Station Bulletin 144. April, 1917

Oregon Agricultural College
Experiment Station
Sherman County Branch Station

Dry Farming Investigations at the Sherman County Branch Experiment Station

BY

D. E. STEPHENS, Superintendent
C. E. HILL, Scientific Assistant

MORO, OREGON

The regular bulletins of the Station are sent free to the residents of Oregon who request them.

STATION STAFF

Board of Regents of the Oregon Agricultural College and Experiment Station

HON. J. K. WEATHERFORD, President ..... Albany
HON. N. R. MOORE, Secretary ..... Corvallis
HON. C. L. HAWLEY, Treasurer ..... McCoy
HON. JEFFERSON MYERS ..... Portland
HON. JAMES WITHYCOMBE, Governor of the State ..... Salem
HON. J. A. CHURCHILL, State Superintendent of Public Instruction ..... Salem
HON. BEN W. OLCOTT, Secretary of State ..... Salem
HON. CHARLES E. SPENCE, Master of the State Grange ..... Oregon City
HON. CLARA H. WALDO ..... Portland
HON. WALTER M. PIERCE ..... La Grande
HON. H. VON DER HELLEN ..... Wellen
HON. G. M. CORNWALL ..... Portland
M. S. WOODCOCK ..... Corvallis

Administration

W. J. KERR, D. Sc ..... President
A. B. CORDLEY, M. S. ..... Director

Department of Animal Husbandry

E. L. POTTER, B. S. ..... Chief in Animal Husbandry
G. R. SAMSON, B. S. ..... Assistant in Animal Husbandry
O. M. NELSON, B. S. ..... Assistant in Animal Husbandry

Department of Bacteriology

T. D. BECKWITH, M. S. ..... Chief in Bacteriology

Department of Botany and Plant Pathology

H. P. BARSS, M. S. ..... Chief in Botany and Plant Pathology
M. B. McKAY, M. S. ..... Research Assistant in Botany and Plant Pathology
C. S. HURSCH, B. S. ..... Assistant in Botany and Plant Pathology

Department of Chemistry

*H. V. TARTAR, B. S. ..... Chief in Agricultural Chemistry
BERT FILKINGTON, B. S. ..... Research Assistant in Agricultural Chemistry
R. H. ROBINSON, B. S. ..... Research Assistant in Agricultural Chemistry
R. E. BEARD, B. S. ..... Research Assistant in Agricultural Chemistry
NAO UYEI, B. S. ..... Research Fellow

Department of Dairy Husbandry

R. R. GRAVES, M. S. ..... Chief in Dairy Husbandry

Department of Drainage and Irrigation

W. L. POWERS, M. S. ..... Chief in Drainage and Irrigation

Department of Entomology

A. L. LOVETT, B. S. ..... Chief in Entomology
W. J. CHAMBERLIN, B. S. ..... Research Assistant
G. F. MOZNETTE, B. S. ..... Research Assistant
LEROY CHILDS, B. S. ..... Entomologist, Hood River, Acting Superintendent

Department of Farm Crops

G. R. HYSLOP, B. S. ..... Chief in Farm Crops
H. A. SCHOTH, M. S. ..... Expert in Vetch Investigations

Department of Horticulture

C. I. LEWIS, M. S. A. ..... Vice-Director, and Chief in Horticulture
V. R. GARDNER, M. S ..... Pomologist
*E. J. KRAUS, B. S. ..... Professor of Research
A. G. BOUQUET, B. S. ..... Assistant in Olericulture
A. F. BARSS, M. S. ..... Assistant in Research
J. R. MAGNESS, M. S. ..... Assistant in Research
G. G. BROWN, B. S. ..... Horticulturist, Hood River
E. W. MONTELL, B. S. ..... Research Fellow

Department of Soils and Farm Management

H. D. SCUDDER, B. S. ..... Chief in Soils and Farm Management
C. V. RUZEK, B. S. ..... Assistant in Soils

Department of Veterinary Medicine

B. T. SIMMS, D. V. M. ..... Chief in Veterinary Medicine

Robert Withycombe, B. S. ..... Supt. Eastern Ore. Branch Experiment Station, Union
R. W. Allen, M. S. ..... Supt. Umatilla Branch Experiment Station, Hermiston
D. E. Stephens, B. S. ..... Supt. Sherman County Branch Exp. Station, Moro
F. C. Reimer, M. S. ..... Supt. Southern Oregon Experiment Station, Talent
L. R. Breithaupt, B. S. ..... Supt. Harney Co. Branch Experiment Station, Burns
A. E. Engbretson, B. S. ..... Act. Supt. John Jacob Astor Branch Exp. Station, Astoria

---

*On leave of absence.

DRY FARMING INVESTIGATIONS AT THE SHERMAN COUNTY BRANCH EXPERIMENT STATION, MORO, OREGON

D. E. Stephens, Superintendent
C. E. Hill, Scientific Assistant

INTRODUCTION

The Sherman County Branch Experiment Station is maintained cooperatively by the State of Oregon, through the Oregon Agricultural College, and the United States Department of Agriculture, through the Office of Cereal Investigations. A description of the Branch Station and the history of its establishment have been given in previous publications.*

The work of the Branch Station has been continued along four general lines; (1) Varietal testing experiments, (2) improvement of field crops; (3) experiments to determine the most profitable crop-rotation systems for the dry uplands of Eastern Oregon; and (4) tillage experiments to find out the best methods of soil cultivation for the production of wheat under the summer-fallow system. The Station has been able to do more work with the forage crops during the last two years because of the cooperation of the Office of Forage Crop Investigations of the U. S. Department of Agriculture. All the weather-recording instruments were furnished by the Biophysical Laboratory of the U. S. Department of Agriculture.

The results reported in this bulletin have been obtained by the cooperation of the officials of the Oregon Agricultural Experiment Station and of the Offices of Cereal and Forage Crop Investigations of the U. S. Department of Agriculture. It is desired to give these officials full credit for their assistance in securing these results.

The following men were instrumental in planning and starting many of the experiments reported in this bulletin:

H. J. C. Umberger, Superintendent, and O. Beaty, Assistant Superintendent, from 1909 to 1911, inclusive.

H. D. Scudder, Agronomist, Oregon Agricultural Experiment Station.

M. A. Carleton, Cerealist, U. S. Department of Agriculture.

F. D. Farrell and P. V. Cardon, Agronomists, U. S. Department of Agriculture.

---

*Bul. 119, Ore. Exp. Sta. Report of the E. O. Dry-Farming Branch Sta. 1913-14. Bul. 498, U. S. Dept. of Agri.

Valuable suggestions and assistance, both in field work and in the preparation of the manuscript, were rendered by C. R. Ball, C. W. Warburton, and C. V. Piper of the Bureau of Plant Industry of the U. S. Department of Agriculture, and by G. R. Hyslop of the Oregon Agricultural Experiment Station.

Mr. C. E. Hill, a graduate of the Oregon Agricultural College, was appointed Assistant to the Superintendent in June, 1915, and Scientific Assistant in Forage-Crop Investigations in March, 1917. Mr. F. J. Schneiderhan, Scientific Assistant, was detailed in the spring of 1916 by the Office of Cereal Investigations of the U. S. Department of Agriculture for special wheat breeding and other wheat investigations.

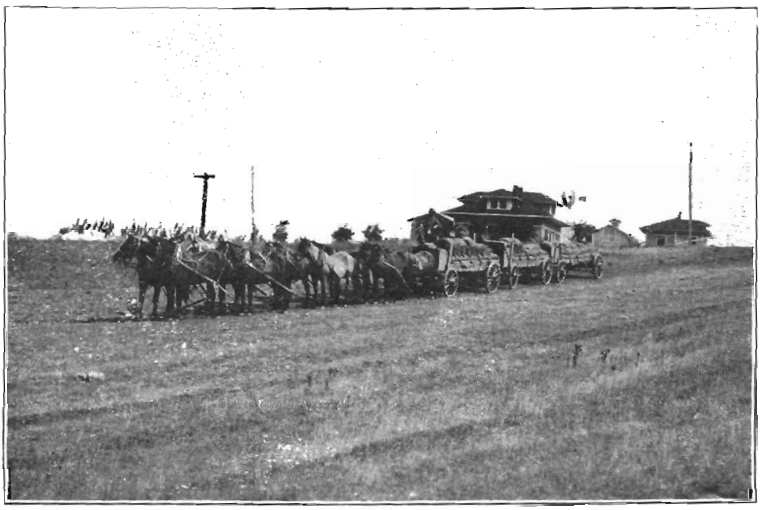

Fig. 1. Hauling wheat to market. Station buildings in background.

CLIMATIC DATA

Weather records have been kept on the Branch Station since 1910. These include: precipitation, evaporation, humidity, wind, and temperature records.

PRECIPITATION

The average annual precipitation at Moro is 11.6 inches. This normal has been determined by using the precipitation records obtained, prior to the year 1910, at Grass Valley; where records have been kept since 1905. As shown in Table I, the lowest precipitation recorded was 7.68 inches in 1908; the highest 14.86 inches in 1915.

