervision of a farm superintendent, who is an employee of the Bureau of Plant Industry.

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production of the more important crops grown on the Umatilla project from 1914 to 1925, inclusive, and the average yields for the period.

TABLE 1.—*Acreages and the average production per acre of the more important crops produced on the Umatilla reclamation project from 1914 to 1925, inclusive*[1]

Year	Alfalfa				Barley		Corn				Wheat		Potatoes	
	Hay		Seed				Grain		Fodder					
	Acres	Tons	Acres	Bushels	Acres	Bushels	Acres	Bushels	Acres	Tons	Acres	Bushels	Acres	Bushels
1914	2,048	3.7	NR[2]	------	NR	------	52	34.9	80	3.0	7	38.7	61	91.5
1915	2,396	3.8	NR	------	72	26.4	113	33.3	67	3.8	9	28.9	55	107.8
1916	2,985	3.8	8	3.1	NR	------	101	27.3	100	3.2	NR	------	41	78.9
1917	4,047	3.7	83	3.1	4	12.0	130	29.2	110	5.2	9	16.7	106	97.3
1918	5,274	3.6	117	5.1	48	11.6	252	25.4	114	6.8	31	14.5	49	65.2
1919	6,837	3.8	68	2.6	38	44.0	108	29.6	200	5.5	18	13.3	49	57.8
1920	8,512	3.8	34	3.1	8	43.7	124	30.2	100	6.0	20	12.0	48	87.6
1921	9,824	3.7	89	2.7	34	26.5	116	25.9	62	6.0	45	11.6	83	77.3
1922	10,367	3.8	70	3.4	60	29.6	123	36.3	61	8.6	64	29.6	176	108.7
1923	9,975	3.6	NR	------	10	28.0	207	33.3	65	7.9	106	29.5	96	108.8
1924	9,698	2.8	2	3.5	3	33.3	250	26.0	61	6.7	82	14.6	66	95.0
1925	9,140	2.6	107	2.2	52	28.2	250	26.2	81	5.2	129	19.9	108	94.2
Average	------	3.56	------	3.2	------	28.3	------	29.8	------	5.66	------	20.8	------	89.1

The data included in Tables 1, 3, 4, and 5, are compiled from the annual reports of the Bureau of Reclamation.

[2] NR indicates no report.

In general, the yields for 1924 and 1925 were below those of previous years. This decrease was probably due in part to a series of breaks in the main canal in the height of the irrigation season of 1924, and in the case of alfalfa in 1925 to severe winterkilling during the previous winter. The returns obtained from alfalfa seed are rather uncertain, as the yields vary considerably from year to year. The yields of wheat and barley are rather low for irrigated land, but these crops are grown because they are needed in rotations. The returns from corn are somewhat higher, and this crop is grown because it fits into the rotation schedule and also to supply ensilage. The potato reports do not segregate early potatoes marketed in late July and early August from those harvested later, and as a consequence the average yields would appear low if they were for late potatoes only.

CLIMATIC CONDITIONS

Table 2 is a summary of the meteorological observations from 1912 to 1924 and the observations for 1925.

The climatic conditions for the period of this report were not unusual except for 1925. The frost-free period for 1925 was the longest on record, and the mean temperatures were considerably above normal. The rainfall for 1925 was considerably below normal. The minimum temperature of 16° F. in 1925 was the highest for any year since the records were started in 1912.

TABLE 2.—*Summary of meteorological observations at the Umatilla Field Station during the 13-year period from 1912 to 1924, inclusive, with observations for 1925 and frost data at Hermiston, Oreg., for the 17-year period from 1906 to 1925, inclusive*

PRECIPITATION (INCHES)

Year, etc.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Average:													
1912 to 1924	1.18	1.01	0.54	0.69	0.64	0.62	0.22	0.46	0.39	0.71	1.25	1.06	8.77
1925	.67	1.20	.27	.67	.83	.02	T.	.08	.67	.08	.77	1.46	6.72

EVAPORATION (INCHES)

Average:													
1912 to 1924	------	------	------	4.13	5.51	7.27	8.45	6.67	4.34	2.29	------	------	38.66
1925	------	------	------	4.16	4.99	7.65	8.73	7.00	4.33	------	------	------	36.86

DAILY WIND VELOCITY (MILES PER HOUR)

Highest:													
1912 to 1924	15.3	13.0	16.9	15.7	12.0	14.5	12.1	13.7	11.1	12.3	13.4	15.4	16.9
1925	8.3	9.1	10.0	12.4	7.4	7.4	5.1	7.1	4.0	5.7	3.8	7.2	12.4
Lowest:													
1912 to 1924	0	0	.1	.2	0	0	.1	.1	.1	0	0	0	0
1925	.4	.4	.7	1.1	.6	.5	.4	.1	.3	.1	.2	.1	.1
Mean:													
1912 to 1924	3.6	2.5	4.0	4.3	3.6	3.6	3.3	2.4	2.2	2.1	1.5	2.7	3.0
1925	2.9	2.8	3.8	3.4	2.1	3.0	1.9	2.0	1.4	1.3	.8	1.0	2.2

TEMPERATURE (°F)

Absolute maximum:													
1912 to 1924	68	68	79	86	96	107	110	104	98	85	69	70	110
1925	62	66	72	86	89	104	104	103	95	77	64	62	104
Absolute minimum:													
1912 to 1924	−28	−7	6	17	27	34	39	37	27	17	1	−36	−36
1925	22	21	22	30	31	34	46	39	33	23	16	20	16
Mean:													
1912 to 1924	30	35	43	51	59	67	73	72	62	51	40	31	51
1925	38	46	46	55	62	70	76	71	62	51	39	38	54

KILLING FROSTS AT HERMISTON, OREG., 1909 TO 1925, INCLUSIVE

Year	Last in spring		First in autumn		Frost-free period
	Date	Minimum temperature	Date	Minimum temperature	
		°F.		°F.	*Days*
1909	Apr. 21	27	Oct. 16	30	178
1910	Apr. 30	27	Oct. 15	31	168
1911	Apr. 20	31	Sept. 23	26	156
1912	Apr. 16	31	Oct. 6	31	173
1913	Apr. 23	28	Sept. 24	31	154
1914	Apr. 29	30	Oct. 20	31	174
1915	May 2	31	Oct. 5	30	156
1916	May 14	31	Sept. 28	29	137
1917	May 2	31	Oct. 17	22	168
1918	May 25	29	Oct. 8	31	136
1919	May 7	27	Sept. 29	27	145
1920	May 12	29	Oct. 17	27	158
1921	Apr. 30	30	Sept. 12	26	135
1922	May 9	24	Oct. 28	27	172
1923	May 3	30	Sept. 23	30	143
1924	Apr. 27	27	Oct. 6	28	162
1925	Mar. 31	28	Oct. 4	26	187

LIVESTOCK INDUSTRIES

The livestock censuses for 1923, 1924, and 1925 show some rather pronounced changes in the livestock industries of the project. Table 3 gives the numbers of livestock on farms at the ends of the years mentioned.

