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WORK OF THE UMATILLA RECLAMATION PROJECT EXPERIMENT FARM IN 1920, 1921, AND 1922[1]

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CONTENTS

CONDITIONS ON THE PROJECT

The Umatilla project of the United States Reclamation Service is located along the Columbia River in north-central Oregon. The irrigable area in 1922 was 28,300 acres, of which 13,273 acres were irrigated. There were 558 farms under cultivation, having a total irrigable area of 19,227 acres.

The Umatilla Reclamation Project Experiment Farm, which was established in 1909, is jointly maintained by the Office of Western Irrigation Agriculture of the United States Department of Agriculture and the Oregon Agricultural Experiment Station. The work of the farm has to do with the establishment of permanent and profitable agriculture on sandy soils under irrigation.

THE PROGRESS OF AGRICULTURAL DEVELOPMENT

During the settlement period of the project, on account of a lack of knowledge as to the most profitable type of agriculture a large number of crops were grown. Almost every possible crop has been

[1] The Umatilla Experiment Farm 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 The farm contains 40 acres of land withdrawn from entry in 1908 by the Department of the Interior for use as an experiment farm.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 Service 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. 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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tried at one time or another by the farmers. The experiment farm has tested a large number of crops and is continuing to test crops which may be promising.

It was thought at first that the horticultural industries would predominate, but on account of extremely low winter temperatures, such as prevailed during the winters of 1915–16, 1919–20, and 1921–22, the trees have been badly damaged, and spring frosts have also seriously reduced the fruit crops. As a result, orchard fruits have been found unprofitable except in certain small areas. During recent years, and especially during the period covered by this report, the tendency has been to specialize on a few crops which have proved profitable and to feed these crops to livestock on the farms.

TABLE 1.—*Farm values per acre of crops produced on the Umatilla Reclamation Project from 1914 to 1921, inclusive*

NR.=no report; F.=crop failure. The data in this table and those that follow concerning the crops and the livestock on the project have been furnished by the United States Reclamation Service]

Year	Alfalfa		Apples	Barley	Corn		Small fruits	Garden	Peaches	Potatoes	Wheat
	Hay	Seed			Grain	Fodder					
1914	$29.34	NR.	$9.28	NR.	$29.83	$10.30	$64.51	$122.44	$6.62	$81.43	$37.89
1915	30.78	NR.	6.13	$15.83	31.81	13.84	50.12	94.59	14.83	65.57	23.11
1916	36.70	$45.46	34.06	NR.	27.31	14.62	38.51	135.37	F.	72.57	NR.
1917	56.32	31.63	39.86	15.00	56.89	42.09	85.82	133.20	36.84	110.19	35.00
1918	64.48	54.30	7.95	15.77	38.87	47.91	55.09	98.05	10.32	89.73	32.16
1919	70.66	46.40	116.74	68.24	42.40	50.62	134.46	110.05	131.02	110.90	27.05
1920	51.72	67.12	23.56	50.75	40.42	38.58	94.77	154.69	F.	177.75	26.40
1921	25.42	32.50	60.17	18.30	21.25	32.97	110.78	102.29	83.47	91.23	12.63
1922	37.52	48.59	23.04	26.03	31.24	47.51	103.66	112.24	50.17	76.09	29.59
Average	44.77	46.57	35.64	29.99	35.56	33.16	81.97	118.19	37.03	97.27	28.01

Table 1 includes the farm values per acre, as reported by the farmers in the annual crop census of the Reclamation Service, of crops of which the larger areas have been grown. The largest returns have been obtained from gardens, small fruits, and potatoes. A small garden well tended is a profitable investment on any farm. Small fruits are being successfully grown on the slope south of Hermiston and along the Columbia River. Potatoes do well under certain limiting conditions where the moisture may be controlled so as to be uniform. The returns from apples and peaches have been too low to warrant continuing their cultivation except on favorable areas. The crop value for alfalfa seed averages slightly higher than for alfalfa hay, and the seed-growing acreage could be profitably extended, especially on the sandier areas. The small grains, as represented by barley and wheat, work into rotations fairly well on the finer soils, but should not be grown on the medium and coarse soils. Corn and corn fodder when used for silage do not show as large returns as alfalfa, but they are profitable crops because they fit into rotations well and can be grown on most soils.

ALFALFA PRODUCTION

Alfalfa has always been and probably will continue to be the basic crop in the agricultural scheme of the project.

Table 2 gives the acreage of all crops, the alfalfa acreage, the tonnage of alfalfa, and the value of all crops and alfalfa from 1911 to 1922, inclusive. The acreage of alfalfa on the project has increased

more rapidly than the total acreage, so that its percentage has shown an almost constant increase. The percentage for 1922, however, decreased slightly. The total tonnage has increased gradually, while the yield per acre has remained nearly uniform, averaging 3.7 tons for the 12-year period.

TABLE 2.—*Summarized comparison, showing the importance of the alfalfa crop on the Umatilla Reclamation Project during the 12-year period from 1911 to 1922, inclusive*

Year	Acreage			Alfalfa yield (tons)		Farm values					
							Per acre		Total		
	All crops	Alfalfa	Percentage of alfalfa	Total	Average per acre	Alfalfa per ton	All crops	Alfalfa	All crops	Alfalfa	Percentage of alfalfa
1911	2,775	1,765	63.6	5,825	3.3	$8.00	$21.19	$26.40	$58,795	$46,600	79.3
1912	3,218	2,442	75.9	8,388	3.4	7.00	23.99	24.03	77,194	58,716	76.1
1913	3,033	2,024	66.7	8,010	3.9	8.00	27.72	31.66	84,078	64,080	76.2
1914	3,013	2,048	68.0	7,511	3.7	8.00	29.41	29.34	88,613	60,088	67.8
1915	3,603	2,396	66.5	9,141	3.8	8.07	29.04	30.78	104,653	73,767	74.3
1916	3,900	2,985	76.5	11,412	3.8	9.60	35.84	36.70	139,800	109,555	78.4
1917	5,546	4,047	73.0	14,834	3.7	15.37	56.15	56.32	311,395	227,940	89.2
1918	6,819	5,274	77.4	19,063	3.6	17.84	58.75	64.48	400,642	340,083	84.9
1919	8,464	6,837	80.7	25,836	3.8	18.70	74.83	70.66	633,380	483,133	76.4
1920	10,188	8,512	83.8	32,110	3.8	13.71	50.99	51.72	519,468	440,228	84.8
1921	11,610	9,824	84.7	36,355	3.7	6.87	29.62	25.42	343,888	249,758	72.1
1922	12,391	10,367	83.6	39,094	3.8	9.95	39.24	37.52	486,258	388,985	79.9
Average			75.0		3.7						78.3

The farm value of alfalfa is very near the value of all crops, since it largely determines the average value. The total value of alfalfa has varied from 67.8 to 89.2 per cent of the value of all crops. The average for the past five years has been 79.6 per cent. A large part of the alfalfa has been shipped from the project. During the year 1922 the shipments were 1,244 cars, which averaged 15 tons, amounting to 18,660 tons. The annual shipments for the past four years have averaged 44.9 per cent of the production.

LIVESTOCK INDUSTRIES

The results of the livestock census show rather pronounced tendencies toward stabilizing the agriculture with livestock to consume the crop produced.

TABLE 3.—*Number and value of livestock and value of equipment owned on the Umatilla Reclamation Project at the close of the years 1920, 1921, and 1922*

Stock	1920		1921		1922	
	Number	Total value	Number	Total value	Number	Total value
Horses	1,098	$99,720	1,212	$97,796	1,134	$94,610
Mules	31	3,525	47	5,490	44	4,400
Cattle:						
Dairy	1,162	93,041	1,332	109,077	2,293	164,775
Beef	51	5,150	96	8,175	94	8,210
Sheep	1,626	13,919	3,340	18,136	3,544	27,714
Hogs	1,567	32,609	1,356	24,693	2,812	36,415
Fowls	19,078	19,650	20,063	19,862	26,015	26,275
Bees (hives)	2,663	23,834	3,161	23,739	3,369	27,693
Total		291,448		306,968		390,092

Table 3 gives the numbers of stock on farms at the close of the years 1920, 1921, and 1922. The dairy cattle show an increase of 170 head during 1921 and 961 during 1922. The large increase in 1922 reflects very definitely the renewed interest in dairying as a means of utilizing alfalfa hay. This increase was partly due to cows being imported and partly to saving more of the heifer calves. The immediate cause was probably the low price of hay. The quality of the dairy stock has been greatly improved by the use of purebred sires, mostly owned by a local bull association. Another indication of the development of rational agriculture was an increase of 1,456 head of swine during the year. The increase of 5,952 fowls was largely due to the establishment of several large commercial flocks rather than an increase on all farms.