Table I. Monthly and annual precipitation (in inches) at Grass Valley and Moro, Oregon, from 1905 to 1916, inclusive, with the average, maximum, and minimum for each month.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
1905	.76	.20	.05	.03	1.70	1.30	.36	T	.75	1.36	.85	1.35	8.71
1906	1.00	.85	1.65	.10	1.05	1.85	T	.34	.35	T	2.59	2.22	12.00
1907	2.65	.48	1.60	1.06	.90	.89	.30	.71	.50	.20	1.46	2.58	13.33
1908	.55	.02	.68	.11	1.41	.37	.22	.34	.12	1.11	1.12	1.63	7.68
1909	2.56	1.03	.68	.10	.49	.99	.10	.02	.45	.87	3.34	1.14	11.77
1910	.95	1.47	.63	.66	1.25	.89	T	.00	.20	.70	2.76	.88	10.39
1911	1.18	.46	.25	.35	1.05	.64	.00	T	4.03	.33	.30	.61	9.20
1912	3.58	1.36	.69	.78	1.33	.42	.02	.74	.21	.78	1.30	2.12	13.33
1913	1.33	.23	.76	.58	2.27	1.39	.06	.05	.49	1.87	1.45	1.69	12.17
1914	2.20	1.16	.11	2.06	.76	.66	.08	T	1.05	1.48	.88	.88	11.32
1915	1.75	2.31	1.27	.65	2.06	.36	.57	.05	1.14	.23	2.89	1.61	14.86
1916	1.08	2.43	2.05	.75	1.37	1.98	.92	.15	.33	.39	1.69	1.32	14.46
Ave.	1.63	1.00	.84	.60	1.30	.98	.22	.20	.80	.78	1.72	1.51	11.60
Max.	3.58	2.43	2.05	2.06	2.27	1.98	.92	.74	4.03	1.87	3.34	2.58	14.86
Min.	.55	.02	.05	.03	.49	.37	.00	.00	.12	T	.30	.61	7.68

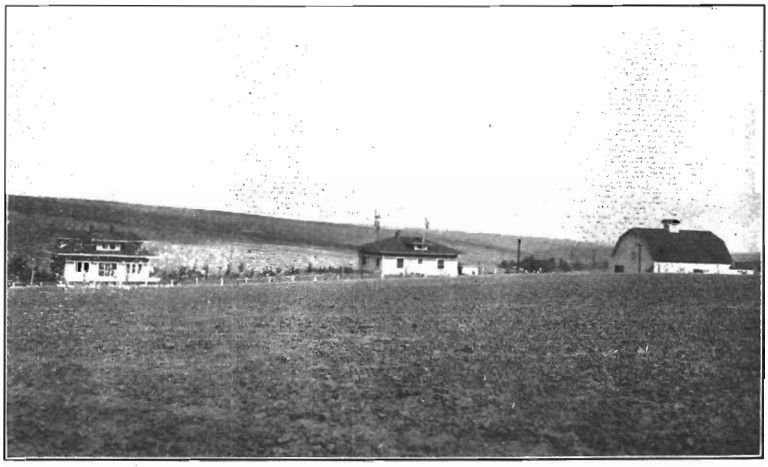

Fig. 2. General view of the Station buildings.

Table II gives the precipitation by crop years, or from September 1 to August 31. From this table, it may be seen that the crop years of 1912 and of 1916, from the standpoint of available moisture for crops, were the most favorable ones of the six reported.

Table II. Precipitation (in inches) for the crop years ending August 31, 1911 to 1916, inclusive.

Period	Precipitation Inches
September 1, 1910 to August 31, 1911	8.47
September 1, 1911 to August 31, 1912	14.19
September 1, 1912 to August 31, 1913	11.08
September 1, 1913 to August 31, 1914	12.53
September 1, 1914 to August 31, 1915	13.31
September 1, 1915 to August 31, 1916	16.60
Average	12.70

The rainfall during the spring and early summer months is an important factor in crop production. This information is given in Table III, which shows that the average rainfall for the five-months period, March 1 to July 31, for six years is 4.37 inches. The growing season of 1916 received 2 inches more rainfall than the growing season of any other year reported, and 2.7 inches more than the six-years average.

Table III. Precipitation for the growing season (March to July, inclusive) for the years 1911 to 1916, inclusive.

Period	Precipitation Inches
March 1 to July 31, 1911	2.29
March 1 to July 31, 1912	3.24
March 1 to July 31, 1913	5.06
March 1 to July 31, 1914	3.67
March 1 to July 31, 1915	4.91
March 1 to July 31, 1916	7.07
Average	4.37

EVAPORATION

The evaporation in inches from a free water surface for the years 1911 to 1916, inclusive is recorded in Table IV. The average evaporation for the seven months is 44.19 inches. The highest evaporation was in 1911; the lowest, in 1916. The average evaporation for the seven months is approximately four times the annual precipitation and nearly eleven times the precipitation for the same seven months.

Table IV. Evaporation (in inches) from a free-water surface for the 7 months from April to October, inclusive, for the years 1911 to 1916, inclusive.

Month	1911	1912	1913	1914	1915	1916	Av'ge
	In.	In.	In.	In.	In.	In.	In.
April	5.92	4.51	4.09	4.02	5.13	4.80	4.75
May	6.13	6.75	6.24	7.43	5.90	5.68	6.36
June	9.61	7.75	7.36	8.29	8.45	6.80	8.04
July	11.57	7.89	7.90	11.43	9.05	7.88	9.28
August	9.28	6.72	7.82	9.64	9.59	7.50	8.43
September	4.16	4.50	4.82	4.40	5.30	4.68	4.64
October	2.34	2.60	3.52	2.20	2.98	2.81	2.74
Total	49.01	40.72	41.75	47.41	46.40	40.15	44.24

Table V. Maximum and minimum temperatures, in degrees F., for each month of the years 1911 to 1916, inclusive.

	Maximum Temperature in degrees.						Minimum Temperature in degrees.					
Month	1911	1912	1913	1914	1915	1916	1911	1912	1913	1914	1915	1916
	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F	°F
January	55	51	58	51	41	51	5	-6	5	28	10	-10
February	46	52	58	38	52	49	9	26	7	28	23	1
March	77	65	57	69	70	64	11	20	9	27	30	27
April	74	68	75	72	75	74	22	28	28	29	32	28
May	86	86	83	88	78	79	30	33	36	32	34	29
June	89	96	89	91	93	96	32	37	37	34	40	36
July	103	98	101	99	96	93	44	43	41	42	40	41
August	89	97	99	100	100	98	42	38	41	43	46	38
September	87	85	88	83	86	87	34	31	33	29	36	34
October	75	69	74	69	73	82	32	25	28	32	33	25
November	61	61	57	59	54	53	4	23	29	19	25	6
December	53	54	47	46	53	47	5	19	10	-3	11	2

TEMPERATURE

The highest, lowest, and mean temperatures for each month of the years 1911 to 1916, inclusive, are given in Tables V and VI.

Table VI. Mean temperatures, in degrees F., in each month of the years 1911 to 1916, inclusive.

Month	Mean 1911 °F	1912 °F	1913 °F	1914 °F	1915 °F	1916 °F	Av'ge °F
January	30.3	29.3	29.5	36.5	29.0	15.8	28.4
February	30.6	36.8	28.8	33.3	36.0	30.6	32.7
March	43.5	37.9	38.2	43.8	45.0	42.5	41.8
April	46.2	45.7	46.6	47.6	50.8	48.1	47.5
May	51.0	54.6	54.6	56.2	53.0	49.9	53.2
June	60.6	61.4	60.4	59.5	60.0	59.6	60.3
July	70.0	66.0	67.9	70.5	64.8	62.3	66.9
August	66.0	62.5	68.0	69.1	71.3	67.8	67.4
September	54.8	55.0	57.6	55.5	57.3	58.6	56.4
October	46.9	44.9	47.3	49.5	50.6	48.0	47.9
November	38.0	40.7	40.7	38.1	38.2	33.4	38.0
December	34.0	33.0	28.0	22.8	32.8	28.9	29.9

Table VII. Dates of the latest frosts in the spring and the earliest frosts in the fall in the years 1911 to 1916, inclusive, with temperatures recorded and the length of the frost-free period in each year.

Year	Last frost in spring		First frost in fall		Frost-free
	Date	Temperature °F	Date	Temperature °F.	period Days
1911	May 8	32	October 17	32	162
1912	April 29	31	September 3	31	127
1913	April 27	31	October 15	32	171
1914	May 27	32	September 12	32	108
1915	April 8	32	November 5	30	211
1916	May 10	29	October 1	29	144
Av'ge	May 3		October 4		154

Table VII shows the dates of the latest spring frosts and the earliest autumn frosts in the six years 1911 to 1916, inclusive. It will be observed from this table that during the six years no frosts occurred in June, July, or August. None of the frosts recorded in the table did any damage to grain crops. The longest frost-free period was in 1915, 171 days, and the shortest in 1914, 108 days. The average frost-free period for the six years is 154 days.

WIND

Table VIII gives the average wind velocity in miles per hour for each month of the six years 1911 to 1916, inclusive. June is the windiest month, though there is little difference in the monthly averages for any month from April to August, inclusive.

Table VIII. Average wind velocity in miles per hour in each month of the years 1911 to 1916, inclusive.