TABLE 3.—*Number of livestock owned on the Umatilla reclamation project at the close of the years 1923, 1924, and 1925*

Stock	1923	1924	1925	Stock	1923	1924	1925
Horses and mules	1,156	1,115	1,072	Hogs	2,466	1,025	845
Cattle:				Fowls	26,736	21,200	24,107
Dairy	2,634	3,051	2,784	Bees (hives)	2,736	2,368	2,202
Beef	141	246	186				
Sheep	6,013	6,444	7,154				

During 1922, 1923, and 1924 the numbers of dairy cattle showed substantial increases, but in 1925 there was a decrease. This is to be regretted, because the project needs more dairy stock instead of less. Of the dairy bulls on hand at the end of 1925, 56 were pure-bred and 18 scrubs.

The sheep on the project have shown definite increases for the last three years. This increase is due partly to increases in farm flocks and partly to the lamb-feeding industry which has been started as a direct result of the station work on lamb feeding. During the last three years 1,300 to 2,300 head of lambs each year have been fed by project farmers.

The low hog prices of 1923 caused an extreme liquidation in the hog industry, which extended into 1925.

The poultry industry showed a decrease during 1924, but partially recovered in 1925.

The number of bees kept has shown a rather pronounced decrease during the three years.

Table 4 shows the relation between the acreage of alfalfa and the livestock on the project.

TABLE 4.—*Number of acres of alfalfa per cow and number of dairy cattle and hogs per farm on the Umatilla reclamation project from 1914 to 1925, inclusive*

Year	Number of farms	Total acres of alfalfa	Number of dairy cattle	Acres of alfalfa per head	Average cattle per farm	Number of hogs	Average hogs per farm
1914	311	2,048	641	3.2	2.0	2,185	7.0
1915	306	2,396	765	3.1	2.5	1,862	6.1
1916	320	2,985	737	4.0	2.3	929	2.9
1917	411	4,047	822	4.9	2.0	1,344	3.3
1918	459	5,274	911	5.8	2.0	1,509	3.3
1919	507	6,837	1,143	6.0	2.3	1,800	3.6
1920	528	8,512	1,162	7.3	2.2	1,567	3.0
1921	544	9,824	1,332	7.4	2.5	1,356	2.5
1922	558	10,367	2,293	4.5	4.1	2,812	5.0
1923	540	9,975	2,634	3.8	4.9	2,466	4.6
1924	534	9,698	3,051	3.2	5.7	1,025	1.9
1925	538	9,140	2,784	3.3	5.2	845	1.6

The number of acres of alfalfa per head of dairy cattle has decreased steadily since the high point in 1921, until in 1925 it averaged 3.3 acres per head. The number of cattle per farm reached the high

point in 1924, with a slight decrease in 1925. The alfalfa now shipped is sufficient to support approximately three more cows per farm. Or, in other words, with alfalfa producing at the rate of 2.6 tons per acre as in 1925, if the ratio of 2 acres of alfalfa per head of dairy stock were reached, no hay would be shipped from the project. If the cattle population were increased to the full capacity of the project, as determined by the hay-producing limit, the project would be much more prosperous than it is now.

The hog population of the project has been decreased so much that the best use of by-products, especially skim milk and other waste products, is not being made. The project average shows 1.6 hogs per farm, but a considerable number of the 845 hogs are in a few large herds, so that the distribution on farms is not uniform. A portion of the skim milk is being fed to poultry, but even then the standard recommendation of one hog to each dairy cow is not nearly approached.

CROPS PRODUCED IN 1923, 1924, AND 1925

The areas of the various crops and the average yields of crops produced on the Umatilla project, including the Hermiston irrigation district and the West Extension irrigation district, which comprise more than 500 farms, for 1923, 1924, and 1925, are given in Table 5.

TABLE 5.—*Acreage and yields of crops produced on the Umatilla reclamation project in 1923, 1924, and 1925*

Crop	Unit of yield	1923			1924			1925		
		Area (acres)	Acre yield		Area (acres)	Acre yield		Area (acres)	Acre yield	
			Total	Average		Total	Average		Total	Average
Alfalfa	Ton	9,975	36,343	3.6	9,698	27,344	2.8	9,140	23,966	2.6
Alfalfa seed	Bushel				2	7	3.5	107	236	2.2
Apples	Pound	497	1,382,000	2,780	455	(1)	(1)	382	883,225	2,312
Apricots	do	5			5	(1)	(1)			
Barley	Bushel	10	280	28	3	100	33.3	52	1,466	28.2
Clover hay	Ton							20	45	2.2
Corn	Bushel	207	6,900	33.3	250	6,502	26.0	250	6,563	26.3
Corn fodder	Ton	65	511	7.9	61	409	6.7	81	421	5.2
Fruits, small		35			19			22		
Garden		186			115			152		
Hay	Ton	58	99	1.7	79	75	.9	73	73	1.0
Melons	do				53			88	542	6.2
Oats	Bushel	3	125	41.7	3	130	43.3	4	46	11.5
Pasture		1,109			1,776			2,746		
Peaches	Pound	13	56,450	4,342	21	(1)	(1)	9	(1)	(1)
Pears	do	9	62,000	6,889	7	(1)	(1)	7	(1)	(1)
Prunes	do	13	21,500	1,654	17	(1)	(1)	12	4,720	393.3
Potatoes	Bushel	96	10,441	108.8	66	6,288	95.3	108	10,150	94.0
Wheat	do	106	3,129	29.5	82	1,198	14.6	129	2,562	19.9
Miscellaneous		44			31			38		
Less duplications		78			231			573		
Total cropped		12,353			12,512			12,847		

[1] Failure.

The irrigated acreage of the project showed a slight increase during the period. The most pronounced changes in crops were the decreases in the alfalfa acreage and the increase in the pasture acreage. The pasture is mostly run-out alfalfa which is no longer profitable for hay.

ALFALFA PRODUCTION

Alfalfa has always been the most important crop for the Umatilla project farmers, but from present indications its importance is decreasing. Table 6 presents the data on the relation of alfalfa to the other crops on the project.

TABLE 6.—*Summarized comparison, showing importance of the alfalfa crop on the Umatilla reclamation project during the 15-year period from 1911 to 1925, inclusive*

Year	Acreage			Alfalfa yield (tons)		Year	Acreage			Alfalfa yield (tons)	
	All crops	Alfalfa	Percentage of alfalfa	Total	Average per acre		All crops	Alfalfa	Percentage of alfalfa	Total	Average per acre
1911	2,775	1,765	63.6	5,825	3.3	1920	10,188	8,512	83.5	32,110	3.8
1912	3,218	2,442	75.9	8,388	3.4	1921	11,610	9,824	84.6	36,355	3.7
1913	3,033	2,024	66.7	8,010	3.9	1922	12,391	10,367	83.6	39,094	3.8
1914	3,013	2,048	68.0	7,511	3.7	1923	12,353	9,975	80.7	36,343	3.6
1915	3,603	2,396	66.5	9,141	3.8	1924	12,512	9,698	77.5	27,344	2.8
1916	3,900	2,985	76.5	11,412	3.8	1925	12,847	9,140	71.1	23,966	2.6
1917	5,546	4,047	73.0	14,834	3.7						
1918	6,819	5,274	77.4	19,063	3.6	Average			75.3		3.6
1919	8,464	6,837	80.7	25,836	3.8						

During the period from 1922 to 1925 the proportion of the area of the project in alfalfa decreased from 83.6 per cent to 71.1 per cent, while the total yield decreased from 39,094 to 23,966 tons.

For a number of years the average yield of alfalfa for the whole project was approximately 3.7 tons per acre, but during the last two years it averaged only 2.8 and 2.6 tons, respectively, per acre. Alfalfa raising can not be continued at a profit under project conditions with these low yields. Factors besides winterkilling which have reduced the yields of alfalfa are poor stands, bluegrass and weed encroachment, and deterioration of irrigation systems. Many farms are in the hands of renters who do nothing but irrigate and cut the hay, with the result that the production is low.