Table 4 represents the livestock situation by bringing out the relation between the acreage of alfalfa and the numbers of dairy cattle and hogs per farm. The number of acres of alfalfa and the number of dairy cattle have gradually increased from 1914 to 1922, but the acres of alfalfa per dairy animal have varied considerably. During 1914 and 1915 there were 3.2 and 3.1 acres of hay land for each dairy animal, but the high prices received for hay from 1915 to 1920 caused many farmers to sell their cows, with the result that the area of alfalfa increased to more than 7 acres per head, but the increase in the cows in 1922 brought the ratio down to 4.5 acres per head. The dairy-cow population per farm varied from 2 to 2.5 animals until 1922, when it increased to 4.1. In 1914 and 1915 there were more hogs per farm than at any time since, but the increase from 2.5 hogs per farm in 1921 to 5 hogs per farm in 1922 is encouraging.

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 1922, inclusive*

Year	Number of farms	Acres of alfalfa	Number of dairy cattle	Acres of alfalfa per head	Cattle per farm	Number of hogs	Hogs per farm
1914	311	2,048	641	3.2	2.0	2,185	7.0
1915	306	2,397	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

CLIMATIC CONDITIONS

The climatic conditions of the Umatilla project are typical of the semiarid region of the Northwestern States except that the temperatures are slightly higher on account of the lower altitude.

Table 5 is a summary of the meteorological observations from 1912 to 1921 and the observations for 1922. Climatic conditions for the period of this report were not unusual except for the excessively low temperatures during December, 1919, when a minimum temperature of −36° F. was recorded.

TABLE 5.—*Summary of meteorological observations at the Umatilla Experiment Farm during the 10-year period from 1912 to 1921, inclusive, with observations for 1922 and frost data at Hermiston, Oreg., for the 14-year period from 1906 to 1922, inclusive*

PRECIPITATION (INCHES)

Year, etc.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Average:													
1912 to 1921	1.30	1.05	0.51	0.75	0.79	0.61	0.18	0.43	0.33	0.58	1.26	1.00	8.79
1922	.89	.69	1.21	.42	.15	.41	0	.45	.45	.45	.56	1.43	7.11

EVAPORATION (INCHES)

Average:													
1912 to 1921	------	------	------	3.92	5.35	7.33	8.48	6.69	4.28	2.60	------	------	38.65
1922	------	------	------	4.06	5.56	8.07	8.45	5.94	4.94	1.97	------	------	38.99

DAILY WIND VELOCITY (MILES PER HOUR)

Highest:													
1912 to 1921	15.3	13.0	16.9	15.7	12.0	14.5	12.1	13.7	11.1	12.3	14.8	16.2	16.9
1922	2.6	4.5	7.5	9.3	6.7	5.5	8.9	6.5	5.3	5.1	4.7	5.4	9.5
Lowest:													
1912 to 1921	0	.1	.1	.2	0	0	.1	.1	.1	0	0	.1	0
1922	.3	.1	.4	1.0	.1	.8	.3	.3	.4	.1	.1	.5	.1
Mean:													
1912 to 1921	2.7	2.7	4.1	4.4	4.2	4.0	3.6	2.6	2.5	2.3	1.8	2.8	3.1
1922	1.3	2.0	3.5	4.7	2.9	2.1	2.7	1.8	2.0	1.5	1.2	2.1	2.3

TEMPERATURE (° F.)

Absolute maximum:													
1912–1921	67	68	75	86	91	103	110	104	96	89	69	70	110
1922	46	59	67	78	90	100	107	99	96	79	60	60	107
Absolute minimum:													
1912–1921	−27	−6	6	17	27	34	39	38	27	17	1	−36	−36
1922	−28	11	18	23	30	43	48	44	35	21	14	−10	−28
Mean:													
1912–1921	32	36	44	51	58	67	73	72	61	52	40	32	51
1922	19	33	42	46	58	71	76	72	65	53	37	28	50

KILLING FROSTS AT HERMISTON, OREG., 1909 TO 1922, 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	138
1917	May 2	31	Oct. 17	22	168
1918	May 25	29	Oct. 8	31	136
1919	May 7	27	Sept. 29	27	144
1920	May 12	29	Oct. 17	27	158
1921	Apr. 30	30	Sept. 12	26	135
1922	May 9	24	Oct. 28	27	172

The average annual precipitation for the 10-year period was 8.79 inches, and the evaporation from a free water surface from April to October, both inclusive, averaged 38.65 inches. No excessively high winds were recorded, and the 1922 mean was below the average mean of 3.1 miles per hour. Maximum temperatures of 110° F. were reached in both 1920 and 1921, which sets new maximum records. The annual average mean was 51° F.

CROPS PRODUCED IN 1920, 1921, AND 1922

Table 6 gives the acreage, yields, and value of crops produced in 1920, 1921, and 1922. The increase in the acreage of crops during 1920 and 1921 was at approximately the same rate as during previous years, but during 1922 the increase was slightly over half of the normal. The decrease in the apple acreage was due to taking out unprofitable orchards.

TABLE 6.—*Acreage, yields, and farm values of crops produced on the Umatilla Reclamation Project in 1920, 1921, and 1922*

Year and crop	Area (acres)	Unit of yield	Yields		Values		
			Total	Average per acre	Per unit of yield	Total	Per acre
1920							
Alfalfa	8,512	Ton	32,110	3.78	13.71	$440,228	$51.72
Alfalfa seed	34	Bushel	106	3.12	21.52	2,282	67.12
Apples	652	Pound	374,690		.041	15,362	23.56
Barley	8	Bushel	350		1.16	406	50.75
Corn, Indian	124	do	3,740	30.2	1.34	5,012	40.42
Corn fodder	100	Ton	601	6.0	6.42	3,858	38.58
Fruits, small	30					2,843	94.77
Garden	143					22,120	154.69
Hay	333	Ton	335		11.81	3,956	11.88
Pasture	422					12,722	30.15
Peaches	50	[Failure]					
Pears	7	do					
Potatoes	48	Bushel	4,203	87.6	2.03	8,532	177.75
Prunes	2	Pound	6,660		.05	333	166.50
Rye	10	Bushel	110	11.0	1.60	176	17.60
Wheat	20	do	240	12.0	2.20	528	26.40
Miscellaneous	33					1,110	
Less duplications	340						
Total cropped	10,188						
Total or average						519,468	50.99
1921							
Alfalfa	9,824	Ton	36,355	3.7	6.87	249,759	25.52
Alfalfa seed	89	Bushel	241	2.7	12.00	2,892	32.50
Apples	614	Pound	1,055,630	1,719.0	.035	36,947	60.17
Barley	34	Bushel	902	26.5	.69	622	18.30
Corn, Indian	116	do	3,006	25.9	.82	2,465	21.25
Corn fodder	62	Ton	375	6.0	5.45	2,044	32.97
Fruits, small	41					4,542	110.78
Garden	195					19,946	102.29
Hay	155	Ton	191	1.2	8.10	1,547	9.98
Pasture	519					8,125	15.66
Peaches	38	Pound	59,840	1,575.0	.053	3,172	83.47
Pears	9	do	21,500	2,389.0	.05	1,075	119.44
Potatoes	83	Bushel	6,417	77.3	1.18	7,572	91.23
Prunes	13	Pound	14,500	1,115.0	.05	725	55.77
Rye	25	Bushel	200	8.0	1.00	200	8.00
Wheat	45	do	520	11.6	1.12	582	12.93
Miscellaneous	39					1,673	42.90
Less duplications	291						
Total cropped	11,610						
Total or average						343,888	29.62
1922							
Alfalfa	10,367	Ton	39,094	3.8	9.95	388,985	37.52
Alfalfa seed	70	Bushel	239	3.4	14.23	3,402	48.59
Apples	586	Pound	587,100	1,002.0	.023	13,503	23.04
Apricots	5	do	12,900	2,580.0	.055	710	142.00
Barley	60	Bushel	1,775	29.6	.88	1,562	26.03
Clover hay	10	Ton	30	3.0	10.00	300	30.00
Corn, Indian	123	Bushel	4,468	36.3	.86	3,842	31.24
Corn fodder	61	Ton	524	8.6	5.53	2,898	47.51
Fruits, small	64					6,634	103.66
Garden	234					26,265	112.24
Hay	73	Ton	110	1.5	11.00	1,210	16.58
Oats	2	Bushel	100	50.0	.60	60	30.00
Pasture	732					18,167	24.82
Peaches	35	Pound	46,225	1,321.0	.038	1,756	50.17
Pears	7	do	1,000	143.0	.05	50	7.14
Potatoes	176	Bushel	19,131	108.7	.70	13,392	76.09
Prunes	13	Pound	10,400	800.0	.04	416	32.00
Wheat	64	Bushel	1,894	29.6	1.00	1,894	29.59
Miscellaneous	24					1,213	50.54
Less duplications	315						
Total cropped	12,391						
Total or average						486,258	39.24

The yields reported do not vary materially from those of previous years. The total value of crops and the value per acre in 1921 were low, owing not to decreased production but to the general agricultural depression.