Month	1911	1912	1913	1914	1915	1916	Ave.
January	5.3	3.7	2.4	5.4	3.2	5.8	4.8
February	5.4	4.9	2.8	5.0	4.0	3.7	4.3
March	6.3	6.1	5.9	5.6	4.7	5.6	5.7
April	9.6	8.4	7.3	6.5	6.7	6.4	7.5
May	9.2	7.8	8.3	7.1	5.4	6.6	7.4
June	11.8	5.9	6.9	8.8	8.2	4.7	7.7
July	9.4	5.6	5.9	8.8	8.1	4.5	7.0
Angust	9.2	5.3	6.3	7.5	7.5	3.9	6.6
September	7.2	2.8	3.8	6.0	7.0	3.6	5.1
October	4.8	2.0	5.0	4.0	6.1	3.1	4.2
November	6.7	2.9	4.0	4.5	4.3	2.6	4.2
December	5.5	4.1	2.7	3.9	5.4	3.8	4.2
Average	8.2	4.9	5.1	6.1	6.9	4.5	5.7

Fig. 3. General view of the spring-sown experimental plots in 1916. Cultivated summer fallow in foreground.

WHEAT

The principal cereal crop in Eastern Oregon is winter wheat. According to the last Census report, approximately 75 percent of the total grain acreage in the counties of Wasco, Sherman, Gilliam, Morrow, and Umatilla, was in winter wheat. The total acreage in winter wheat, however, varies considerably from year to year. When the autumn season is unfavorable, a larger portion of the acreage devoted to cereals is planted to spring grains. A comparison of the yields of winter and spring grains is given on page 19.

WINTER WHEAT

At the Branch Station, the work with winter wheat has consisted mainly of testing varieties and experimenting to determine the best methods of cultivating the soil for winter wheat production. The work of improving certain of the most desirable varieties, through selection and hybridization, is also in progress. A discussion of the tillage experiments with winter wheat will be found on pages 30 to 38.

VARIETAL TEST

The winter wheat varieties have been grown, under as uniform conditions as possible, after a summer fallow. The methods of cultivation have been those ordinarily used by the best farmers in the vicinity. The ground for summer fallow has been plowed early and kept free of weeds. Several plots of each variety were grown and the average yield of these plots taken as the yield of a variety.

The rates of planting have been from 3½ to 5½ pecks per acre of seed, which has been treated with formaldehyde. This would be at the rate of 45 to 65 pounds of untreated seed. The stands were thick enough every year except for the crop year of 1913, when a four-peck rate, sown on November 4, gave stands that were much too thin for nearly all varieties.

The dates of sowing the varietal test have been between October 15 and November 5, the average date being October 22.

In Table IX are listed 17 winter wheat varieties which are still being retained in the varietal test. Of these, there are four-years average yields for all varieties except Hybrid No. 123 and Dale Gloria. The varieties are arranged in the order of their average yield for the four years 1912 and 1914 to 1916, inclusive, except the last two varieties for which there are only two-year average yields.

Table IX also shows the yield of all varieties in percentages of the yield of the local Turkey variety. The local Turkey is the variety commonly grown in the vicinity of Moro.

Table IX. Four-years average yields of winter wheat varieties and the yield of each variety expressed in the percentage of the yield of the local Turkey variety.

Rank	Variety	Yield per acre	Yield of Local Turkey
		bu.	%
1	Argentine (1569)	32.0	118
2	Kharkov (1442)	31.2	116
3	Alberta Red (2979)	31.0	115
3	Armavir (1355)	31.0	115
4	Turkey (1571)	30.9	114
5	Theiss (1561)	30.0	111
6	Crimean (1437)	29.4	109
7	Turkey (1756)	29.0	107
8	Turkey (1558)	28.9	107
8	Prohibition (4068)	28.9	107
9	Beloglina (2239)	28.7	106
10	Turkey (local)	27.0	100
11	Turkey (2998)	26.6	98
12	Fortytold (4156)	25.4	94
13	Ghirka (1438)	24.6	91
	Hybrid No. 123	43.8*	
	Dale Gloria	27.1**	

*Average yield for two years.

**Average yield for three years.

Besides the varieties listed in Table IX as Turkey wheats, the following varieties are either strains of the Turkey or are botanically identical with that variety: Alberta Red, Armavir, Argentine, Beloglina, Crimean, Kharkov, and Theiss.

It will be noted from Table IX that the first nine varieties are wheats of the Turkey type. Prohibition, a beardless, white-chaff, soft-kerneled wheat, is next in rank, followed by two more Turkey varieties.

Thirteen varieties have ranked higher than the Fortyfold, which, like the Turkey, is a popular winter wheat on the dry farms of eastern Oregon. The highest yielding Turkey variety has exceeded the Fortyfold by 6.6 bushels per acre for an average of four years.

It will also be noted from Table IX that several varieties of the Turkey group have given higher average yields during the four years than the local Turkey wheat. The four-year average yields of Alberta Red, Kharkov, and Argentine have exceeded the four-years average yield of the local Turkey from 15 to 18 percent. A 10 percent increase in the winter wheat yield of Sherman County would amount to about 15,000 bushels annually.

DESCRIPTION OF LEADING VARIETIES

Turkey. The Turkey or Crimean wheats are the leading winter wheats in most sections of the western half of the United States where winter wheat can be grown. The Turkey, which is frequently called Turkey Red, is a bearded, smooth, white-chaff variety with hard, red kernels. The variety is prized highly for its excellent milling qualities. This group of wheats includes the most cold-resistant varieties known. They are also drought resistant, being widely grown in all dry-farming districts. Objections to the Turkey varieties are the rather long, stiff beards and their tendency under certain conditions to produce starchy or "yellow berry" kernels. For a discussion of "yellow berry" kernels in Turkey wheat, see page 34. In certain sections of the Columbia Basin, where the rainfall is heaviest, Turkey wheats are not grown, because of their liability to lodge and because of the usual presence of "yellow berries."

Hybrid No. 123. The only variety yet tested that gives any promise of exceeding the Turkey wheats in yield is Hybrid No. 123. This is a soft, red-kerneled, beardless, club wheat. It has been tested only for the two years 1915 and 1916. In 1915 it exceeded any of the Turkey varieties in yield, but in 1916 it ranked fourth in yield, being exceeded by three Turkey varieties. On account of its poor milling quality, Hybrid No. 123 usually sells on the market for a less price than other club wheats. It is a cross between Little Club and Jones Winter Fife. Hybrid No. 123 is more susceptible to damage from smut than is Turkey wheat. Schafer and Gaines of the Washington Station, where this wheat was originated,* make the statement that this variety is "no longer considered a desirable wheat because of its poor milling value." A considerable area of

*Wash. Agri. Expt. Sta., Bulletin No. 121.

Hybrid No. 123 was sown by farmers in Sherman County in 1914 and in 1915. The unsatisfactory yield obtained by many farmers in 1916 resulted in a decrease in the acreage planted to that variety in the fall of 1916.

Fortyfold. The Fortyfold or Gold Coin variety, from the standpoint of total acreage, ranks next to the Turkey variety in importance in the Columbia Basin of Oregon. It is a beardless, brown-chaff, white-kerneled variety of poor milling quality. In certain sections of the State it is a good yielder. It usually grows taller than the Turkey, has a little stiffer straw, and is probably as winter hardy as the Turkey. It is usually found badly mixed with other varieties and field hybrids. It shatters easily and much of the grain of this variety is shelled out by the wind and by harvesting operations.

RATES AND DATES OF SOWING WINTER WHEAT

Tests of rates and dates of sowing winter wheat have been carried on at the Branch Station every year to find out what rate and what date of sowing will give best returns. The results thus far have not been consistent on account of varying seasonal conditions during the autumn months.

Fig. 4. Increase rows of spring wheat started from single heads. The progeny of a single head is called a pure line. This method is extensively used to improve grain varieties. It is known as the pure-line method.

The sowing of winter wheat in September, unless the ground is wet, is usually not advisable, as a thin or irregular stand is likely to result. Sowing later than November 1, also frequently results in thin stands of

wheat. The experiments at the Branch Station thus far indicate that the safest time for sowing winter wheat is between October 10 and 25. The main consideration is to get a good stand. With approximately the same stands, no significant differences in yield have been obtained from the different dates of sowing.

Rates of sowing Turkey wheat varying from two to eight pecks per acre have been conducted on several different dates. The time of sowing and the condition of the seed bed are important factors influencing the proper rate of sowing winter wheat. A two-peck rate, sown early in October will frequently give a thicker stand than an eight-peck rate sown late in November. A well-cultivated summer fallow with moisture near the surface, will require less seed than a poorly cultivated summer fallow that is rough or dry near the surface.

With a good, moist seed bed, 35 to 45 pounds of seed an acre may be sufficient, if the sowing is done before the middle of October. For later sowing, the rate should be increased. Allowance should always be made for the swelling of the seed after treating it for smut. At the Branch Station, best results have been obtained by sowing winter wheat with the drill set to seed about five pecks of treated seed an acre. When sown, the seed had increased in volume about twenty percent. The general tendency among farmers is to increase the rate of sowing for winter wheat, on account of the prevalence of weeds. Weeds are rarely troublesome in a thick stand of wheat. Sowing should be thinner on shallow soil than on deep soil. It is also generally advisable to increase the rate of sowing on north slopes where the ground is colder and where there is more likelihood of injury from wireworms.

HOME-GROWN AND IMPORTED SEED OF TURKEY WHEAT.

Five years' results in exchanging seed of Turkey wheat show a slight advantage in favor of the local seed over imported seed. Every year seed of Turkey No. 1558 is received from Moccasin, Montana, and Nephi, Utah. This is sown along side of seed of the same variety grown at Moro. Table X gives the results obtained.

Table X. Showing yields of Turkey wheat grown from seed from different sources.