Rather more than 40 per cent of the alfalfa raised on the project is baled and shipped out. This is very unfortunate, because over a period of years much more can be realized by feeding hay to livestock than by shipping it, and because the light, sandy soils of the project need the crop residue to build them up.

TEST OF ALFALFA VARIETIES

A test of 12 varieties of alfalfa has been conducted for five years, with an additional test of nine varieties for four years. The average annual production of air-dry hay and the percentage of plants killed during the winter of 1924–25 are given in Table 7.

During the winter of 1924–25 winterkilling of alfalfa was severe on the project and in neighboring sections of Oregon. The killing varied greatly from field to field, but it is estimated to have been from 20 to 30 per cent of the alfalfa on the project. Observation showed that the killing was most severe where the plants were having a struggle for existence on account of unfavorable conditions, such as the weather being too dry or too wet, and particularly where the

plants were growing on land which had been heavily graded in preparation for irrigation. It is believed that the killing occurred during the middle of December, when temperatures of 11° and 12° F. below zero were reached without snow on the ground, following a few very warm days, as previously during the history of the station temperatures of from −20° to −36° F., but with snow on the ground, had been recorded without killing the alfalfa.

TABLE 7.—*Percentage of plants winterkilled in 1924–25 and average yield of hay in tons per acre in an alfalfa variety test at the Umatilla Field Station, 1921–1925*

Type and variety	Percentage of plants killed, winter of 1924–25	Average yield per acre (tons)
Common group:		
Black Hills seed	2.1	6.78
Black Hills seed D–79 [1]	4.1	5.16
Dry-land seed	9.5	6.36
Dry-land seed D–38 [1]	7.7	6.90
Dry-land seed D–80 [1]	2.1	4.52
High altitude seed	3.8	5.86
Kansas seed	3.2	6.15
Local seed	4.3	6.77
Turkestan	0	6.52
Turkestan D–26 [1]	1.1	5.00
Hardy group:		
Baltic	2.2	5.14
Cossack	1.6	6.28
Grimm	0	6.84
Grimm D–19 A [1]	.7	5.09
Ladak [1]	5.8	4.40
Liscomb	3.5	6.51
D–11c [1]	1.0	5.30
D–28 [1]	2.7	6.40
Tender group:		
Chilean [1]	62.4	4.64
Indian	68.1	3.96
Hairy Peruvian	15.2	4.96

[1] Tested four years; other varieties tested five years.

The variety test on the station was located on a rather good piece of land with conditions generally favorable, and the killing in that field was not so severe as in some of the other fields on the station. It serves, however, to bring out the relative hardiness of the several varieties.

Estimates of the percentage of winterkilling were made by two counts at a month's interval in late March and April. Four counts, at different places, of the plants, dead and alive within an area of a square yard were made for each variety. The figures presented are the average of these determinations.

The most severe winterkilling occurred in the varieties of the tender group as represented by Chilean, Indian, and Hairy Peruvian. Two strains from dry-land grown seed had the highest winterkilling in the common group. The proportion of plants killed in the other varieties was not large enough to be of material consequence. One strain each of Grimm and Turkestan came through without killing, and the other two strains of these varieties had only slight killing. The yields of the varieties in the tender group for 1925 were materially lower than previously.

In field D4 on the station those plots which were not manured showed considerable killing, whereas the manured plots came through the winter in good condition. This observation was also borne out by

the experiences of farmers on the project. During the 30 years of alfalfa raising on Butter Creek, south of the project, winterkilling was not known before; on the other hand similar weather conditions might occur almost any winter, so it is believed that the hardy varieties should be grown on the project.

The highest yields in the common groups were obtained from strains grown from dry-land seed D–38 from Black Hills seed and from local seed. However D–38 killed rather badly. In the hardy

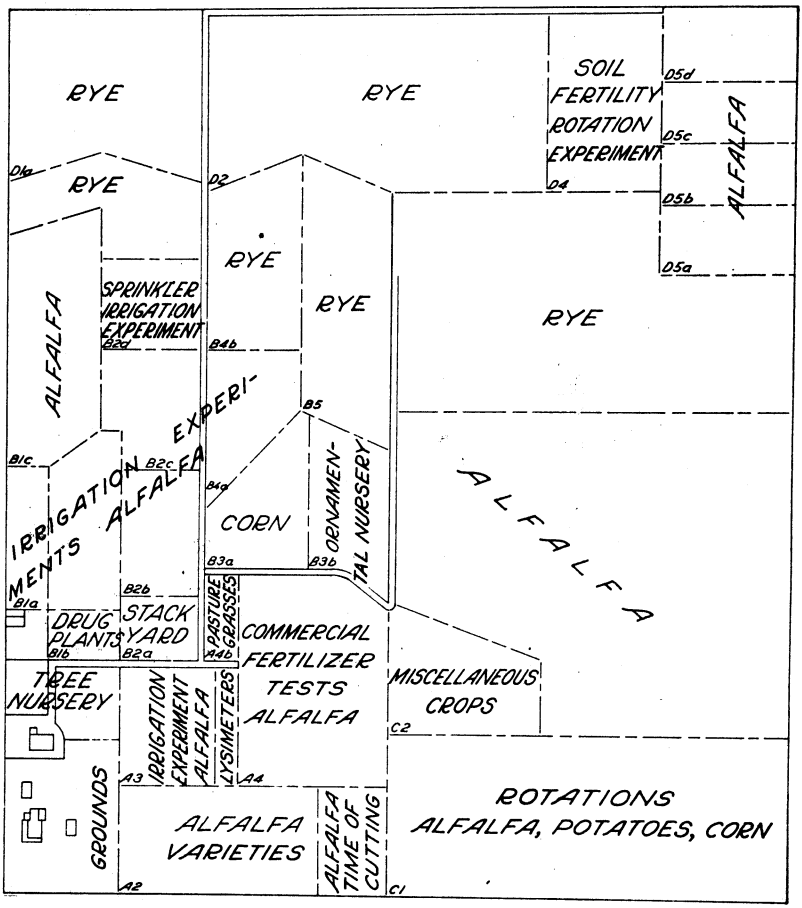

FIG. 1.—Diagram of the Umatilla Field Station, showing arrangement of fields and location of experiments in 1925

group Grimm gave the highest yield, with Liscomb second. The differences in yield of Black Hills common and Grimm have not been pronounced enough to give decided preference to either, but Black Hills common has the advantage that the seed is cheaper. In case local seed is used care should be taken to see that it is free from weeds and that it comes from a field which has given good hay yields.

Figure 1 shows the location of crops grown on the field station in 1925.

SWEET-POTATO VARIETY TRIAL

Considerable local interest has been manifested recently in growing sweet potatoes. The results of a trial of eight varieties grown in 1923 are given in Table 8.