WEEDS, INSECT PESTS, AND ANIMAL DISEASES

Under the new State hay grades for Oregon neither Choice nor No. 1 alfalfa hay may contain more than one-half of 1 per cent by weight of harsh-bearded grasses. Cheat-grass (*Bromus tectorum*) continues to be the most serious weed in alfalfa and is classified as a harsh-bearded grass. On the station farm it has been found possible to keep the weed below this limit by thorough spring-tooth harrowing in the early spring, preferably during windy weather, which dries out the exposed roots, and following with another harrowing where the grass is especially bad just as the alfalfa begins to grow. So-called foxtail, or wild barley (*Hordeum jubatum*), which is also classified as a harsh-bearded grass, is prevalent on limited areas and should be given careful attention so that it does not spread. It can be controlled by cultivating and cutting and burning before the seeds form. A new weed which is becoming serious is sandbur (*Cenchrus tribuloides*). It is usually found along ditch banks and on the edges of cultivated fields, but is also found occasionally in thin stands of alfalfa. Sandbur should be hoed out, removed from the fields, and burned before the seeds (burs) form.

Dodder (*Cuscuta epithymum*) is becoming more common each year and is serious in the alfalfa fields producing seed. It usually does not become serious in hayfields, which are cut more frequently, but patches which do not disappear should be cut early and burned to prevent spreading. A field known to have dodder should not be used for seed production, and careful inspection should be made during the season to remove any infected plants. Samples of all alfalfa seed should be sent to the Seed Laboratory, Corvallis, Oreg., for examination.

The codling-moth pest has been very serious during the past two seasons and has caused a large percentage of wormy apples, especially in orchards having light crops where the owners did not feel that spraying was justified.

An outbreak of hog cholera in the fall of 1922 wiped out one herd of purebred hogs and did very serious damage in another herd before it was stopped. A few hogs in other herds died, but the disease was finally controlled by vaccination.

Contagious abortion is present in a large percentage of the dairy herds on the project. The Oregon experiment station is attempting to eradicate it on a community basis in the Columbia district by frequent testing of the cows and isolation or by disposing of the reacting animals. The dairymen of the district are cooperating splendidly and making an honest attempt to clean up the area.

CROP EXPERIMENTS

The results of the work of the Umatilla Experiment Farm dealt with in this circular bear mainly on the irrigation and soil-fertility experiments, but also include variety tests of corn and pasture grasses

and summaries of orchard-cultivation experiments. The principal problems worked on during the past two years were irrigation experiments with borders, varying intervals of irrigation and quantities of water, lysimeter investigations, rotation experiments with manure and commercial fertilizers, variety tests of corn and pasture grasses, and tests of miscellaneous field crops.

Figures 1, 2, and 3 show the location of crops grown during 1920, 1921, and 1922.

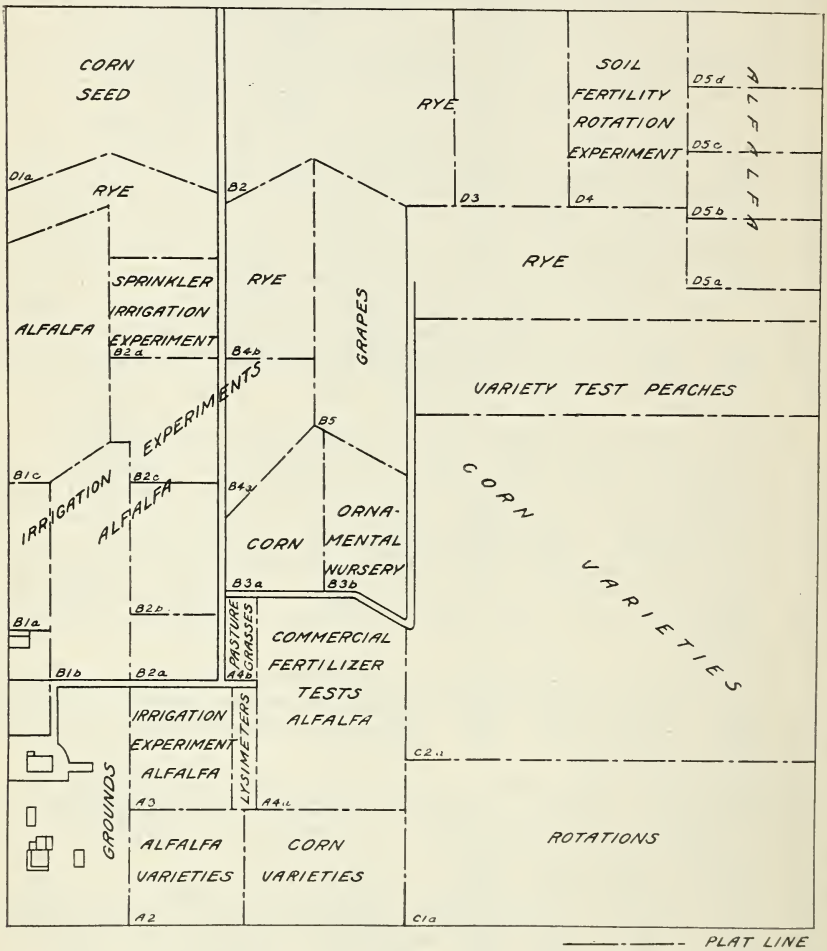

FIG. 1.—Diagram of the Umatilla Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1920

HOG-FEEDING EXPERIMENTS

Twenty head of purebred Duroc pigs were used in the feeding tests during 1921. These pigs were divided into three uniform lots. Lot 1, containing seven pigs, was placed in a pasture of 0.218 acre and fed during the growing period a 2 per cent ration of barley and middlings. During the finishing period they were fed a 4 per cent ration of

cracked corn, middlings, and tankage mixed at the rate of corn 5 parts, middlings 1 part, and tankage one-half part. The pigs used in lot 1 are shown in Figure 4.

Lot 2 consisted of eight pigs on a ⅕-acre pasture. During the growing period these received a grain ration of 2 per cent corn and middlings at the rate of corn 3 parts and middlings 1 part. Their finishing ration was corn 5 parts, middlings 1 part, tankage one-half part, self-fed.

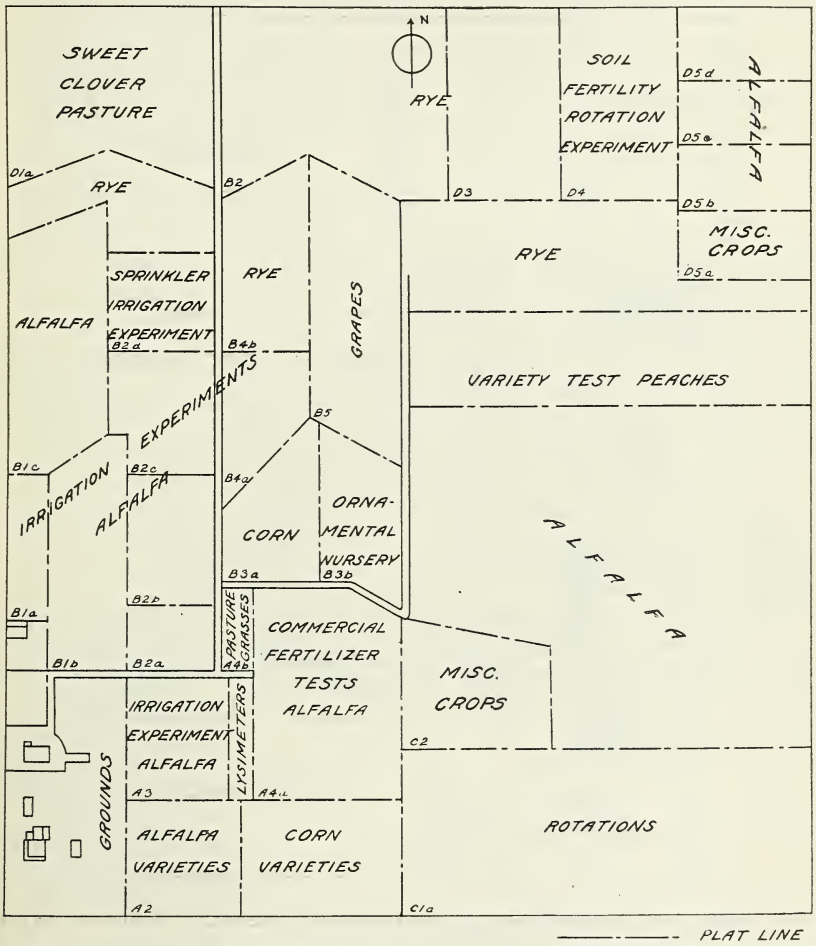

FIG. 2.—Diagram of the Umatilla Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1921

Lot 3, which included five pigs, was on a pasture containing 0.084 acre. These pigs were self-fed during the entire period. For the growing period the grain ration was corn and middlings mixed at the rate of 3 to 1. The finishing ration was corn, middlings, and tankage in 5–1–½ proportions.