Source	Yield, Bushels per acre.					
	1912	1913	1914	1915	1916	Ave.
	bu.	bu.	bu.	bu.	bu.	bu.
Moro Seed	25.2	24.0	21.9	26.3	53.0	30.1
Montana Seed	25.5	25.6	24.7	25.5	48.8	30.0
Utah Seed	21.5	23.2	24.6	26.6	44.7	28.1

SPRING WHEAT

In addition to the regular varietal test with spring wheat, considerable nursery work has been done, both for testing new varieties and for developing desirable pure line selections from single heads. Some of these pure line selections have been among the highest yielding varieties when tested in plots.

Table XI. Average yield, in bushels per acre, of spring wheat varieties, for the years 1913 to 1916, inclusive, and the yield of each variety expressed in percentage of the yield of the Bluestem variety.

Rank	Variety	Yield, Bu. per acre	Percentage of Yield of Bluestem
1	Koola (2203-2)*	32.0	126
2	Talimka (2495-1)*	30.2	119
3	Early Baart (1697)	29.6	117
4	Karun (2200-1)*	29.1	114
5	Aulieata (2407-2)*	27.0	106
6	Yantagbay (2404-1)*	27.0	106
7	Heine Sq. Head (2669-1)*	26.9	106
8	Little Club (4068)	26.8	105
9	Marquis (4158)	26.2	103
10	Chul (2227-1)*	25.8	101
11	Zacatecas (2799-2)*	25.7	101
12	Bluestem (4067)	25.4	100
13	Sonora (3036-2)*	24.4	96
14	Rieti (2793)	23.8	94
15	Ble Noir (2511-2)*	23.6	93
16	Ghirka (1517)	23.6	93
16	Kubanka (1516)	21.2	84
	Bobs (2826-1)*	31.9**	116**
	Saumur (2346-1)*	31.1**	114**
	Fretes (1596)	30.4***	99***

*Pure line selections developed at the Moro Branch Station.
**Average yield for three years.
***Average yield for two years.

Twenty varieties of spring wheat are shown in Table XI, arranged in the order of their average yield an acre for the four years 1913 to 1916, inclusive. Table XI also gives the yield of each variety in the percentage of the yield of the Bluestem variety, which is the most commonly grown spring wheat in the Columbia Basin. For two varieties there are average yields for only three years, and one variety has been grown only two years.

It will be noted from Table XI that nine varieties have exceeded the Bluestem in yield for an average of four years. Two other varieties, Bobs and Saumur, have also exceeded the Bluestem for the period grown.

DESCRIPTION OF LEADING VARIETIES

Koola. This is a pure line selection from Koola spring wheat which was introduced by the U. S. Department of Agriculture from Arabia. It has short and rather weak straw and is bearded. It has smooth, white chaff. It matures early. The wheat is fair in milling quality, and an attempt is being made to improve it in this respect, as well as in stiffness of straw, before distributing the variety to farmers.

Early Baart. The Early Baart is an early maturing white wheat that is rapidly supplanting the Bluestem as a spring wheat on the drier soils of the Columbia Basin. It grows nearly as tall as Bluestem, but matures a week or ten days earlier. Tests made with this variety indicate that it is superior to the Bluestem as a milling wheat. On the Portland market it

sells as No. 1 Bluestem. The bulk seed can easily be distinguished from Bluestem by the longer and slightly yellower kernels. The chaff of Early Baart is white and smooth, and the spike bearded.

Talimka. When growing, this variety closely resembles several of a group of early-maturing spring wheats of which Chul is probably the best known variety. The kernels of Talimka are amber and hard, while the Chul has hard red kernels. The heads are slender, with white smooth chaff, and long stiff beards. The kernels are held tightly by the chaff so that they do not shatter readily. It has been a consistently high yielder on the Branch Station lands, and tests indicate that it is a good milling wheat.

Marquis. This variety, which is a hybrid developed by Dr. Saunders of the Central Farm, Ottawa, Canada, matures a little earlier than Bluestem. It is not as early maturing as several other varieties of spring wheat which have been grown in the varietal test and which have given higher yields. The Marquis is highly prized by millers, if it has not been grown under excessive moisture conditions and is free from starchy or "yellow berry" kernels. The Marquis variety would be better than any of the white-kerneled wheats for reseeding Turkey wheat that has been partly winter killed. At the Branch Station, difficulty has been experienced in getting the Marquis to test as high as 58 pounds per bushel. It probably requires thinner rates of seeding than most spring wheat varieties.

Karun. This is a pure line selection from Karun spring wheat, which was introduced by the U. S. Department of Agriculture from Persia. The heads are short and beardless, and the chaff smooth and white. The kernels are small, hard, and white. This variety has always tested high in weight per bushel. It ripens early. The straw is not very stiff and in some locations it might lodge. It appears to be especially well adapted to dry districts.

Bobs. This variety, like the Bluestem, originally came from Australia. The variety grown at the Branch Station is a pure line selection. Though it has been in the varietal test only three years, it gives promise of being among the highest yielding spring wheats. Milling tests indicate that the Bobs is probably equal to the Marquis for bread making. Bobs is a beardless, white-chaff wheat, with heads that somewhat resemble Bluestem. The kernels are semi-hard and white. The plant is shorter than Bluestem and matures earlier.

RATE AND DATE OF SOWING TESTS WITH SPRING WHEAT.

A combined rate and date of sowing test has been conducted for four years with the Bluestem variety. Only two dates have been used, early and late. The average date of the early sowing was March 26, and of the late sowing April 23.

The sowing was done with a Superior disk drill, and the rates indicate where the drill was set for sowing the swollen seed after treating it for smut.

Table XII. Average yield per acre for five years of Bluestem spring wheat sown early in the spring, and late in the spring at different rates.

Early Sowing.		Late Sowing.	
Rate Pecks	Bu. per Acre.	Rate Pecks	Bu. per Acre.
2	16.5	2	12.7
3	16.7	3	13.6
4	17.4	4	11.6
5	18.4	5	12.0
6	17.0	6	11.7
7	17.5	7	12.1
8	20.3	8	11.6
Average	17.7	Average	12.2

Table XII shows that the average yield of all rates of the early (March 28) sowing exceeded the average yield of the late (April 23) sowing by 5.5 bushels an acre. For the early sowing, the thickest rate gave the highest average yield and for the late sowing the three-peck rate yielded highest for the five-years period.

BARLEY

Barley is the second cereal in importance in the Columbia Basin. Both spring and winter forms have been tested at the Branch Station.

WINTER BARLEY

Winter barley is not as hardy as winter wheat, but there are several varieties of winter barley that will generally survive the winters

Fig. 5. Increase fields of grain in 1916. After testing grain varieties in duplicate or triplicate twentieth-acre plots, the most promising ones are further tested in larger plots of several acres before distributing seed to farmers.

of the Columbia Basin region. Of the many varieties of winter barley that have been tested at the Branch Station, all except the five listed

in Table XIII have been discarded, either because of low yield or lack of winter hardiness.

No winter barley yields were obtained in 1913, as none of the varieties sown in the fall of 1912 emerged. The yields given in Table XIII are average yields for the four years, 1912 and 1914 to 1916, inclusive.

Table XIII. Four-years average yields of winter Barley varieties, arranged in the order of their rank in yield.

Rank	Variety	Yield Bu. per acre
1	Texas Winter	49.0
2	Maryland Winter	45.0
3	Tennessee Winter	42.1
4	Chevalier	39.9
5	Utah Winter	36.8

Texas Winter barley has given the highest average yield for the four-years period. When growing, Texas Winter, Maryland Winter, Tennesse Winter, and a local variety of winter barley obtained from Dufur, Oregon, appear identical. The five varieties listed in Table VIII are bearded. No variety of beardless barley tested has been winter hardy.

Table XIV. Yields, in bushels per acre, of spring barley varieties, with the yield of each variety expressed in percentage of the yield of the Coast variety for the period grown.

Variety	Period Grown	Yield Bu.*	% of Yield of Coast Variety
Trebe (936)	1 Year, 1916	95.8	132
Sandrel (937)	1 Year, 1916	84.2	116
Odessa (927)	1 Year, 1916	81.7	113
Horn (926)	1 Year, 1916	79.6	110
Peruvian (935)	1 Year, 1916	77.5	107
Mariout (261)	4 Years, 1913-1916	51.6	106
White Smyrna (658)	4 Years, 1913-1916	50.1	103
Hannchen (531)	4 Years, 1913-1916	48.9	101
Coast (626)	4 Years, 1913-1916	48.6	100
Peru (707-1)	3 Years, 1914-1916	49.9	96
Coast (691-1)	3 Years, 1914-1916	49.2	94
Beldi	4 Years, 1913-1916	45.6	94
Local Beardless	2 Years, 1915-1916	57.0	92
Franconian (679-1)	3 Years, 1914-1916	47.6	91
Svanhals (187)	4 Years, 1913-1916	43.7	90
Chili Brewing (657-1)	3 Years, 1914-1916	46.8	90
Oderbrucker	4 Years, 1913-1916	42.1	87
Himalya (620-1)	3 Years, 1914-1916	44.7	86
Hanna	4 Years, 1913-1916	41.5	85
Black Algerian (708)	3 Years, 1914-1916	43.4	83
Gatami (575)	4 Years, 1913-1916	39.7	82
Withycombe Hull-less	2 Years, 1915-1916	47.9	78
Servian (915)	1 Year, 1916	55.0	76
Manchuria (Minn. No. 105)	4 Years, 1913-1916	31.7	65

*All varieties figured at 48 lbs. per bushel.