TABLE 8.—*Yields of marketable potatoes and percentage of total yield marketable in a sweet-potato variety trial at Umatilla Field Station in 1923*

Variety	Marketable yield per acre (pounds)	Percentage of total yield marketable	Variety	Marketable yield per acre (pounds)	Percentage of total yield marketable
Big-Stem Jersey	1,965	62.3	Pumpkin "yam"	2,805	74.0
Dooley	1,794	60.0	Triumph	10,051	88.6
Nancy Hall	8,555	83.8	Yellow Strassburg	15,390	93.7
Porto Rico	2,390	62.5	Yellow Jersey		

Three of the varieties, Nancy Hall, Triumph, and Yellow Strassburg, gave good yields. In each of these varieties the percentage of marketable potatoes was also highest. Since sweet potatoes require a rather long growing season, it is likely that the yields will vary from year to year, being light during the short, cool summers. In 1925, which had a long, hot summer, exceptionally good yields were obtained by growers at Irrigon. This test was conducted during a season that was rather warmer than the average.

VALUE OF MANURE APPLIED TO ALFALFA AND CORN

For 11 years an experiment has been conducted on the coarse, sandy soil in field D4 to determine the value of manure applied to alfalfa and corn. This is the longest uninterrupted experiment which has been conducted on the station, and on that account the figures on yields are believed to be very reliable. In this test manure was applied to each group, 6 years of the 11, at the rate of 8 and 32 tons per acre, making a total of 48 and 192 tons. The check plots did not receive manure. The yields given are of air-dry hay and of green corn about ready for the silo. The annual yield of alfalfa hay, in tons per acre, the 11-year average yields, and the increased yields from the manure are given in Table 9.

The yields from year to year have not varied greatly, so the averages and totals only are considered in this discussion. The average yield of hay from the check plot which did not receive manure was 3.71 tons per acre; that from the plots which received manure six times at the rate of 8 tons per acre, or a total of 48 tons, was 5.07 tons; and that from the plots which received manure six times at the rate of 32 tons per acre, or a total of 192 tons, was 6.10 tons. The average annual increase due to the manure applied at the rate of 8 tons was 1.38 tons of hay and to the application at the rate of 32 tons was 2.39 tons over the untreated check plots. The light applications increased the yield of hay 36.7 per cent and the heavy application 64.4 per cent over the untreated check plots. The total increase from the light applications for the 11 years was 14.93 tons and from the heavy applications 26.27 tons of hay. Manure applied at the rate of 43 tons was much more valuable per ton than when applied at the

rate of 192 tons per acre. The light dressing has given to date increased returns at the rate of 0.311 ton of hay per ton of manure, while the heavier application increased returns at the rate of 0.137 ton per ton of manure. Since the manured plots are still producing more hay than the unmanured, the total increase of yield per ton of manure is still to be determined. Manure at the lighter rate is 127 per cent more valuable per ton than at the heavier rate (fig. 2).

TABLE 9.—*Annual yield of alfalfa hay (in tons per acre), average of three plots from unmanured land and from land given light and heavy dressings of manure, Umatilla Field Station, 1915 to 1925, inclusive*

[The application of manure, when shown, was made during the winter preceding the crop year]

Year	No manure (check plots)	Yield		Increased yield from—	
		Light application (48 tons)	Heavy application (192 tons)	Light application	Heavy application
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
1915 (manure)	1.65	2.15	2.85	0.50	1.20
1916 (manure)	4.64	6.37	7.37	1.73	2.73
1917 (manure)	4.47	5.47	6.25	1.00	1.78
1918	3.11	4.12	4.91	1.01	1.80
1919 (manure)	3.37	5.03	6.17	1.66	2.80
1920 (manure)	3.66	5.95	7.43	2.29	3.77
1921 (manure)	4.43	5.95	7.46	1.52	3.03
1922	4.20	5.61	6.99	1.41	2.79
1923	4.55	5.52	5.98	.97	1.43
1924	3.46	4.49	5.47	1.03	2.01
1925	3.25	5.06	6.18	1.81	2.93
Total				14.93	26.27
Average	3.71	5.07	6.10	1.36	2.39

The general impression prevalent on the project that alfalfa is not giving such high yields as it formerly did is not borne out by the yields obtained in this test. Eliminating the first year, during which only a light crop was harvested, the results were as follows: Without

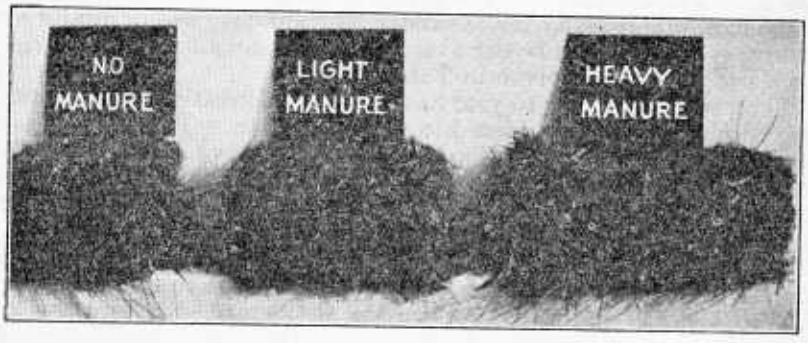

FIG. 2.—Bales of alfalfa hay, showing relative quantity produced in field D4 without manure, with a light application of manure, and with a heavy application, at the Umatilla Field Station

manure the annual yield was 3.85 tons per acre during the first five years and 3.98 during the second five. With the light application of manure the annual yield was 5.39 tons during the first 5-year period and 5.33 tons during the second 5-year period. With heavy manure the yield was 6.43 and 6.42 for the first and second 5-year periods,

respectively. This experiment was conducted on class 6 land—"lands that appear to be permanently nonagricultural under the practices of irrigation farming," so classified by the board of survey and adjustments.

The annual yield of green corn fodder in tons per acre, the 11-year average yields, the annual increased yields, and the total increase are given in Table 10.

TABLE 10.—*Annual yields of green corn fodder (in tons per acre), average of three plots from unmanured land and from land given light and heavy dressings of manure, Umatilla Field Station, 1915 to 1925, inclusive*

[The application of manure, when shown, was made during the winter preceding the crop year]

Year	No manure (check plots)	Manure		Increased yield from—	
		Light application (48 tons)	Heavy application (192 tons)	Light application	Heavy application
	Tons	*Tons*	*Tons*	*Tons*	*Tons*
1915 (manure)	1.93	3.05	4.55	1.12	2.62
1916 (manure)	.62	1.98	3.40	1.36	2.78
1917 (manure)	.68	2.07	3.57	1.39	2.89
1918	.69	1.83	3.39	1.14	2.70
1919 (manure)	1.05	2.48	3.98	1.43	2.93
1920 (manure)	.29	1.20	1.36	.91	1.07
1921 (manure)	.30	1.67	2.91	1.37	2.61
1922	.68	2.40	4.86	1.72	4.18
1923	.47	1.89	3.48	1.42	3.01
1924	.36	1.42	2.38	1.06	2.02
1925	.76	1.85	3.62	1.09	2.86
Total				14.01	29.67
Average	.71	1.99	3.41	1.27	2.70

The average yield of fodder on the check plots without manure was 0.71 ton per acre, with the light application of manure 1.99 tons, and with the heavy application 3.41 tons. The total increased yield from the lightly manured plots was 14.01 tons, which was at the rate of 0.292 ton of corn fodder per ton of manure. The heavy application increased the yield 29.67 tons, or 0.155 ton of corn fodder per ton of manure.

The manure applied at the light rate gave higher yields per ton than when applied at the heavy rate for both alfalfa and corn. Since the increases in yields per ton of manure were practically the same for alfalfa and for corn, the manure was more valuable when applied to alfalfa than when applied to corn, because alfalfa has a higher feeding value than corn.