The pastures were of alfalfa and some bluegrass. It was thought that too many pigs were carried to obtain the best results from the pasture, even though the area had been cut in half and the pigs rotated. Lot 1 was at the rate of 32 pigs per acre, lot 2 at 40 pigs per acre, and lot 3 at 58 pigs per acre, while it is believed that a pasture should carry only 25 to 30.

The pigs were put on pasture on May 23, and the grain supplements began the same day. On this date the pastures were all growing

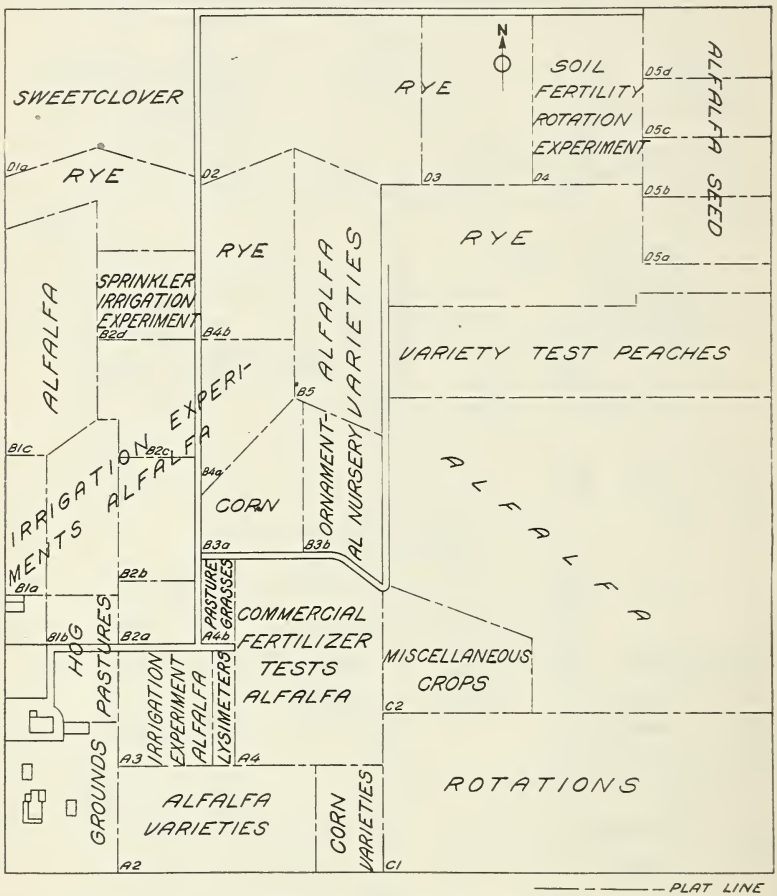

FIG. 3.—Diagram of the Umatilla Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1922

vigorously. On September 19 the pasture period was closed, and finishing rations were started. There was practically no growing alfalfa in the pastures during the finishing period.

Table 7 gives the weights of each lot of hogs, and the gains by weeks. Soon after the finishing period started lot 2 (self-fed) overtook lot 1 on the 4 per cent ration, indicating that the self-feeder made larger and quicker gains than the 4 per cent lot. Lot 3, self-fed from the first, made practically uniform gains throughout the whole feeding period.

TABLE 7.—*Weights and gains of each lot of hogs for each week and summarized results by periods in the hog-feeding experiments on the Umatilla Experiment Farm in 1921*

Pasture period	Lot 1, 2 per cent barley and middlings		Lot 2, 2 per cent corn and middlings		Lot 3, self-fed corn and middlings	
	Weight	Gain	Weight	Gain	Weight	Gain
Week ended:	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
May 23	309		320		201	
May 31	348	39	334	14	237	36
June 13	389	41	380	46	288	51
June 20	407	18	412	32	331	43
June 27	426	19	424	12	380	49
July 5	484	58	461	37	409	29
July 11	524	40	491	30	430	21
July 18	553	29	524	33	474	44
July 25	581	28	554	30	510	36
Aug. 2	605	24	582	28	559	49
Aug. 8	645	40	633	51	580	21
Aug. 15	655	10	676	43	641	61
Aug. 22	672	17	733	57	695	54
Aug. 28	692	20	738	5	740	45
Sept. 5	746	54	798	60	799	59
Sept. 12	778	42	867	69	825	26
Sept. 19	834	46	890	23	856	31

Finishing period	Lot 1, 4 per cent corn, middlings, and tankage		Lot 2, self-fed corn, middlings, and tankage		Lot 3, self-fed corn, middlings, and tankage	
	Weight	Gain	Weight	Gain	Weight	Gain
Week ended:	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
Sept. 26	935	101	935	45	899	43
Oct. 3	993	58	1,175	240	935	36
Oct. 10	1,090	97	1,299	124	1,018	83
Oct. 17	1,190	100	1,458	159	1,094	76
Oct. 22	1,302	112	1,565	107	1,155	61

SUMMARY OF RESULTS BY PERIODS

Items of comparison	Lot 1, 2 per cent barley and middlings	Lot 2, 2 per cent corn and middlings	Lot 3, self-fed corn and middlings
Growing period, from weaning to 100 pounds:			
Number of pigs	7	8	5
Time required to bring pigs to 100 pounds—days	98	105	63
Average initial weight—pounds	44	40	40
Average final weight—do	99	100	102
Average gain per pig—do	55	60	62
Average daily gain per pig—do	0.56	0.57	0.98
Feed required per pig—do	180	159	219
Cost to bring pig to 100 pounds	$6.62	$5.34	$7.08
Entire growing period from weaning:			
Duration of test—days	119	119	119
Average initial weight—pounds	44	40	40
Average final weight—do	119	111	171
Average daily gain per pig—do	0.63	0.60	1.01
Grain fed per 100 pounds of gain—do	309	266	391
Cost per 100 pounds of gain	$6.12	$5.29	$7.77

Items of comparison	Lot 1, 4 per cent corn, middlings, and tankage	Lot 2, self-fed corn, middlings, and tankage	Lot 3, self-fed corn, middlings, and tankage
Finishing period:			
Duration of test—days	33	33	33
Average initial weight—pounds	119	111	171
Average final weight—do	186	196	231
Average daily gain per pig—do	2.02	2.58	1.81
Grain fed per 100 pounds of gain—do	359	354	415
Cost per 100 pounds of gain	$7.42	$7.29	$8.57
Costs, both periods:			
Grain fed per 100 pounds of gain	332	313	398
Cost per 100 pounds of gain	$6.73	$6.37	$8.02

During the growing period lot 3 on self-feeder ate 2,564 pounds of grain, an average rate of 4.3 pounds per pig per day. During the finishing period they ate 1,240 pounds of grain, an average rate of 7.5 pounds per pig per day. Lot 2, finished on self-feeder, ate 2,430 pounds of grain, an average of 8.1 pounds per pig per day.

Comparative data on the feeding tests to the time the pigs averaged 100 pounds, for the entire growing period and for the finishing period, including a summary of all periods, are shown in the last half of Table 7. The cost prices are calculated on a basis of $40 per ton for barley, corn, and middlings and $60 per ton for tankage. No charge has been added for the pasture, but it is believed that $1 or $1.50 per head per season will cover this expense.