SPRING BARLEY

Nearly sixty varieties of spring barley have been tested at the Branch Station. Only the varieties named in Table XIV are still being retained in the varietal test. A few of these have been tried only one year.

For a four-years average, Mariout, White Smyrna, and Hannchen lead, in the order named. Two of the varieties listed in the table are hull-less, Himalya and Withycombe Hull-less. The latter is a beardless hybrid barley produced by Mr. Robert Withycombe, Union, Oregon.

DESCRIPTION OF LEADING VARIETIES

The Mariout barley has been the highest yielding variety for a four-years period. It was introduced into this country from Egypt. The straw is short and has a club head. It matures earlier than most of the other varieties. It is a six-rowed form and is heavily bearded. The kernel is large and coarse and many of the beards are not broken off the kernels in threshing. On account of its rather weak straw, it may lodge in some locations.

The White Smyrna barley ranks second in yield for a four-years period. This variety is two-rowed. It matures early and produces large kernels of excellent quality. On account of its short straw, the variety does not always give a good impression when seen growing. It usually grows tall enough, however, to harvest successfully. This variety is now one of the highest yielders in many of the drier sections of the country.

The Hannchen variety is a two-rowed form that has given good results at the Branch Station. This variety was produced by the Svalof Plant Breeding Association of Svalof, Sweden. It grows taller than White Smyrna and matures a little later. It has a long, narrow, nodding spike, and is bearded, though many of the beards drop off when the barley is ripe and practically none adhere to the kernel after threshing.

The Coast variety is the common six-rowed barley grown in the Pacific Coast states. It is frequently called Blue barley, and is also grown under the names Common California, California Feed, and Bay Brewing. It has a rather compact head, but not quite so compact as the Mariout. Like that variety, the beards are not entirely removed from the kernels in threshing. It does not ripen quite so early as the Mariout, but the straw of the Coast is stiffer and it is less likely to lodge.

OATS

No variety of winter oats has been found that will stand the winter at Moro. Very little spring oats are grown in the Columbia Basin of Oregon. This is probably on account of the fact that the crop is not very well adapted to handling with the combine or header, as there is considerable loss from shattering if the grain is left standing very long after ripening. Forty varieties of spring oats have been tried at the Branch Station. Four-years average yields have been obtained for the varieties listed in Table XV.

Table XV. Average yield, in bushels per acre, for spring oat varieties for the years 1913 to 1916, inclusive, arranged according to rank in average yield.

Variety	4-years yield per Acre Bu.
Siberian (635)	62.1
Sixty Day (165)	60.4
Western Wonder (local)	59.8
Swedish Select (134-1)	58.8
Kherson (459)	58.7
Swedish Select (134)	57.7
Shadeland Climax	54.5
Black American (549)	54.2
Canadian (444)	52.3

During years of normal or less than normal rainfall, the early-maturing varieties like Sixty Day and Kherson give the highest yields. In 1916, when the rainfall was considerably above normal and the growing season cool, some of the later-maturing varieties gave considerably higher yields than the Sixty Day and Kherson. It is believed, however, that the latter varieties are the safest ones to grow on most of the dry uplands of the Columbia Basin.

DESCRIPTION OF VARIETIES

The **Sixty Day** and **Kherson** varieties are practically identical. They are the earliest-maturing varieties known. The straw is short and the weight per bushel not so high as for the later-maturing varieties. Some object to the usual light weight of Sixty Day and Kherson, but the percentage of hull is lower than in most varieties of oats.

The **Siberian** variety has been the highest yielder for the four-years period. This variety is medium late in maturing and has large plump kernels. For locations in the Columbia Basin where the average annual precipitation is about 15 inches or more, the Siberian variety would probably give higher yields than the Sixty Day or Kherson.

The **Western Wonder** is a locally grown variety similar to Siberian. When obtained, it was badly mixed with barley. It has been grown in the vicinity of Moro for about ten years and was originally obtained by Mr. A. H. Barnum from an Iowa Seed Company.

EMMER AND SPELT

Emmer and Spelt are still advertised by many seedsmen as being exceptionally high yielding grains for dry lands. The results at the Branch Station show that neither emmer nor spelt will give as high yields per acre as barley or oats. Winter emmer and winter spelt are hardier, however, than winter barley.

Some seed companies advertise emmer and spelt as "emmer or Speltz" but the grain usually offered for sale is emmer. Emmer and spelt are two distinct grains, though they look much alike when threshed. Emmer is always bearded, and spelt is either bearded or beardless.

Table XVI gives the average yield per acre for the emmer and spelt varieties tested at the Branch Station during the years 1913 to 1916, inclusive. It will be noted that for the period grown, the Red Winter spelt, a beardless variety, has exceeded all varieties of emmer in yield by nearly 200 percent.

Table XVI. Average yield of emmer and spelt varieties for the years 1913 to 1916, inclusive.

Variety	3-years average yield, Bu. per acre 1914-1916.	4-years average yield, Bu. per acre 1913-1916
Red Winter Spelt (1772)	57.4	
Black Winter emmer No. 2483	26.1	25.1
Black Winter emmer No. 2337	29.4	28.0
Buffum Black Winter emmer	28.6	26.7
White Spring emmer No. 1524		26.6

RYE

Most of the rye grown in the Columbia Basin of Oregon is grown in Morrow and Gilliam counties. Rye is especially valuable for growing on shallow or poor soil. Seed yields are usually not so high as those of wheat or barley, but if cut for hay, rye will frequently be the most profitable crop to grow on certain types of soils. Rye makes a fairly satisfactory hay if cut soon after heading. If left too long, the stems become woody and tough.

There are both winter and spring forms of rye. No beardless rye has yet been developed. Of the winter forms that have been tested at the Branch Station, Abruzzes and Giant Winter have given the highest yields. A spring rye, No. 26101, obtained by the U. S. Department of Agriculture, in Idaho, has proved to be an exceptionally valuable spring variety. It matures early as a spring crop, and may also be planted with safety in the fall. The straw is finer than that of most varieties and soon after heading many of the beards drop off.

ACRE VALUE OF GRAIN CROPS

Table XVII gives the yields in pounds per acre of the leading variety of winter and spring wheat, winter and spring barley, spring oats, and winter spelt. The yields per acre are the average yields of each grain for the years 1913 to 1916, inclusive. The price per pound is based on the ten-years average price of Bluestem wheat, feed oats, and barley in Portland on December 1.

It will be noted from Table XVII that spring barley ranks first in total yield and value an acre and that winter spelt ranks last. The price for the spelt was assumed to be the same as that of barley. All crops mentioned in Table XVII were grown after a summer fallow, except the oats, which were grown two seasons on disked corn ground and two after a summer fallow.

Table XVII. Acre value of grain crops based on highest yielding varieties on Branch Station and on ten-years average prices in Portland, Ore., on December 1.

Variety	Yield lbs. per Acre	Value per acre, f.o.b. Portland, Ore.
Winter Wheat, Alberta Red (2979)	1932	$31.88
Spring Wheat, Koola (2203-2)	1920	31.78
Winter Barley, Texas winter (554)	2352	31.40
Spring Barley, Mariout (261)	2477	33.06
Spring Oats, Siberian (635)	1987	28.21
Emmer and Spelt, Red Winter Spelt	1837	24.52

The price per pound of each grain was based on figures compiled from the files of the Morning Oregonian and the Oregon Evening Journal of Portland for the years 1907 to 1916, inclusive. The compilation was made by the Office of Grain Standardization of the U. S. Department of Agriculture. As these ten-years average prices will be of interest to all farmers, they are given in Table XVIII.

Table XVIII. Ten-years average prices of Bluestem spring wheat, feed barley, and oats, in Portland, Oregon, on the first of each month for the years 1907 to 1916, inclusive.

	Bluestem Wheat, per Bushel.	Feed Barley. per Ton.	Feed Oats per Ton.
January 1	$ .946	$26.22	$27.92
February 1	.995	27.05	29.40
March 1	.971	25.95	31.10
April 1	.985	26.25	29.60
May 1	1.00	26.05	30.07
June 1	.984	26.22	29.47
July 1	.956	26.15	29.02
August 1	.913	25.00	26.50
September 1	.927	25.00	26.77
October 1	.953	25.67	26.45
November 1	.977	26.67	27.92
December 1	.990	26.70	28.37

FIELD PEAS

Field peas have been the most profitable of all the leguminous crops tested at the Branch Station. The results indicate that this crop will be the best legume to grow in a rotation with grain to increase and maintain the fertility of the soil.

The equipment on the ordinary dry farm is usually sufficient for the production of field peas. The crop is sown with the grain drill and may be harvested with the mower, reaper, header, or combine. Some form of a lifter guard must be placed on the cutter bar to harvest the crop, because the peas, when grown alone, lodge after ripening. The peas may be threshed with the grain separator by removing some of the concaves and reducing the speed of the cylinder to avoid cracking the seed.

The soil suspension method of inoculating the peas before sowing has been used successfully at the Branch Station. The method is simple: the seed is dipped into muddy water prepared with soil which has grown field peas and is known to contain the bacteria.

It is important that field peas be sown as early in the spring as possible in order that the crop may escape injury from the hot weather in June and July. Fall plowing is desirable, as it lessens the amount of spring work necessary to put the ground in proper condition for sowing.