COMMERCIAL-FERTILIZER TESTS

Commercial fertilizers were applied to a field of alfalfa in the spring of 1922. The fertilizers applied included nitrate of soda, potash in both the sulphate and chloride forms, acid phosphate, and sulphur. The average production of air-dry alfalfa hay in tons per acre from the treated plots and the untreated check plots from 1922 to 1925, inclusive, is given in Table 11.

Although this test is not entirely conclusive on the subject of commercial fertilizers applied to alfalfa on the light soils of the project, so far as it goes it proves that the yields were not increased

by the use of fertilizers. The highest yielding plot was an untreated one, the next highest received sulphur, and the third was another untreated plot. Sulphur on the slightly heavier soil on the hill south of Hermiston, at Boardman, and at Stanfield has been followed by increased yields of alfalfa hay; but on lighter soil, such as that on which this experiment was conducted, it has not increased the yield.

TABLE 11.—*Four-year average yield of alfalfa hay, in air-dry tons per acre, on land treated with commercial fertilizers and on untreated check land on the Umatilla Field Station*

Plot No.	Treatment (pounds per acre)	Yield per acre (tons)	Plot No.	Treatment (pounds per acre)	Yield per acre (tons)
1	Nitrate of soda, 100	4.23	9	Untreated check	5.72
2	Nitrate of soda, 100; potassium sulphate, 160	4.543	10	Sulphur, 200	5.71
3	Untreated check	4.52	12	Nitrate of soda, 100; acid phosphate, 160	4.70
4	Potassium chloride, 160	5.00	13	Phosphate-potash-nitrate, 350	5.25
5	Acid phosphate, 320	5.34	14	Untreated check	5.66
6	Acid phosphate, 320; potassium chloride, 160	5.36		Average of untreated check plots	5.23
7	Untreated check	5.01		Average of treated plots	5.02
8	Calcium sulphate, 200	5.03			

STRIP-BORDER IRRIGATION EXPERIMENTS

The strip-border method of irrigation, which was first tried and recommended in the Northwestern States by the Umatilla Field Station, is very generally used on the Umatilla reclamation project and has resulted in materially better use of irrigation water. A number of experiments have been conducted to determine what length and what width of border are most economical of irrigation water. Some of these tests have been conducted for 10 years and all of them for 5 years or longer. With the results of this number of tests available, very accurate and definite conclusions can be reached. These tests were conducted on medium sandy soils of practically uniform texture. Table 12 is a summary of the water requirements for the season and for each irrigation and the yield in tons per acre and per acre-foot of water. In these experiments different lengths and widths of borders on both steep and flat lands were used. Steep land is considered to be that having a fall in excess of 3 feet per 100 feet of run.

In all instances the yields obtained in these tests from the flat land were much higher than those from steep land, largely because better stands and growth are obtained on flat land which is more thoroughly soaked and does not gully as does the steep land.

Experiments to ascertain the best length of run included, on steep land, borders 25 feet wide and from 90 to 210 feet long by 30-foot steps. On flat land the borders were 22 feet wide and 100, 175, and 250 feet long.

In the length experiment on steep land the borders 90, 120, and 150 feet long did not use excessive quantities of water, but the longer ones did. The yields did not vary materially from border to border. The duty of water as expressed in the yield per acre-foot was very low, mainly because of the low yields obtained. The yields per acre-foot were considerably better on the shorter runs than on the longer.

TABLE 12.—*Annual water requirement, average application, and yield of alfalfa hay, in tons per acre and tons per acre-foot of water applied, at the Umatilla Field Station*

Description of borders	Years covered	Average water requirement		Yields	
		Annual	Per application	Per acre	Per acre-foot of water
Length experiments:		*Acre-feet*	*Acre-inches*	*Tons*	*Tons*
Steep land—					
25 by 90 feet	5	3.93	3.60	2.37	0.60
25 by 120 feet	5	4.28	3.91	2.40	.56
25 by 150 feet	5	4.58	5.18	2.56	.56
25 by 180 feet	5	5.86	5.38	2.53	.43
25 by 210 feet	5	6.81	7.61	2.52	.37
Flat land—					
22 by 100 feet	10	4.53	4.18	4.69	1.04
22 by 175 feet	10	5.38	5.03	3.82	.71
22 by 250 feet	10	6.76	6.30	3.23	.48
Width experiments:					
Steep land—					
20 by 200 feet	5	4.10	3.88	1.92	.46
25 by 200 feet	5	5.23	4.81	2.09	.40
30 by 200 feet	5	5.16	4.68	1.78	.34
35 by 200 feet	5	6.78	6.11	2.54	.37
Flat land (1)—					
20 by 200 feet	5	4.97	4.40	3.27	.66
25 by 200 feet	5	5.70	5.19	3.35	.59
30 by 200 feet	5	5.99	5.46	3.47	.58
35 by 200 feet	5	5.65	5.09	4.08	.72
Flat land (2)—					
20 by 200 feet	9	3.78	4.36	3.60	.95
25 by 200 feet	9	3.79	4.37	4.04	1.07
30 by 200 feet	9	4.37	5.02	3.92	.90
35 by 200 feet	9	4.53	5.36	4.49	.99
40 by 200 feet	9	5.06	6.21	3.75	.74

The length experiment on the flat land required more water than would have been necessary had a larger head been available. The average head available for this test was 2.01 second-feet. The test serves, however, to bring out the relative water requirement. The 100-foot and 175-foot borders were fairly economical, but the 250-foot run was entirely too long.

The tests conducted to determine the most economical widths were in all instances on borders 200 feet long. Borders 20, 25, 30, and 35 feet wide were included on steep and on flat land, and the second flat-land test had in addition one border 40 feet wide.

The width experiment on steep land used the same head of water as the length tests discussed above. On this type of land the 20-foot border was very economical of water, and the 25-foot or 30-foot borders did not require excessive quantities. The water requirement of the 35-foot border was too high.

In the first test on flat land, the borders were of the same widths as in the test just discussed. Using the same head of water on this flat land made the water requirement higher than on the steep land, as it took longer to flood the borders. The yields were higher, however, so the duty of water as expressed by the yield per acre-foot was considerably higher. The 20-foot border in this test was the only economical one.

In the second experiment on flat land the average head of water available was 3.02 second-feet, so that excessive quantities of water were not required. This, combined with the higher yields of hay, made the yield per acre-foot the highest of any of the tests.

In general, it may be said that with heads of 3 or more second-feet of water on land not having excessive slopes, borders from 30 to 40 feet wide and from 150 to 200 feet long are the best sizes for sandy soils. If water were expensive or scarce, yields below 0.75 ton per acre-foot would not be profitable.

LYSIMETER INVESTIGATIONS

In order to study more closely than was possible under field conditions the moisture relations of the sandy soils and the effect of crops on these relations, four lysimeters were installed in 1915 and four more in 1917. These lysimeters, constructed of waterproof concrete, are 3.3 feet square and 6 feet deep. Soil was taken from the field in 6-inch layers and placed in the tanks in the same order and density. The percolating water is collected through a hole in the bottom of the tank.

Four of the lysimeters have medium sand, and in one each there is fine sand, coarse sand, silt, and silt loam. One of the medium-sand lysimeters is not cropped, one grows soy beans in the summer and vetch in the winter, and two have alfalfa, with manure applied to one of these. The others all grow alfalfa. The water applied includes the irrigation rate and the rainfall.