The figures for bringing the pigs from weaning to 100 pounds are included in order that a comparison may be made between the relative returns to be secured from selling the pigs as feeders when they weigh approximately 100 pounds and finishing them on the

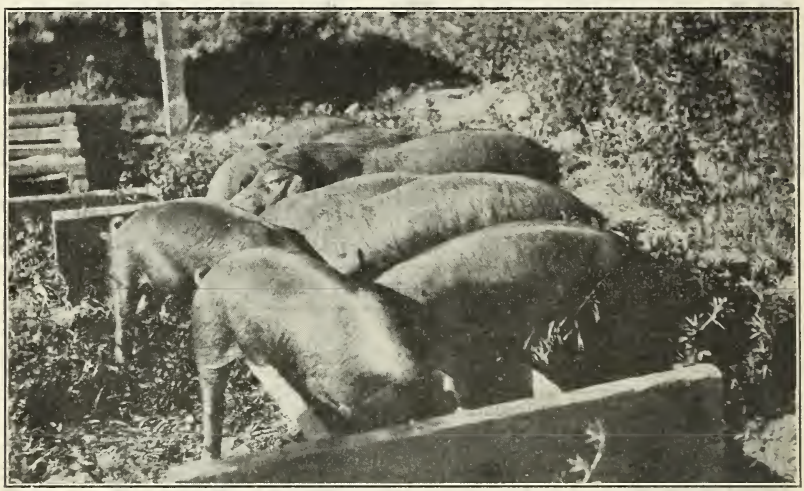

FIG. 4.—Pigs used in feeding tests on the Umatilla Experiment Farm in 1921

project farms. The time required to bring lots 1 and 2 to 100 pounds was 98 and 105 days, respectively, while lot 3 required only 63 days. The average daily gains for lots 1 and 2 were practically equal, 0.56 and 0.57 pound, respectively, while the gain for lot 3 (self-fed) was 0.98 pound. The weight of feed per pig required to bring the pigs to 100 pounds was 180 pounds for lot 1 (fed barley and middlings), 159 pounds for lot 2 (fed corn and middlings), and 219 pounds for lot 3 (self-fed corn and middlings). The grain cost $6.62 per pig for lot 1, $5.34 for lot 2, and $7.08 for lot 3.

The growing period was 119 days. At the end of it lot 1 averaged 119 pounds per pig, lot 2 111 pounds, and lot 3 171 pounds. The average daily gain was 0.63 and 0.60 pound, respectively, for lots 1 and 2 and 1.1 pounds for lot 3. The grain fed per 100 pounds of gain was 309 pounds for lot 1 (barley and middlings), 266 pounds for lot 2 (corn and middlings), and 391 pounds for lot 3 (self-fed corn and middlings). The costs of grain per 100 pounds of gain were $6.12, $5.29, and $7.77 for lots 1, 2, and 3, respectively.

The duration of the finishing period was 33 days. During the finishing period lot 1 was fed 4 per cent corn, middlings, and tankage; lots 2 and 3 were self-fed corn, middlings, and tankage. The final weights were 186, 196, and 231 pounds, respectively. The average daily gain per pig was considerably higher than during the growing period. Lot 1 gained an average of 2.02 pounds per day, lot 2 gained 2.58 pounds, and lot 3 gained 1.81 pounds. Lot 1 consumed 359 pounds of feed per 100 pounds of gain; lot 2 practically the same, 354 pounds; and lot 3, 415 pounds. For the finishing period the cost of grain required for 100 pounds of gain was $7.42 for lot 1, $7.29 for lot 2, and $8.57 for lot 3. The last section of Table 7 summarizes the grain fed per 100 pounds of gain and the costs per 100 pounds of grain for the entire feeding period. For each 100 pounds of gain, lot 1 consumed 332 pounds of grain, which cost $6.73; lot 2, 313 pounds of grain, which cost $6.37; and lot 3, 398 pounds of grain, which cost $8.02.

DUTY-OF-WATER EXPERIMENTS

During the irrigation season of 1921 six duty-of-water trials were run in cooperation with farmers on the project to compare the water required on types of soil varying from very coarse sand to very fine sand. On two of these soil types comparisons were made of the relative efficiency of borders and checks in irrigating alfalfa. A summary of the results is given in Table 8.

TABLE 8.—*Summary of cooperative irrigation experiments in growing alfalfa on the Umatilla Reclamation Project in 1921*

[The data given for plats marked with a star (*) were for the second and third crops only]

Description of plats					Average application	Season application	Average yield per acre	Yield per acre-foot
Soil type	Method of irrigation	Number of plats	Average length of run	Average area				
			Feet	*Acre*	*Acre-inches*	*Acre-feet*	*Tons*	*Tons*
Very coarse sand	Long strip borders	9	232	0.142	8.24	8.24	2.04	0.25
	Short strip borders	6	91	.053	5.27	5.27	1.98	.38
Coarse sand	Strip borders	6	133	.099	4.00	2.68	5.54	2.07
	Flat checks	4	--------	.389	9.95	7.46	4.99	.67
Medium sand	Strip borders	* 6	224	1.36	8.03	4.01	5.55	1.38
	----do	5	200	.137	5.15	4.29	4.46	1.04
Fine sand	----do	12	162	.107	3.55	2.98	6.78	2.28
	----do	18	141	.094	2.55	2.96	8.05	2.72
Very fine sand	----do	4	148	.148	3.22	1.88	8.26	4.40
	Flat checks	2	--------	.204	4.82	2.82	7.84	2.78

Water was applied during the season to 72 plats, varying in size from 0.053 acre for the smallest border to 0.389 acre for the largest checks. Of these plats 6 were flat checks, the remainder being strip borders. The shortest borders were 91 feet in length and the longest 232 feet. The narrowest borders were 25 feet in width and the widest 43.5 feet. One series of checks averaged 92 by 96 feet and the other 124 by 143 feet.

On the very coarse soil 15 borders were used in the experiment. Of these, 9 averaged 232 feet in length and had but a slight slope. The other 6 averaged 91 feet in length but had a steep slope, as high

as 4.2 feet fall in 100. The larger borders averaged 0.142 acre in area and the smaller ones averaged 0.053 acre. They were irrigated at intervals of about 10 days, and the average application on the long borders was 8.24 acre-inches per acre and on the short ones 5.27 acre-inches per acre. The total water used during the season was 8.24 acre-feet per acre on the long borders and 5.27 acre-feet per acre on the short borders. The water required on the long borders was 56 per cent greater than on the short ones. The total yield for the long borders was 2.04 tons per acre and for the short ones 1.98 tons per acre.

The longer borders with the slight slope produced 0.25 ton per acre-foot of water applied, and the short borders with a steep slope produced 0.38 ton per acre-foot of water. The short borders produced 0.13 ton more alfalfa for a like application than the longer borders.

On the coarse type of soil six borders averaging 133 feet in length and 0.099 acre in area and four checks averaging approximately 0.389 acre in area were used. The checks were irrigated nine times and the borders eight times during the season. The average application on the borders was 4 acre-inches per acre and on the checks 9.95 acre-inches per acre. The total application for the season was 2.68 acre-feet per acre on the borders and 7.46 acre-feet per acre on the checks. The average yield for the borders was 5.54 tons per acre and for the checks 4.99 tons per acre. The borders proved to be much superior to the checks in the economical use of water. They gave an average yield per acre-foot of water of 1.40 tons more than the checks. In the case of the borders the yield was probably increased by the effect of seepage water, which was present at a depth of approximately 4 feet at the close of the season.

Three sets of borders were used in determining the water relation on medium sand. In one set six borders were used, averaging 224 feet in length with an average area of 0.136 acre. The data on yields for the second and third crops were obtained. They were irrigated approximately every 14 days, and the average application was 8.03 acre-inches per acre. The total application for the entire season was 4.01 acre-feet per acre. The yield per acre-foot of water applied was 1.38 tons per acre-foot. The total yield for these two crops was 5.55 tons per acre. This is high, owing to the moist condition of the alfalfa when the third crop was weighed.

On the station farm, field A3, made up of five borders 200 feet long, was used in conjunction with these experiments. They averaged 0.137 acre in area. The average water application was 5.15 acre-inches per acre, and the average application for the season was 4.29 acre-feet per acre. The borders were irrigated about every 14 days, produced an average of 4.46 tons per acre, and gave a return of 1.04 tons per acre-foot of water applied.

The 12 borders on medium sandy soil used in this work averaged 162 feet in length with an average area of 0.107 acre. They were irrigated at intervals of 14 days. The average water application was 3.55 acre-inches per acre, and the average seasonal irrigation was 2.98 acre-feet per acre. The yield per acre was 6.78 tons, and the return per acre-foot of water applied was 2.28 tons.

On the fine sandy soil 18 borders were used, averaging 141 feet in length with an average area of 0.094 acre. The plats were irrigated

at intervals of two weeks. The average application was 2.55 acre-inches per acre and 2.96 acre-feet per acre for the season. The average yield was 8.05 tons per acre, and the yield per acre-foot of water was 2.72 tons.

Four borders and two checks were used on very fine sandy soil. The checks averaged 92 by 96 feet, or 0.204 acre, in area. The borders were 148 feet long and 0.148 acre in area. The plats were irrigated seven times during the season at average intervals of 17 days. The average water application on the borders was 3.22 acre-inches per acre, and on the checks it was 4.82 acre-inches per acre. The average application for the season on the borders was 1.88 acre-feet per acre and on the checks 2.82 acre-feet per acre. For each acre-foot of water applied to the borders there was a crop return of 4.40 tons. On the checks the yield per acre-foot of water was 2.78 tons. For each acre-foot per acre of water applied to the borders there was an increase in production of 1.62 tons over a similar amount applied to the checks. Here, as in the work done on coarse soil, the borders demonstrated their greater efficiency over checks.