Field peas are sown at the Station with a 14-hole, 7-inch grain drill. The two holes at each end are left open, the next four closed, and the two middle, or the 7th and 8th holes, left open. The peas are thus

Fig. 6. A plot of French June field peas in full bloom, June 1916. This plot yielded at the rate of 32.2 bushels an acre.

sown in double or paired rows. The space between the two rows of the pair is 7 inches, and that between the pairs of rows is 35 inches. About 75 pounds per acre is sown. The rate of sowing, however, has varied with the size of the seed, more being used in sowing the large-seeded varieties like Marrowfat, Agnes, and Cavalier. The average date of sowing for the four years 1913 to 1916, inclusive, was March 23.

Fifty varieties of field peas have been tested. Of these, all have been discarded except twenty varieties. Four-years average yields are available for eighteen varieties.

The varietal test in 1913 was on ground that grew field peas the previous year; in 1914 and 1915, the peas were on ground that had been

fallowed the previous season; and in 1916 the peas were on ground that grew barley in 1915. The aphis did some damage to the peas in 1914 and 1915, but were not present during the other two years. The pea weevil has not yet been troublesome. Table XIX gives the yield of the field pea varieties for the years 1913 to 1916, inclusive, and the average four-years yield for this period.

Table XIX. Yields, in bushels per acre, of field pea varieties for 1913 to 1916, inclusive, with average yields for this period.

	Yield, Bushels per acre.				
Variety	1913	1914	1915	1916	Ave.
Lima	22.1	21.8	20.8	26.7	22.8
White Canada	20.9	19.0	23.0	27.3	22.5
O'Rourke	19.1	19.0	24.5	26.6	22.3
Solo	24.1	13.6	20.7	30.8	22.3
Carleton	22.4	12.1	18.2	34.8	21.9
Cavalier	17.8	15.8	24.2	26.1	21.0
Wellwood	25.0	13.3	15.3	29.2	20.7
Gregory	19.1	16.1	18.2	28.9	20.6
Amraoti	19.1	12.6	23.3	26.0	20.2
Husbands	20.8	13.7	20.4	24.8	19.9
Early Britain	21.8	10.5	20.1	26.5	19.7
Bangalia			21.1	18.3	19.7*
Grey Winter	26.8	8.8	12.2	30.5	19.6
Kaiser	20.6	9.8	18.7	28.9	19.5
Prince	10.3	18.5	16.7	31.3	19.2
Agnes	18.3	13.9	18.1	23.9	18.5
Marrowfat	21.1	12.8	15.2	25.0	18.5
Cossack	19.0	8.2	13.9	26.5	16.9
Blue Prussian	10.9		18.2	19.9	16.3**
White Scimitar	3.3	15.2	21.1	20.0	14.9

*Average Yield for two years.
**Average yield for three years.

DESCRIPTION OF LEADING FIELD PEA VARIETIES.

Lima. Lima is one of the earliest varieties to mature. It makes a fairly large vegetative growth. The flowers are colored, the seed medium in size, and of a gray, green color, some having purple or bluish dots. The variety does not crack badly in drilling or threshing.

White Canada. There are probably several varieties of field peas sold by seedsmen under the name White Canada. The genuine White Canada has been a consistently good yielder at the Branch Station. The variety ripens about a week later than Lima. The flowers and the seed are white and small. It cracks some in threshing.

O'Rourke. This is an early-maturing variety with fine leaves and stems. The flowers and seed are white. It does not grow as tall as White Canada, but the size of the seed is about the same as that variety. O'Rourke and Amraoti are probably identical, though O'Rourke has given slightly higher yields than Amraoti.

Solo. This variety was produced by the Svalof Plant Breeding Association of Svalof, Sweden. It is a tall-growing variety with fine

leaves and stems and is medium late in maturing. The flowers are purple. The seed is large and of a gray, green color, usually having purplish dots. The green axil of the leaflets distinguishes this variety from all others having purple flowers. The Solo variety does not crack badly in threshing.

Carleton. This has been one of the best of the later-maturing varieties. It has been given quite a wide distribution in Oregon, and has given good results when grown by farmers. The flowers of the Carleton variety are colored; the seed is of medium size and spotted or marbled with rust-red to brownish spots. It is very similar to the Partridge variety in appearance and habit of growth, but differs slightly in the shape of the seed. The seed is tough and does not crack badly in threshing.

Bangalia. The Bangalia variety has been widely advertised as a suitable variety for growing in dry lands. It has been tested at the Branch Station for only the two years, 1915 and 1916, and during those

Fig. 7. Field peas in cultivated rows. 1916. The plot in the foreground has grown peas continuously for five years. The yield in 1916 was 27.2 bushels an acre.

years its yield has been exceeded by many other varieties. This variety, however, has several good qualities. It ripens very early and on account of its dwarf stature, fine leaves, and stems, it is a satisfactory variety to handle. The flowers are colored; the seed is small and of a gray-green color. It shatters but little in handling, and there is practically no cracking in threshing.

CONTINUOUS CROPPING TO PEAS

Profitable yields of field peas can be obtained when grown continuously on the same land without summer fallowing. At the Branch Station, a section of ground has given the following yields of field peas:

1912	14.8	bushels per acre.
1913	24.0	bushels per acre.
1914	19.0	bushels per acre.
1915	9.0	bushels per acre.
1916	27.4	bushels per acre.
Average	18.8	bushels per acre.

The average yield of Bluestem spring wheat, grown after summer fallow during the same period on ground near the section seeded to peas continuously, was 22.2 bushels an acre.

FIELD PEAS IN THE ROTATION

Four-years results are available for a four-course rotation in which peas have been substituted for one summer fallow. Four tenth-acre plots have been used for this rotation each year and the crops grown in the following sequence: fallow — spring wheat — field peas — spring wheat. The preparation of the soil for the spring wheat following the peas has been a double disking and one harrowing. The field peas used were the Marrowfat variety, sown on fall-plowed wheat land harrowed once in the spring before sowing. The peas were sown each year with all drill holes open, and given no cultivation. The average yields per acre of seed obtained for the four years, 1913 to 1916, inclusive, in this rotation, are given below:

Field peas after spring wheat	15.7 bushels.
Spring wheat after field peas	22.3 bushels.
Spring wheat after summer fallow	23.5 bushels.

In 1916, three new field-pea and wheat rotations were started on ground that had grown field peas continuously since 1912. Following is a summary of the results obtained in 1916:

Average yield of 4 plots of spring wheat after field peas for four years	40.2 bushels.
Average yield of 3 plots of field peas after field peas four years	27.4 bushels.
Average yield of two adjacent plots of wheat after summer fallow	38.5 bushels.

It will be noted that there is but little difference in the yields of spring wheat following field peas and following summer fallow. Whether it will pay the farmer to grow field peas, will of course depend largely upon the profit realized on the peas.

SOIL MOISTURE USED BY FIELD PEAS

Some work was done at the Branch Station in 1915 and 1916 to determine the relative amounts of soil moisture used by field peas, wheat, and corn, and the amount of moisture conserved by summer fallowing. These tests indicate that the percentage of soil moisture in

the ground is higher after a crop of peas than after a crop of wheat or corn, but less than after a summer fallow. Table XX gives the moisture content of soil, in percentage of dry weight, of several plots after removing crops of wheat, corn, and peas, and the moisture content of fallow plots. The table also gives the average seed yield of the plots in bushels per acre.

Fig. 8. First year's growth of Grimm Alfalfa. Sown on March 29; photographed August 1.

The soil samples were taken to a depth of six feet on each plot, in triplicate cores. The samples were taken on Nov. 9 and Nov. 22.

Table XX. Moisture content, in percentage of dry weight, of fallow soil and of soil from which were removed crops of field peas, wheat, and corn, and average seed yields in bushels per acre.

	Moisture	Seed yield.
	%	Bu.
Spring wheat (average of 4 plots)	7.5	39.4
Corn (one plot)	8.0	27.1
Field peas (average of 3 plots)	9.0	27.7
Fallow (average of 2 plots)	13.4	....

UTILIZATION OF THE CROP

Pasturing field peas with hogs or sheep will probably prove to be the best method for the farmer to utilize the crop. Hogs or sheep may be turned into the field when the seed in the lower pods is be-

ginning to harden. Tests by experiment stations and by farmers have proved that "hogging off" field peas is a profitable method of handling the crop. For this purpose, field peas would be better than grain, as the peas may be either followed with peas or grain and profitable yields obtained without summer fallowing. Peas mixed with grain may also be used for silage. When grown for hay, field peas at the Branch Station will usually yield from 1½ to 2½ tons an acre.

ALFALFA

The alfalfa investigations have been directed mainly to determine the best method of growing this crop for seed. Different varieties have been sown in rows at distances varying from 7 to 72 inches apart. The plants have also been spaced at varying distances in the row.