In all instances the lysimeters have been irrigated with enough water to maintain the crops in good condition. Lysimeters 1 to 6 have all been irrigated with practically the same quantities of water. Lysimeters 7 and 8 received these same quantities until 1922, but beginning with that year additional quantities were applied to start percolation. The water applied has averaged 58 to 60 inches on the lysimeters having sandy soils and until 1922 on those having silt. All the other lysimeters had given steady percolation previously. The water applied as irrigation and rainfall and lost by percolation as acre-inches and percentages is given in Table 13.

The highest rate of percolation was from lysimeter 1, without crop. For the 11-year period under consideration, of the 58.40 acre-inches applied, 41.10 inches, or 70 per cent of the irrigation, was lost by deep percolation. The soy-bean crop during the summer on lysimeter 2 did not use as much water as the alfalfa on 3 and 4, which had the same soil type. The percolation from lysimeter 2 was 25.25 acre-inches, or 43.5 per cent of the irrigation, while from 3, growing alfalfa, it was 10.78 acre-inches, or 19.1 per cent. When manure was applied, as on lysimeter 4, the percolation was further reduced to 8.90 acre-inches, or to 16 per cent. The percolation from the fine sand in lysimeter 5 was lower than from the medium sand, being 4.98 inches, or 8.7 per cent. The coarse-sand percolation was higher than from any of the others growing alfalfa. For the 11 years it averaged 15.15 acre-inches, or 25.52 per cent of the water applied. During the first five years that lysimeters 7 and 8 were used the application averaged 57 acre-inches. Although this quantity was sufficient to keep the crops growing vigorously, it was not enough to induce percolation; so, beginning in 1922, additional quantities were applied. During that year the 113 acre-inches applied was not enough to start percolation, but it did soak up the soils so that percolation started soon after the first irrigation water was applied in 1923. During the subsequent three years an average of 121.53 acre-inches

was applied, of which 13.29 acre-inches percolated from lysimeter 7 and 14.48 inches from 8. These quantities were 12 and 11.9 per cent, respectively, of the water applied during those years.

TABLE 13.—*Annual water application and percolation in lysimeter experiments with various types of soil and crop treatments on the Umatilla Field Station during the 11-year period from 1915 to 1925, inclusive*

Year	Lysimeters with medium sand and various crops											
	No. 1. No crop			No. 2. Soy beans and winter vetch			No. 3. Alfalfa			No. 4. Alfalfa, manured		
	Water applied	Percolation		Water applied	Percolation		Water applied	Percolation		Water applied	Percolation	
		Actual	Comparative		Actual	Comparative		Actual	Comparative		Actual	Comparative
	Acre-inches	*Acre-inches*	*Per cent*	*Acre-inches*	*Acre-inches*	*Per cent*	*Acre-inches*	*Acre-inches*	*Per cent*	*Acre-inches*	*Acre-inches*	*Per cent*
1915	38.57	25.20	65.3	38.57	18.83	48.8	38.57	12.98	33.6	38.57	13.32	34.5
1916	50.46	35.74	70.8	50.46	18.26	36.1	50.46	4.13	8.1	50.46	3.96	7.8
1917	53.83	39.74	73.8	54.83	22.15	40.3	53.83	16.53	30.7	53.83	11.32	21.0
1918	61.67	38.14	61.8	61.67	29.60	47.9	61.67	9.39	15.2	61.67	7.64	12.3
1919	60.33	37.19	61.7	60.33	28.09	46.6	60.33	8.33	13.8	60.33	5.66	9.4
1920	57.19	42.14	73.6	57.19	25.83	45.1	57.19	9.90	17.3	57.19	7.14	12.5
1921	61.38	41.37	67.3	61.38	25.33	41.3	61.38	7.54	12.2	61.38	5.67	9.2
1922	61.02	39.44	64.7	61.02	25.39	41.6	61.02	8.23	13.5	61.02	5.69	9.3
1923	72.65	59.89	82.4	72.65	31.15	42.9	72.65	9.13	12.6	72.65	9.59	13.2
1924	68.00	52.90	77.8	65.00	22.02	33.8	68.00	12.30	18.1	68.00	6.32	9.3
1925	57.34	40.34	70.4	57.34	31.13	54.3	57.34	20.14	35.1	57.34	21.54	37.6
Average	58.40	41.10	70.0	58.22	25.25	43.5	58.40	10.78	19.1	58.40	8.90	16.0

Year	Lysimeters with various soils and alfalfa crops											
	No. 5. Fine sand			No. 6. Coarse sand			No. 7. Silt			No. 8. Silt loam		
	Water applied	Percolation		Water applied	Percolation		Water applied	Percolation		Water applied	Percolation	
		Actual	Comparative		Actual	Comparative		Actual	Comparative		Actual	Comparative
	Acre-inches	*Acre-inches*	*Per cent*	*Acre-inches*	*Acre-inches*	*Per cent*	*Acre-inches*	*Acre-inches*	*Per cent*	*Acre-inches*	*Acre-inches*	*Per cent*
1917	43.34	5.84	13.4	43.34	12.99	29.9	42.34	-------	-------	45.34	-------	-------
1918	61.67	6.02	9.7	61.67	14.13	22.9	61.67	-------	-------	61.67	-------	-------
1919	60.33	3.85	6.3	60.33	10.76	17.8	60.33	-------	-------	60.33	-------	-------
1920	57.19	6.35	11.1	57.19	17.22	30.1	57.19	-------	-------	57.19	-------	-------
1921	61.38	1.50	2.4	61.38	15.15	24.7	61.38	-------	-------	61.38	-------	-------
1922	61.02	.62	1.0	61.02	10.30	16.9	113.03	-------	-------	113.02	-------	-------
1923	72.65	3.68	5.1	72.65	18.01	24.8	141.65	17.94	12.7	141.65	22.45	15.8
1924	68.00	2.65	3.9	68.00	11.99	17.6	134.00	3.28	2.4	134.00	9.73	7.3
1925	57.34	14.36	25.0	57.34	25.83	45.0	88.93	18.66	21.0	88.93	11.26	12.7
Average	60.32	4.98	8.7	60.32	15.15	25.52	84.50	13.29	12.0	84.83	14.48	11.9

LAMB-FEEDING EXPERIMENTS

During each of the three winters 1922–23, 1923–24, and 1924–25 a carload of lambs was fattened at the station. The primary object of these tests was to ascertain the practicability of marketing hay, under project conditions, by feeding it to lambs. The secondary object in one instance was to determine the relative value of corn, wheat, oats, and barley as grain supplements to alfalfa for fattening

lambs, and in the other instances to ascertain the best rate of feeding grain and the best means of carrying lambs preliminary to the fattening period, so as to put them on the late winter market. The 15-year average increase in the price of lambs since the North Portland stockyards were established has been 52 cents a month per 100 pounds during five months in the winter. A view of the lamb-feeding lots at the station is shown in Figure 3.