In the two instances where the duty of water on borders and checks was compared the borders required less water than the checks, and the yield per acre-foot was higher on the borders. On coarse sand 2.68 acre-feet per acre for the season were required on the borders, while the checks required 7.46 acre-feet. On very fine sand the borders required 1.88 acre-feet, while the checks required 2.82 acre-feet.

Two lengths of borders, 232 feet and 91 feet, were compared on the very coarse type of soil. The seasonal application on the long borders was 8.24 acre-feet and on the short borders 5.27 acre-feet.

The average water application on the very coarse sandy soil was 6.75 acre-inches per acre, on the medium sand it was 5.58 acre-inches per acre, on the fine sand it was 2.55 acre-inches per acre, and on the very fine sand borders it was 3.22 acre-inches per acre.

The seasonal application was the highest on the very coarse sand and decreased regularly as the texture of the soil became finer. The seasonal application on borders for each soil type was as follows: Very coarse sand, 6.75 acre-feet per acre; medium sand, 3.76 acre-feet per acre; fine sand, 2.96 acre-feet per acre; and very fine sand, 1.88 acre-feet per acre.

Using the soil on the medium sandy borders of field A3 of the station farm as a standard, the long borders on very coarse sand required 92.1 per cent more water.

The short steep borders on very coarse sandy soil required 22.8 per cent more water. The checks on coarse sand used 74 per cent more water and the borders on the same soil used 37.5 per cent less water than those on field A3, the difference probably being due to the shallow water table. The borders on fine sand used 31 per cent less than the medium sand on the station farm. The borders on the very fine sand used 55.2 per cent less, and the checks on the same soil type used 34.3 per cent less.

On the very coarse sand the yield of alfalfa per acre was but 2.04 tons, while on coarse sand it was 5.05 tons per acre. On medium sand it was 5.55 tons per acre, on fine sand it was 8.05 tons per acre, and on very fine sand 8.26 tons per acre.

The soil types ranged the same way in tons of hay produced per acre-foot of water applied. The very coarse sand produced but

0.315 ton per acre-foot. The coarse-sand borders yielded 2.07 tons per acre-foot, the medium sand 1.57 tons per acre-foot, the fine sand 2.72 tons per acre-foot, and the very fine sand borders 4.40 tons per acre-foot. The relation, therefore, between the type of soil and the water required is evident. The yield per unit of water applied to the land was greatest on the finest soil and ranged in order from the finest to the coarsest soil. Each unit of water applied to the very fine sandy soil gave a return in tons per acre-foot which was 14 times greater than the same application on the very coarse sandy soil, 2.1 times greater than on the coarse sandy soil, 2.9 times greater than on the medium sand, and 1.6 times greater than on the fine sand. Where the yields per acre-foot exceeded 2 tons, it is believed that some additional factor, such as a shallow water table, entered into the tests.

FIG. 5.—Alfalfa variety test in field A2 on the Umatilla Experiment Farm in 1922

ALFALFA VARIETIES

A test of 12 varieties of alfalfa was started in 1920, and 9 varieties were added in 1921. The test is on a uniform soil in field A2, which had previously grown corn. (Fig. 5.) The yields in tons per acre of field-cured hay are given in Table 9. Turkestan gave a very exceptional yield in 1922 and brought the average for the two years up next to common local. Common Kansas seed has given high yields in both years.

It has been found that the hardy northern varieties as represented by Grimm, Liscomb, Cossack, and Black Hills common start earlier in the spring than do the southwestern varieties, Indian, Peruvian, and Chilean. In the fall the northern varieties become dormant after the third crop is cut, while the southern varieties make considerable growth during the cooler weather following the third cutting.

Whether or not the additional fall pasture from the southern varieties is sufficient to offset the somewhat lower hay yields has not been ascertained, but will be given further study.

TABLE 9.—*Yields of alfalfa varieties on the Umatilla Experiment Farm in 1921 and 1922*

Variety	Yields per acre (tons)			Variety	Yields per acre (tons)		
	1921	1922	Average		1921	1922	Average
Baltic	5.01	5.08	5.04	Peruvian	5.31	6.72	6.01
Common:				Turkestan	5.14	8.13	6.63
Black Hills seed	6.04	7.93	6.98	D–26	------	3.85	------
Dry-land seed	5.64	6.16	5.90	D–28	------	5.89	------
High-altitude seed	5.38	5.79	5.58	D–38	------	5.69	------
Kansas seed	6.25	6.77	6.51	D–79	------	4.35	------
Local seed	6.49	7.32	6.90	D–80	------	3.84	------
Cossack	5.98	6.14	6.06	19A—Grimm type	------	5.37	------
Grimm	6.66	7.21	6.93	11C—Baltic type	------	5.19	------
Indian	5.33	5.26	5.30	Ladak	------	4.45	------
Liscomb	6.13	6.59	6.36	Chilean–Arizona (common)	------	5.27	------

VALUE OF MANURE APPLIED TO ALFALFA AND CORN

On the coarse sandy soil in field D4 an experiment in manuring alfalfa and corn has been conducted for eight years. On one set of plats each crop has been grown without manure; on another set of plats each crop has had manure applied six times during the 8-year period at the rate of 8 tons per acre; on the third set of plats each crop has had manure applied six times during the 8-year period at the rate of 32 tons per acre. (Fig. 6.)

For the alfalfa plats those without manure have yielded an average of 3.69 tons per acre, or 29.5 tons per acre for the 8-year period; the plats receiving the light applications of manure have yielded an average of 5.08 tons per acre, or 40.6 tons per acre for the 8-year period, while the plats receiving the heavy applications of manure have yielded an average of 6.18 tons per acre, or 49.4 tons per acre for the 8-year period. The plats receiving the light applications, 48 tons of manure per acre, yielded 11.1 tons of hay per acre more than the unmanured plats, while the plats receiving the heavy applications, 192 tons of manure per acre, yielded 19.9 tons of hay per acre more than the unmanured plats. For the corn plats those without manure yielded an average of 0.78 ton of corn fodder per acre, or 6.24 tons per acre for the 8-year period; those receiving the light application of manure averaged 2.07 tons per acre, or 16.56 tons per acre for the 8-year period, while the plats receiving the heavy application averaged 3.48 tons per acre, or 27.8 tons per acre for the 8-year period. The plats to which 48 tons of manure were applied yielded 10.32 tons more than the unmanured plats, while those to which 192 tons were applied yielded 21.6 tons more than the unmanured plats.

These results indicate that with both alfalfa and corn on the coarse sandy soil where this experiment was located the increase in yield per unit of manure was larger for the light applications than for the heavy applications. The increases of yields were substantially the same in