The alfalfa plants make a vigorous growth and blossom profusely, but in some seasons the blossoms wither and fall to the ground without tripping, and consequently do not produce seeds. It was at first

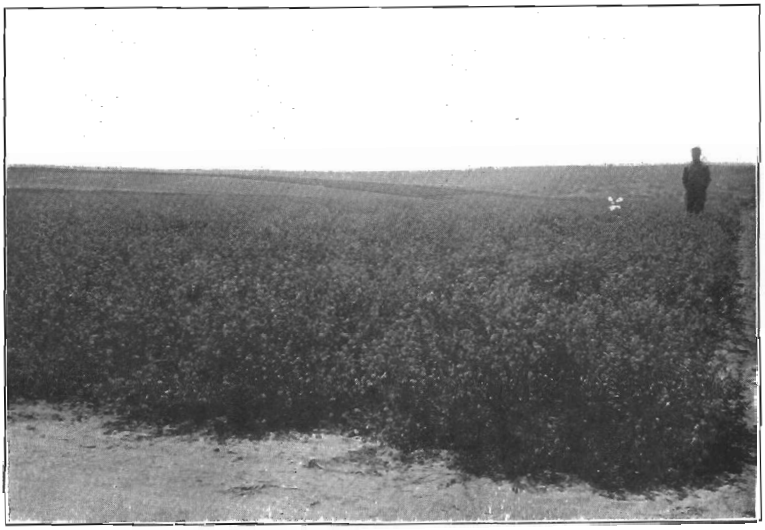

Fig. 9. An acre plot of Grimm alfalfa in 1916. Sown spring of 1913.

thought that this might be due to thickness of stand and lack of moisture. The year 1916 was a favorable one from the standpoint of moisture, but the alfalfa seed crop was a failure. The plants in the plots with rows 72 inches apart showed no evidence of suffering from lack of moisture at any time, nevertheless the blossoms failed to set seed.

The Baltic and the Grimm varieties have given the best results for seed production.

Alfalfa is promising for a hay or pasture crop. About 1 to 1½ tons an acre of hay can be expected with considerable pasture in addition. When grown for hay on dry land it is best to have the alfalfa in rows at least three feet apart.

SWEET CLOVER

The results obtained with sweet clover indicate that it may be equal to or even better than alfalfa. It is a biennial and therefore must be sown every other year. The seeding should be done early in the spring, and indications are that growing sweet clover in rows will be the best method. Harvesting the crop for hay must not be delayed, as the plants become woody after blossoming. It is equal to alfalfa in feeding value, but not so desirable on account of its lack of palatibility. It is claimed, however, that stock will eat sweet clover readily after once acquiring a taste for it.

Fig. 10. Sudan grass cut for seed, 1915. Walla Walla White Dent corn at left.

VETCH

Several varieties of vetch have been tried, but hairy vetch sown in the fall has been the most promising. When the rains come early so that the crop can emerge before the ground freezes, a hay yield of 1½ to 2 tons can be obtained. It does not seem advisable to sow hairy vetch later than the middle of October. The present high price of hairy vetch seed prohibits the sowing of any large acreage, and the raising of the seed would probably not be profitable in the Columbia Basin.

GRASSES

A number of grasses have been tried, but none has shown indications of being superior to alfalfa or sweet clover for pasture or for hay.

Sudan grass has yielded from 1 to 1½ tons of hay an acre. The early growth is slow, sometimes making it difficult and expensive to control weeds. Being a sorghum, it is better adapted to a warmer climate.

CORN

Twenty-three varieties of corn have been tested at the Branch Station. The five most satisfactory varieties are listed in Table XXI, with average four and five-years yields.

Table XXI. Five leading corn varieties, with seed yields in bushels per acre for a four-years and a five-years period.

	Av. yield Bu. per Acre 1912-1916.	Av. yield Bu. per Acre 1913-1916.
Northwestern Dent	24.4	23.2
Minn. No. 13	19.5	19.0
Minn. No. 23	16.1	14.4
Walla Walla White Dent	....	22.5
Brown Co. Yellow Dent	....	20.0

Of the varieties listed in Table XXI, the Northwestern Dent, Minn. No. 23, and Brown Co. Yellow Dent mature early. Walla Walla White Dent is a little later in maturing than Minn. No. 13. These two varieties are recommended for silage purposes in the Columbia Basin. For "hogging off" the Northwestern Dent or Brown Co. Yellow Dent would probably give best results.

Corn which has been grown at the Branch Station for several years has always given higher yields than corn of the same varieties obtained from other localities.

The corn at the Branch Station has usually been planted with a corn planter in rows 3½ feet apart on spring-plowed ground which has been thoroughly harrowed. Listing was tried one season but the results from this method of planting were not satisfactory. Planting in check rows is best where weeds are troublesome. From two to four cultivations have been given during the summer.

POTATOES

Twenty-eight varieties of potatoes have been tested at the Branch Station. On account of the prevalence of potato diseases in 1913 and 1914, the varietal test during those years was unsatisfactory. This was especially true in 1914. The leading varieties are listed in Table XXII, with two- and four-years average yields. New seed of all varieties was obtained in 1915 from the Aberdeen, Idaho, Substation. The yields for 1914 are not included in Table XXII.

Table XXII. Leading potato varieties with four-years (1912-13 and 1915-16) and two years (1915-16) average yields in bushels per acre.

	Four-years Av. Yield Bu. per acre.	Two-years Av. Yield Bu. per acre.
Green Monutain	184.0	271.0
Early Rose	155.5	219.0
Burbank	150.3	200.0
Russet Burbank	149.19	200.0
Irish Cobbler	141.8	189.0
Vt. Gold Coin	128.4	211.0
Early Ohio	100.2	138.0
Pearl	.....	236.0

It will be noted from Table XXII that the Green Mountain variety has exceeded all others in average yield for a two-years and a four-years period. The cooking quality of the Green Mountain, however, has not been up to the standard of several of the other varieties.

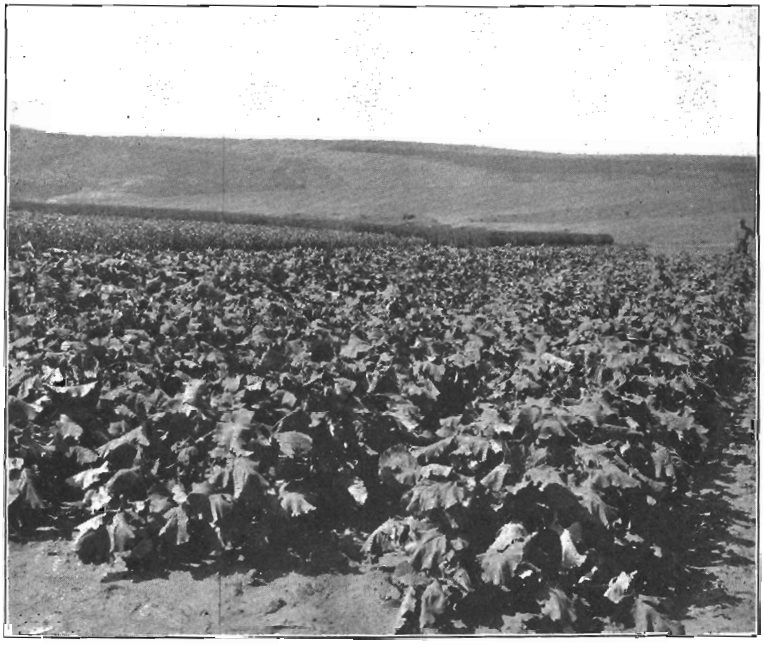

Fig. 11: Kale and Rape, 1916. Rape, on right, yielded at the rate of 12.9 tons of green feed an acre.

Of the early potatoes, the Early Rose has given the highest yields. The quality of the Early Rose is generally good. The objection to this variety is its tendency to produce a large percentage of tubers of undesirable shape. It will also occasionally make second growth. The Irish Cobbler, an early-maturing white potato, has given fairly satisfactory yields of tubers of good quality.

The Burbank and Russet Burbank (Netted Gem) are standard varieties in Oregon. The cooking qualities of these two varieties are usually of the best. They are fair yielders on dry lands, but if the seed is not carefully selected, the tubers are likely to be of unmarketable shapes and sizes. These varieties will also make second growth some seasons.

The Idaho Rural, a variety tried only in 1916, promises to be of some merit. It gave the second highest yield in the varietal test, 296 bushels an acre, and the cooking qualities of the potatoes were good. It is a standard potato in Southern Idaho, where it produces higher yields than the Burbank under dry-land conditions.

The potato varieties have always been planted on re-plowed summer fallow. The seed has been treated either with formalin or a 1-1000 solution of corrosive sublimate. The seed pieces were dropped 2 feet apart in rows 3½ feet apart, and placed about 5 inches deep on the side of a furrow 8 or 9 inches deep. Enough cultivation was given to keep the potatoes free from weeds.

Potatoes grown under dry-farming conditions in Eastern Oregon are generally of much better quality than potatoes grown in the more humid sections of the State.

TILLAGE EXPERIMENTS

Fourteen acres of ground are devoted to tillage experiments to find out the best methods of soil cultivation for wheat production under the summer-fallow system. Nine surface cultivation methods are used on five kinds of spring plowing. Four of these same cultivation methods are also used on four kinds of spring plowing.

For all spring-plowing tests, four-years results are available. For the fall-plowing tests, only three-years results have been obtained.

Winter wheat (Alberta Red No. 2979) has been used in all the tillage tests, except for the depth of plowing test, for which Bluestem spring wheat has been used. Following is a brief summary of the results obtained in these tillage experiments:

DISPOSITION OF STUBBLE

After removing a grain crop, should the ground be given any cultivation in the fall? The practice of disking the stubble in the fall has been recommended and is followed by a number of farmers. Following are some of the advantages claimed for fall disking of the stubble: (1) It hastens the decay of the stubble by breaking it up and burying it in the soil; (2) by loosening the surface it puts the soil in better condition to absorb moisture and also to prevent run-off; (3) by disking, weed seeds and grain are covered and quicker germination is thus insured.