In these tests, average-quality cross-bred lambs, the result of crossing Hampshire or Lincoln bucks on fine-wool ewes, were used. All the grain fed was whole and all the hay was long. Approximately equal quantities of each cutting of hay went to each lot of lambs, so the kind of hay was not a factor in the results. Each lot contained 50 lambs at the beginning of the tests, but in some instances lambs died during the feeding period. The results given here are for the

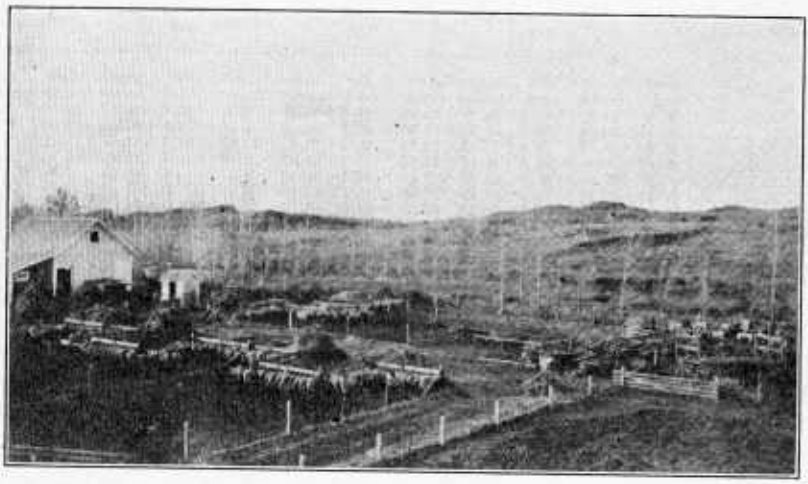

FIG. 3.—General view of the lamb-feeding lots at the Umatilla Field Station

lambs which actually completed the feeding tests. Table 14 is a summary of average results after lamb-feeding experiments with corn, wheat, oats, and barley during the winter of 1922–23.

TABLE 14.—*Comparative per head results of feeding corn, wheat, oats, and barley for fattening lambs in lots of 50 head each at the Umatilla Field Station during the winter of 1922–23*

Items of comparison	Corn	Wheat	Oats	Barley
Number of days fed	99	99	99	99
Total grain per head—pounds	94	94	94	94
Initial weight—do	52.4	51.5	52.1	48.9
Final weight—do	88.6	86.0	85.0	82.0
Total gain—do	36.2	34.5	32.9	33.1
Gain per day—do	.366	.348	.332	.334
Hay offered per day—do	3.32	3.19	2.92	3.00
Hay refused—per cent	27.1	25.4	27.1	27.7
Grain per day—pounds	.95	.95	.95	.95
Hay offered per 100 pounds of gain—do	907	915	878	897
Grain offered per 100 pounds of gain—do	259	272	285	283

This test was conducted for 99 days, during which time the lambs were fed all the hay they would clean up and 94 pounds of grain per

head, a daily average of 0.95 pound. These lambs were rather small at the beginning of the trial, having an average weight of approximately 51 pounds. They made very good gains, however.

The corn-fed lot made a total gain of 36.2 pounds per head, which was a daily gain of 0.366 pound. The next highest gain, 34.5 pounds total or 0.348 pound daily, was made by the lambs in the wheat lot. The lots fed oats and barley made practically equal gains. The hay offered per day to the corn-fed lambs was slightly the highest, with the lambs fed wheat, barley, and oats following in the order mentioned. The percentage of hay refused by the lambs was rather high. This was probably due to inexperience in feeding. The lambs fed corn, oats, and barley wasted practically the same percentage and slightly more than those fed wheat. Neither the quantity of hay nor of grain required for 100 pounds gain varied greatly with the different feeds. The corn and wheat lots required more hay than the oats and barley lots, but the grain requirements were the reverse. Taking barley as a standard, the corn was worth 8 per cent more, wheat 3 per cent less, and oats practically equal to barley. The finish was best and practically equal for the corn and wheat lots. They were better than the barley-fed lots, and the oats lot was poorest. The differences in finish, however, were not sufficient to cause a discrimination in prices on the Portland market.

TABLE 15.—*Results per head from feeding lambs 75 pounds each of barley at varying rates per day and from feeding alfalfa hay and pasturing during the preliminary periods at the Umatilla Field Station during the winter of 1923–24*

Items of comparison	Lot 1, 0.55 pound grain for entire time	Lot 2, no grain first 34 days, 0.73 pound grain last 102 days	Lot 3, no grain first 57 days, 0.95 pound grain last 79 days	Lot 4, no grain first 78 days, 1.29 pounds grain last 58 days	Lot 5, pasture first 57 days, 0.95 pound grain last 79 days
Period of hay or pasture alone:					
Number of days fed	----------	34	57	78	57
Initial weight, pounds	----------	60.2	60.8	60.3	60
Final weight, do	----------	62.7	65.2	64.7	67.3
Total gain, do	----------	2.5	4.4	4.4	7.3
Daily gain, do	----------	0.073	0.077	0.056	0.128
Hay offered per day, do	----------	2.15	2.56	2.57	----------
Hay refused, per cent	----------	16.3	13.4	10.3	----------
Hay offered per 100 pounds gain, pounds	----------	2,928	3,330	4,550	----------
Period of hay and grain:					
Number of days fed	136	102	79	58	79
Total grain per head, pounds	75	75	75	75	75
Daily grain, do	0.55	0.73	0.95	1.29	0.95
Initial weight, do	59.6	62.7	65.2	64.7	67.3
Final weight, do	85.9	86.5	91.4	88.2	90.2
Total gain, do	26.3	23.8	26.2	23.5	22.9
Daily gain, do	0.193	0.233	0.332	0.405	0.289
Hay offered per day, do	2.67	2.94	2.55	2.36	2.67
Hay refused, per cent	14.5	14.8	19.7	23.7	20.1
Hay offered per 100 pounds gain, pounds	1,382	1,259	769	582	922
Grain per 100 pounds gain, do	285	315	286	319	327
Both periods:					
Number of days fed	136	136	136	136	136
Total grain per head, pounds	75	75	75	75	75
Initial weight, do	59.6	60.2	60.8	60.3	60
Final weight, do	85.9	86.5	91.4	88.2	90.2
Total gain, do	26.3	26.3	30.6	27.9	30.2
Daily gain, do	0.193	0.193	0.225	0.205	0.222
Hay offered per day, do	2.67	2.74	2.55	2.48	1.55
Hay refused, per cent	14.5	15.1	17	15.8	20.1
Hay offered per 100 pounds gain, pounds	1,382	1,417	1,135	1,207	785
Grain per 100 pounds gain, do	285	285	245	269	248

The conclusion from this test is that the feeding value of the grains tested, when they were fed with good quality alfalfa hay, was practically equal. The choice of these feeds to be used would be governed by their prices.

The results of two winters' tests on methods of carrying lambs preliminary to feeding grain and the rate of feeding grain are given in Tables 15 and 16.