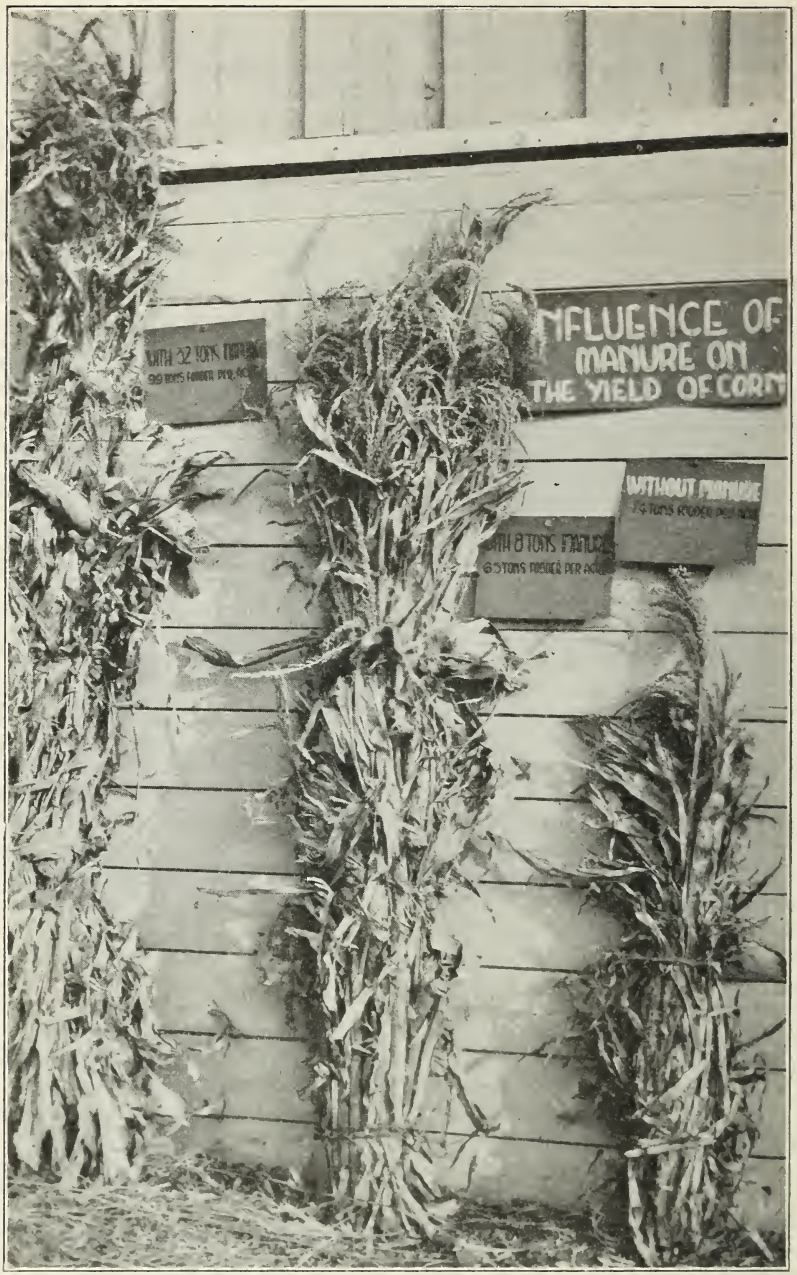

FIG. 6.—Relative heights and yields of corn produced without manure and with manure at 8 and 32 tons per acre, respectively, on coarse sandy soil at the Umatilla Experiment Farm in 1921

quantity for both crops, but the feeding value of alfalfa is higher than that of corn fodder; so that the manure applied to the alfalfa gave larger returns than that applied to the corn.

In another phase of the experiment alfalfa was plowed under after growing two years, and corn was planted. The yields of corn following alfalfa show very pronounced increases over corn following corn. The yield of corn following corn without manure was 0.75 ton of fodder per acre and of corn following alfalfa 3.09 tons, an increase of 2.34 tons. Corn following alfalfa with 8 tons of manure yielded 3.94 tons, and corn following corn with the same rate of manure yielded 2.23 tons. Corn following alfalfa with 32 tons of manure yielded 4.58 tons, and corn following corn with manure at the same rate yielded 3.74 tons. From these results it is clear that larger yields of corn may be obtained on these sandy lands by letting this crop follow alfalfa whenever possible.

TABLE 10.—*Silage yields of corn varieties and sunflowers at the Umatilla Experiment Farm during the 4-year period from 1918 to 1921, inclusive*

Varieties	1918		1919		1920		1921		Average	
	Fodder	Ears	Fodder	Ears	Fodder	Ears	Fodder	Ears	Fodder	Ears
Australian White Flint			4.16	1.43					4.16	1.43
Barry Golden Tip (probably Bloody Butcher)	8.18	1.56							8.18	1.56
Bloody Butcher			5.50	1.66	7.62	1.55	1.04	.27	4.72	1.16
Boone County White			6.41	1.06	8.55	1.39			7.48	1.22
Brazilian Flour			5.56	1.37	5.02	.89			5.29	1.13
Clarage			5.07	1.54	5.75	1.22			5.41	1.38
Colorado Giant Fodder			8.39	.82	13.47	1.73			10.93	1.27
Dependable Yellow Dent			7.57	1.21	11.06	1.66			9.31	1.43
Diamond Joe's Big White			4.89	1.06	5.98	1.42			5.43	1.24
Droughtproof			4.75	.89	7.30	1.60			6.02	1.24
Eiker Yellow Dent					1.23	.58			1.23	.58
Elephant Fodder			4.84	.95	6.54	1.21			5.69	1.08
Eureka Silage			6.41	.45	6.79	.62			6.60	.53
Golden Beauty B			7.32	.55	8.42	.89			7.87	.72
Golden Beauty M			5.26	.97	5.56	.61			5.41	.79
Golden Dent			6.29	.64	6.83	.71			6.56	.68
Golden Surprise			5.16	1.27	4.74	.80			4.95	1.03
Hickory King			6.53	.88	6.48	.61			6.50	.74
Hopi	10.8	2.60	8.93	.85	7.31	.83			9.01	1.43
Johnson County White			5.73	.68	5.85	.99	2.84	.75	4.81	.81
Kaw Chief			5.73	.65	6.87	1.01			6.30	.83
Kilbury Yellow Hybrid			5.32	.88	6.18	.91			5.75	.89
Leaming			6.09	1.19	6.92	1.48	2.71	.95	5.24	1.21
Longfellow			5.42	1.13	4.52	1.02			4.97	1.07
Mammoth White Dent			6.02	1.07	5.73	.95			5.87	1.01
Mastodon			5.81	1.16	5.86	1.02			5.84	1.09
Minnesota Ideal			4.31	.88	4.18	.67			4.24	.77
Minnesota King			3.29	.97	2.92	.59			3.10	.78
Minnesota No. 13	4.38	.92							4.38	.92
Navajo	6.61	.70	4.44	1.01	3.50	1.22			4.85	.97
Neller			5.15	.85	2.92	.66			4.03	.75
Ninety-Day			3.83	1.31	4.08	.54	3.30	1.83	3.73	1.23
Northwestern Dent	3.27	.25							3.27	.25
Pawnee Blue	3.47	.41							3.47	.41
Payne White					1.79	.26			1.79	.26
Pride of Oregon			5.47	1.23	4.33	.37			4.90	.80
Pride of the North	5.67	.51							5.67	.51
Pueblo	6.18	1.12	8.73	.65					7.45	.88
Red Cob Fodder			4.88	.64	4.13	.39			4.50	.51
Reid Yellow Dent							2.08	.69	2.08	.69
Rosebud County					1.61	.26			1.61	.26
Rustless White Dent					1.51	.22			1.51	.22
Silver King	6.13	.46	5.63	1.43	3.68	.67			5.14	.85
Silvermine			5.90	1.51	5.24	.87	3.00	.89	4.71	1.09
Sugar Forage			4.41	1.12	2.99	.47			3.70	.79
Sullivan White Dent			5.68	1.43	4.75	.81			5.22	1.12
Swadley	5.67	.69							5.67	.69
Tribrid			4.36	1.28	6.31	.69			5.33	.98
Three Twenty-Nine							1.88	.74	1.88	.74
White Cap Yellow Dent			4.79	.95	5.12	.91			4.95	.93
Winslow Squaw	7.46	1.25							7.46	1.25
Yellow Dent			5.06	.76	4.65	.81	2.42	.97	4.04	.85
Sunflower (Mammoth Russian)	28.4		11.42		10.81		9.29		15.00	

CORN VARIETY TESTS

The variety tests of corn from 1918 to 1921, inclusive, comprised 50 varieties. The results of this work show that the longest season Corn-Belt varieties can be matured well under the conditions existing at the station farm. These tests were conducted to give information primarily on the yield of varieties for silage, so the fodder and ear weights recorded in Table 10 are green weights. The weights of ears are with the husks removed. Killing frosts coming unusually early in 1919 and 1921 caught the crops in those years, but the yields were comparable with those of the project, as none of the silos had been filled at the time of frost. The soils on which these tests were conducted were the average of those on the project.

The 10 varieties which gave the highest fodder yields, in the order mentioned, were Colorado Giant Fodder, Dependable Yellow Dent, Hopi, Barry Golden Tip,[2] Golden Beauty, Boone County White, Winslow Squaw, Pueblo, Eureka Silage, and Golden Dent. The 10 highest yielding ear-corn varieties were Barry Golden Tip, Hopi, Dependable Yellow Dent, Australian White Flint, Clarage, Colorado Giant Fodder, Winslow Squaw, Diamond Joe's Big White, Drought-proof, and Ninety-Day. The varieties placed in the first 10 in both fodder and ear yields were Colorado Giant Fodder, Hopi, Dependable Yellow Dent, Barry Golden Tip,[2] and Winslow Squaw.

SIZE-OF-BORDER EXPERIMENTS

The border method of irrigation has come into general use on the project and has resulted in material savings of water and labor in irrigation. Experiments have been conducted to determine the size of border which is most economical of water on both steep and flat land. Steep land is considered to be that having a fall in excess of 3 feet per 100 feet of run. The results of these tests are averaged in Table 11.