TABLE 16.—*Results per head from feeding lambs 75 pounds each of barley at varying rates per day and from feeding alfalfa hay during the preliminary periods at the Umatilla Field Station during the winter of 1924–25*

Items of comparison	Lot 1, 0.55 pound grain daily for 150 days	Lot 2, no grain first 48 days, 0.74 pound grain last 102 days	Lot 3, no grain first 74 days, 0.99 pound grain last 76 days	Lot 4, no grain first 96 days, 1.39 pounds grain last 54 days	Lot 6, shelter; no grain first 44 days, 0.99 pound grain daily for last 76 days
Period of hay alone:					
Number of days fed		48	74	96	44
Initial weight—pounds		61.4	61.4	61.7	62.9
Final weight—do		64.6	64.1	64.9	64.5
Total gain—do		3.2	2.7	3.2	1.6
Daily gain—do		0.067	0.036	0.033	0.036
Hay offered per day—do		2.99	2.79	2.70	3.03
Hay refused—per cent		21.1	13	11.5	9.1
Hay offered per 100 pounds gain—pounds		4,618	7,436	8,475	8,375
Period of grain alone:					
Number of days fed	150	102	76	54	76
Total grain—pounds	75	75	75	75	75
Daily grain—do	0.5	0.74	0.99	1.39	0.99
Initial weight—do	62.2	64.6	64.1	64.9	64.5
Final weight—do	85.6	88.5	89.2	84.8	85.8
Total gain—do	23.4	23.9	25.1	19.9	21.3
Daily gain—do	0.156	0.234	0.330	0.369	0.281
Hay offered per day—do	2.66	2.45	2.33	1.91	2.36
Hay refused—per cent	14.6	13.3	18.5	30.6	20.2
Hay offered per 100 pounds gain—pounds	1,699	1,040	757	520	840
Grain per 100 pounds gain—do	320	314	299	377	352
Both periods:					
Number of days fed	150	150	150	150	120
Total grain per head—pounds	75	75	75	75	75
Initial weight—do	62.2	61.4	61.4	61.7	62.9
Final weight—do	85.6	88.5	89.2	84.8	85.8
Total gain—do	23.4	27.1	27.8	23.1	22.9
Daily gain—do	0.156	0.181	0.185	0.154	0.191
Hay offered per day—do	2.66	2.62	2.56	2.42	2.61
Hay refused—per cent	14.6	16.1	15.5	16.1	15.4
Hay offered per 100 pounds gain—pounds	1,699	1,450	1,401	1,596	1,372
Grain per 100 pounds gain—do	320	277	274	329	329

In the first trial the lambs were carried on feed for 136 days and in the second test for 150 days. During this time they were fed 75 pounds of grain at varying rates. In all instances, except during the preliminary period when lot 5 in the 1924–25 test was on pasture, the lambs had all the alfalfa hay they would clean up. The plans called for feeding hay alone until time required to feed 75 pounds of grain per head was reached, so that all lambs finished feed together. The planned rates of feeding grain were: Lots 1, 0.5 pound per day per head; lots 2, 0.75 pound per day; lots 3, 1 pound per day; lots 4, 1.5 pounds per day; but because of the necessity of starting them on grain gradually, neither the exact number of days nor the exact rate of feeding could be governed, though the total quantity of grain was the same.

In the 1923–24 trials the lambs in lot 1 received grain at the rate of 0.55 pound per head for the entire 136 days. Lot 2 had no grain during the first 34 days and grain at the rate of 0.73 pound per head for 102 days. Lot 3 had no grain for the first 57 days and 0.95 pound per head for the last 79 days. Lot 4 had hay alone for 78 days and 1.29 pounds of grain per head for 58 days. Lot 5 was run on alfalfa pasture for 57 days and received grain at the same rate as lot 3, 0.95 pound per head per day for 79 days. The initial weights were almost equal at the beginning of the test.

In 1924–25, lot 1 received grain at the rate of 0.55 pound per day per head for the entire 150 days. Lot 2 was fed hay alone for 48 days and grain at the rate of 0.74 pound per head for 102 days. Lot 3 received hay only during the first 74 days and 0.99 pound of grain per head during the last 76 days. Lot 4 was on hay alone for 96 days and received 1.39 pounds of grain per head for 54 days. Lot 6 was used to try the value of shelter, which consisted of a lean-to shed of poles and straw roof with tight back and open front. This lot was fed hay alone for 44 days and grain at the same rate as lot 3, 0.99 pound per day per head, during the 76 days of the grain period.

The lambs made very small gains when carried on hay alone. The length of time that the lambs were fed hay apparently had little effect on the amount of gain. The monthly weights, in fact, showed that the lots fed longest on hay lost some weight during the latter part of the period. The lot on pasture gained 7.3 pounds per head. This feed was cheaper than hay, so that considering the difference in gain, it was much the most profitable method of carrying the lambs. The hay costs per 100 pounds of gain were extremely large, the quantity of hay required being from 2,928 to 8,475 pounds. These figures were considerably higher for the 1924–25 tests than for the previous one, no doubt on account of the longer time which the lambs were on hay alone. These costs were paid by the increase in the price of the lambs as a result of getting them on the late market.

When the hay and grain periods are considered, the lambs all made roughly the same total pounds of gain, with the exception of lot 4 in the second test. The reason for this is not positively known, but it is believed to be a variation no larger than is to be expected from year to year. The gains per day increase directly with the quantity of grain fed. The hay offered was practically equal for the lighter feeds and decreased little for the heavier feeds. The percentage of hay refused increased directly as the rate of grain fed. The hay costs per 100 pounds of gain were inversely proportional to the quantity of grain fed. The grain costs show considerable variation between the different lots and the two tests.

During the entire feeding period the two lots which received approximately 1 pound of grain made the largest total gain and the best average daily gain, although the lots all gained very similarly. Little difference in the hay offered or the percentage refused is noticed when the entire feeding period is considered. The test with the shelter does not show great advantage from it.

Since the problem of the project farmer is one of marketing hay, these long feeding periods are to be preferred rather than shorter periods, because the lambs consume relatively more hay and less grain than would be the case if the lambs were fed rapidly on heavy grain rations, as was done for the grain periods of lots 4, for instance.

Feeding grain means a cash outlay by the farmer. The conclusions reached from this test are that the increase in the price of fat lambs during the winter months will pay for the hay required to carry the lambs prior to grain feeding, so that they can be put on the late market, and that this is an entirely practicable method of marketing hay.

WEEDS AND PESTS

The most serious weed pest, sand bur (*Cenchrus tribuloides*), appears to be spreading rapidly. It occurs along ditch banks and in waste places, and where the stand of alfalfa is thin it becomes a menace in alfalfa fields. It is extremely persistent and, besides being detrimental to stock, makes the handling of hay very unpleasant. It may be controlled by close pasturing or by growing cultivated crops. Spring-tooth harrowing between crops of alfalfa does not control it in hay fields. Harrowing at that time kills out the pigeon grass but not the sand bur, which grows much more rank where it does not have competition from the pigeon grass.

Cheat grass (*Bromus tectorum*) is detrimental to the first crop of hay, but it can be successfully controlled by spring-tooth harrowing early in the spring, preferably during windy weather, which dries out the exposed roots, followed by another harrowing just as the alfalfa starts to grow. If this second harrowing is with a spiketooth, it will give better results than if a spring tooth is used, and in addition the ground will be left smoother for the first irrigation.

During the period covered by this report an alfalfa eelworm was discovered on the project. This was the first time this pest was found on alfalfa in this country, and it was at first supposed to be present on this project only; but subsequent search has shown that it occurs in a number of alfalfa-growing regions of the West. It is not doing any particular damage.

HIGHWAY TREES

At the request of the Oregon State Highway Commission, assistance has been given in growing trees for planting along the Old Oregon Trail. During 1925 approximately 1,000 locust and ailanthus sprouts, which had been dug from along windbreaks on the project but which were too small for road planting, were grown in the tree nursery. These trees are ready for planting in 1926. In addition 8,000 ailanthus trees were grown from seed for planting in 1927. Ailanthus trees have been grown for many years in the dry country west of Hermiston with no moisture besides the natural rainfall, and it is believed that they will make fine trees for highway planting through the desert when they are once established. Provision is made for watering the trees for the first two or three years from tank trucks.

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