TABLE 11.—*Annual water requirement and average for each application at the Umatilla Experiment Farm in 1922*

Description of borders	Period covered	Average water requirement per acre	
		Annual	Per application
Length-of-border experiments:			
Steep land—	*Years*	*Acre-feet*	*Acre-inches*
25 by 90 feet	2	3.69	3.27
25 by 120 feet	2	3.89	3.44
25 by 150 feet	2	4.48	3.97
25 by 180 feet	2	5.65	5.02
25 by 210 feet	2	7.73	6.82
Flat land—			
22 by 100 feet	7	4.69	4.33
22 by 175 feet	7	5.09	5.02
22 by 250 feet	7	6.55	6.33
Width-of-border experiments:			
Steep land—	*Years*	*Acre-feet*	*Acre-inches*
20 by 200 feet	2	4.74	4.21
25 by 200 feet	2	6.22	5.51
30 by 200 feet	2	6.52	5.76
35 by 200 feet	2	9.07	8.00
Flat land (1)—			
20 by 200 feet	2	5.59	4.95
25 by 200 feet	2	7.12	6.31
30 by 200 feet	2	7.42	6.59
35 by 200 feet	2	6.89	5.90
Flat land (2)—			
20 by 200 feet	6	4.08	4.58
25 by 200 feet	6	4.00	4.47
30 by 200 feet	6	4.66	5.17
35 by 200 feet	6	4.80	5.57
40 by 200 feet	6	5.19	6.23

[2] Probably Bloody Butcher.

LENGTH-OF-BORDER EXPERIMENTS

A series of borders 25 feet wide and increasing from 90 to 210 feet in length at intervals of 30 feet is being tried on steep land. The quantity of water applied annually and the depth per application required increased directly with the length of the run, but excessive amounts were not used on the 90-foot, 120-foot, and 150-foot borders. The same head of water was used on borders 22 feet wide by 100, 175, and 250 feet long on flat land. The water required was slightly higher on the 100-foot and 175-foot borders than on the borders up to 150 feet in length on the steep land. A larger head of water could have been used on the flat land, and if it had been available it is probable that the water requirement would have been reduced.

WIDTH-OF-BORDER EXPERIMENTS

The width-of-border experiments included borders 20 to 40 feet wide at 5-foot intervals, and all were 200 feet long. The heads of water used were the same on the steep-land test and the first flat-land test, and a larger head was used on the second flat-land test.

On the steep land the only border which was economical of water was the 20-foot one, the other borders being too wide. All the borders on the flat land were too large for economical irrigation with the head of water available, but undoubtedly a larger head would have lowered the water requirement on the narrower borders.

The second flat-land width-of-border test was on land well suited to irrigation, and a good head of water was available. The results show that the 20-foot and 25-foot borders were very economical of water, and the 30-foot and 35-foot borders did not require excessive quantities. The 40-foot border was too wide for the best results.

The soil on which all these tests were conducted has been found to hold approximately an acre-inch of water per acre-foot of soil, and since the root zone of alfalfa on it is practically all in the first 4 feet single applications much in excess of 4 acre-inches are wasteful.

LYSIMETER INVESTIGATIONS

In order to study more closely than was possible in the field 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 for fine sand, coarse sand, silt, and silt loam there is one each. One of the medium-sand lysimeters is not cropped, one grows soybeans in the summer and vetch in the winter, and two have alfalfa, with manure applied to one. The others all grow alfalfa.

The lysimeters have been irrigated with practically the same quantities of water except those having silt and silt loam, which during 1922 were given excessive applications in an unsuccessful attempt to start percolation. The average percolation from the

lysimeter without crop was 37.37 inches deep and that from the one growing soybeans and vetch was 24.18 inches. The alfalfa crops in the medium sand used still more of the irrigation water, and there was also a decrease in the amount of percolation where manure was applied. The percolation from alfalfa without manure was 9.63 inches and with manure 7.55 inches. The percolation from the fine sand growing alfalfa was lower than from the medium sand with the same crop, being 4.03 inches; but from the coarse sand it was higher, 13.42 inches. Water has not drained through the silt and silt-loam soils, even when 113.02 inches of water were applied in 1922. The tendency of the soils to hold more water as they are continuously cropped is only slight, except on the fine sand.

The details as to the water applied, the quantity of the percolate, and the percentage of the percolate to the water applied for each lysimeter for each year of the experiment are shown in Table 12.

TABLE 12.—*Water application and percolation in lysimeter experiments with various types of soil and crop treatments on the Umatilla Experiment Farm during the 8-year period from 1915 to 1922, inclusive*

Year	Medium sand											
	No crop			Soybeans and winter vetch			Alfalfa			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
Average	55.56	37.37	67.4	55.68	24.18	43.4	55.56	9.63	18.0	55.56	7.55	13.6

Year	Alfalfa crop							
	Fine sand			Coarse sand			Silt (water applied)	Silt loam (water applied)
	Water applied	Percolation		Water applied	Percolation			
		Actual	Comparative		Actual	Comparative		
	Acre-inches	*Acre-inches*	*Per cent*	*Acre-inches*	*Acre-inches*	*Per cent*	*Acre-inches*	*Acre-inches*
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
Average	57.49	4.03	7.2	57.49	13.42	23.8	65.99	66.49

COMMERCIAL-FERTILIZER TESTS

The commercial-fertilizer tests include applications of nitrate of soda, of potash in both the sulfate and chloride forms, of acid phosphate, and of sulfur. The applications were made in the early spring of 1921 to alfalfa planted the previous fall. Table 13 gives the yields of alfalfa in tons per acre for two crops in 1921 and three crops in 1922.

TABLE 13.—*Yields of alfalfa with different fertilizer treatments on the Umatilla Experiment Farm in 1921 and 1922*

Treatment	Yields per acre (tons)		Treatment	Yields per acre (tons)	
	1921 (two crops)	1922 (three crops)		1921 (two crops)	1922 (three crops)
Nitrate of soda (200 pounds per acre)	2.44	3.64	Untreated (check)	2.88	5.30
Nitrate of soda (100 pounds per acre)+potassium sulfate (160 pounds per acre)	2.48	6.09	Calcium sulfate (200 pounds per acre)	3.29	5.92
Untreated (check)	2.15	5.28	Untreated (check)	3.20	6.65
Potassium chloride (160 pounds per acre)	2.74	6.27	Sulfur (200 pounds per acre)	2.79	6.10
Acid phosphate (320 pounds per acre)	2.36	6.19	Untreated (check)	1.36	3.74
Acid phosphate (320 pounds per acre)+potassium chloride (160 pounds per acre)	2.99	6.87	Nitrate of soda (100 pounds per acre)+acid phosphate (160 pounds per acre)	2.12	4.85
			Complete fertilizer (350 pounds per acre)	2.58	5.80
			Untreated (check)	2.71	6.41

The results show slight increases in yield over the untreated check plats from the potash fertilizers. The highest yield was produced from the application of acid phosphate and potassium chloride. Sulfur has not shown pronounced increases in yield. On some of the heavier soils of the project, however, sulfur has increased the yield of alfalfa materially.

Tests of commercial fertilizers in pots containing uniform soil were made in 1922. In each instance normal applications of each and applications four times the normal were made to test the possible detrimental effects of the fertilizers which might show after a number of light applications. Table 14 shows the treatment given and the yields of alfalfa in grams per pot, the rank of the yields, and the departure in yield from the check in grams and percentage.

TABLE 14.—*Yields of alfalfa on sandy soil in pots with various commercial fertilizers at the Umatilla Experiment Farm in 1922*

Treatment	Rate per acre	Yield per pot (grams)	Departure from check		
			Rank	Grams	Per cent
Sodium nitrate	200 pounds	67.0	6	+3.0	+4.7
Do	800 pounds	65.9	8	+1.9	+3.0
Ammonium sulfate	200 pounds	84.8	1	+20.8	+32.5
Do	800 pounds	75.9	3	+11.9	+18.6
Acid phosphate	400 pounds	72.2	4	+8.2	+12.8
Do	1,600 pounds	66.4	7	+2.4	+3.7
Potassium chloride	200 pounds	68.9	5	+4.9	+7.7
Do	800 pounds	47.0	12	−17.0	−26.6
Sulfur (flowers)	100 pounds	62.8	10	−1.2	−1.9
Do	400 pounds	47.4	11	−16.6	−25.9
Manure	32 tons	77.8	2	+13.8	+21.6
Untreated (check)		64.0	9	0	0

The yields from the pots containing fertilizers were heavier than those from the untreated check pot in all instances except the pots fertilized with the heavy application of potassium chloride and the two having sulfur.

The ammonium sulfate pots gave the highest yields, the light application ranking first, with an increase of 32.5 per cent over the check and the heavy application ranking third, with an increase of 18.6 per cent. The pot fertilized with manure ranked second, with an increase of 21.6 per cent over the check. The light application of acid phosphate was the only other treatment which gave a pronounced increase in yield.

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