Table XXIII gives average yields, in bushels per acre of winter wheat, grown after fallow, on plots which were disked in the fall and

spring prior to plowing; plots that were disked in the spring only; and plots that were not disked. The yields are the averages of tenth-acre plots for the four years 1913 to 1916, inclusive.

Table XXIII. Yields in bushels per acre of winter wheat grown after fallow on plots disked in the fall and spring prior to plowing, plots disked in the spring only, and plots not disked, for the years 1913-1916, inclusive.

Date of Plowing	Disked fall and Spring. bu.	Disked spring only. bu.	Not Disked bu.
April 1	26.6	29.9	33.5
May 1	27.2	29.0	27.2
June 1	27.2	25.9	21.0
Average	27.0	28.3	27.2

It will be noted from Table XXIII, that the undisked plot gave better yields than the disked plots, when plowing was done as early as April 1. The yield of the plot disked only in spring was higher than that of the plot disked in both fall and spring. When the ground was not plowed until May 1, little difference in yield resulted from the three treatments, though the spring disked plot excelled the others. When plowing was done as late as June 1, however, the disking considerably increased the yields. The questionable value of fall disking where the stubble is short, is also brought out in the results obtained in the deep and shallow plowing test. The average four-years yields of Bluestem spring wheat for two plots each are as follows:

Disked spring and fall ..... 17.6 bushels.
Disked in spring only ..... 17.5 bushels.
No disking ..... 18.6 bushels.

In this case the plowing is done early in April. The results of these tillage experiments thus far indicate that fall disking is of no value if the stubble is short. The grains on the Branch Station lands are cut with a self-binder. Experiments have been started to determine if fall disking will have any beneficial effect when the entire straw crop is returned to the land, as is the case when a combine is used.

Spring disking of stubble before plowing has not given increased yields, if the plowing for summer fallow is done early in the spring. When the plowing is deferred, however, increased yields of winter wheat are always obtained on ground which has been thoroughly disked early in the spring. Double-disking in the early spring destroys weeds and volunteer grain and conserves moisture. Early-spring disked ground will retain enough moisture so that it can be plowed easily and well, even if plowed as late as the first of June; while ground that has not been disked, if plowed late, will usually be hard and dry, making plowing both difficult and expensive. Disking in the fall will not take the place of spring disking, because most of the weed seed and volunteer grain ordinarily will not germinate until spring and are therefore not killed by fall disking.

TIME AND MANNER OF PLOWING

There is no general agreement among farmers of the Columbia Basin on questions involving time and manner of plowing for wheat production. The Branch Station is attempting to find answers to questions such as these:

Which is the better plow to use, the disk or moldboard?

Will fall plowing for summer fallow give as high yields as spring plowing?

Is deep plowing beneficial?

What time in the spring is best to plow?

Some interesting and valuable data have been already obtained on these and related questions.

Some of the experiments will have to run for a longer period of time in order to get data that will be more conclusive.

Table XXIV. Average yields of winter and spring wheat, in bushels per acre, on ground plowed at different dates and at different depths in the fall and spring with a moldboard and disk plow.

Manner and Time of Plowing	Number of tests.	Yield, Bu. per acre.
Early fall, disk plow	12	26.5
Early fall, moldboard plow	12	29.2
Late fall, disk plow	12	24.9
Late fall, moldboard plow	12	25.0
Average for early fall plowing	24	28.0
Average for late fall plowing	24	25.0
Average for disk plowing	24	25.7
Average for moldboard plowing	24	27.2
Spring plowing, April 1	32	29.9
Spring plowing, May 1	32	27.0
Spring plowing, June 1	32	22.1
Spring plowing early, deep	32	19.1*
Spring plowing early, shallow	32	18.7*

*Yields of Bluestem spring wheat; all other yields are for Turkey winter wheat (Alberta Red No. 2979).

In Table XXIV is presented a summary of the results obtained in the experiments involving time and manner of plowing. The yields are for winter wheat except for the deep and shallow plowing test, which are for spring wheat.

It will be noted from Table XXIV that in the fall-plowing tests, the ground plowed with a moldboard plow has given slightly higher yields than ground plowed with the disk plow. This has been true, however only for the early-fall plowing when the ground was dry. For the late-fall plowing, the yields obtained with the two types of plows are identical.

The early-fall plowing has given higher yields for the three years than the late-fall plowing. This is contrary to the general belief of

farmers in this section, most of whom maintain that dry fall plowing is injurious. All fall plowing has been left rough during the winter. It has required more work to keep the fallow clean on fall-plowed land than on spring-plowed land.

The highest yields of winter wheat have been obtained on ground plowed April 1, as is shown in Table XXIV. It will be noted from this table that the average four-years yield of 8 tenth-acre plots plowed April 1, is 7.8 bushels per acre more than the average yield of the same number of plots plowed on June 1. It appears from these results that a farmer in the Columbia River Basin loses from 1 to 2 bushels of wheat per acre (depending upon the season) for every week that the ground is left unplowed after April 1. During favorable seasons, the difference in yields between the plots plowed April 1, May 1, and June 1, has not been so great as during years when weather conditions have not been favorable. In 1913 the difference in the average yield per acre of 7 plots (none of which was disked before plowing) plowed June 1 was 8.8 bushels per acre, while the average yield of 7 plots cultivated similarly but plowed April 1, was 24.5 bushels per acre, a difference of 15.7 bushels per acre in favor of the early plowing. In 1916, a very favorable season for grain production, the average yield of the 7 plots plowed June 1 was 35.2 bushels per acre, and the average yield of the same number of plots plowed April 1 was 41.8 bushels per acre, a difference still of 6.6 bushels per acre in favor of the early plowing.

If the ground has not been disked in the spring, the time of plowing is a very important matter—more important, it is thought, than most farmers realize. Weeds and volunteer grain, which always appear in the spring on the wheat lands of the Columbia Basin, may take as much moisture out of the ground as a crop of wheat. Theoretically, the turning under of volunteer grain and weeds should be of value as green manure, but the conservation of soil moisture is apparently of much more importance than the addition of fertilizer in the form of green manure. No important increased yields have been yet obtained in the rotation experiments where a leguminous crop is purposely turned under for green manure.

"YELLOW BERRY" IN TURKEY WHEAT

An important discovery has been made in the tillage experiments in connection with the quality of Turkey wheat grown under different tillage methods. During each of the four years, 1913-1916, the plots plowed June 1, without previously being disked, produced wheat with a high percentage of starchy or "yellow berry" kernels, while the plots sown on the same date and at the same rate, but on ground plowed April 1, produced wheat with no starchy or yellow berry kernels. It is not yet known just why the late-plowed plots always have produced "yellow berry" wheat, but the question is being carefully investigated. Late plowing or poor cultivation of the fallow are undoubtedly not the

only causes of "yellow berry" in Turkey wheat, but the results at the Branch Station prove quite conclusively that they are among the causes.

Table XXV gives a partial analysis of the wheat grown on the early- and late-plowed plots in the tillage experiments in 1915. It will be seen from this table that the wheat on the late plowing had 86 percent of "yellow berry" or starchy kernels, while the wheat grown on the early plowing had none. The "yellow berry" wheat was lower in protein content by 4.84 percent. Table XXV also gives a partial analysis of the flour milled from the flinty and yellow berry wheat.

Table XXV. Analysis of two samples of Turkey wheat (Alberta Red No. 2979), one grown on early plowing and one on late plowing in the spring. Time and rate of sowing were identical for both samples.

	Early Plowing, Flinty.	Late Plowing, Starchy.
Wheat.		
Water ....%	8.17	8.40
Ash ....%	1.93	2.03
Nitrogen ....%	2.34	1.49
Protein ....%	13.35	8.49
Wt. per 1000 kernels, grams	19.80	28.90
Wt. per bushel ....lbs.	55.1	60.5
Yellow berry ....%	0.	84.0
Flour.		
Water ....%	11.75	11.98
Ash ....%	.475	.437
Nitrogen ....%	1.95	1.29
Protein ....%	11.12	7.35
Color ....%	96.5	97.0
Acidity ....%	.103	.081
Wet gluten ....%	29.8	18.7
Dry gluten ....%	10.5	6.6
Absorption (100 grams)..cc.	68.5	66.0
Maximum expansion "..cc.	650.	630

Figure 12 shows the loaves of bread baked from the flour milled from the two samples of wheat. There was little difference in the appearance or texture of the loaves, except that the loaf from the flinty wheat had a crust with much more attractive golden-brown color than the crust of the loaf from the "yellow berry" wheat. This is only partly shown in the photograph of the two loaves. The analyses and the milling and baking were done by the Bureau of Chemistry of the U. S. Department of Agriculture.

A test of the gluten and hardness of the wheat grown in 1916 on the late-plowed and early-plowed plots of the tillage experiments was made by Prof. G. R. Hyslop of the Oregon Agricultural College Experiment Station. Table XXVI gives the data obtained.

Table XXVI shows that there were 60 percent more kernels with yellowberries in the wheat grown on the land plowed late in the spring.

There was a difference of 11.7 percent in the moist gluten content of the two samples of wheat. The crushing point was ascertained by recording the average pressure required to break twenty-five kernels. The weight per bushel and the moisture content was higher in the wheat containing starchy or yellowberry kernels.

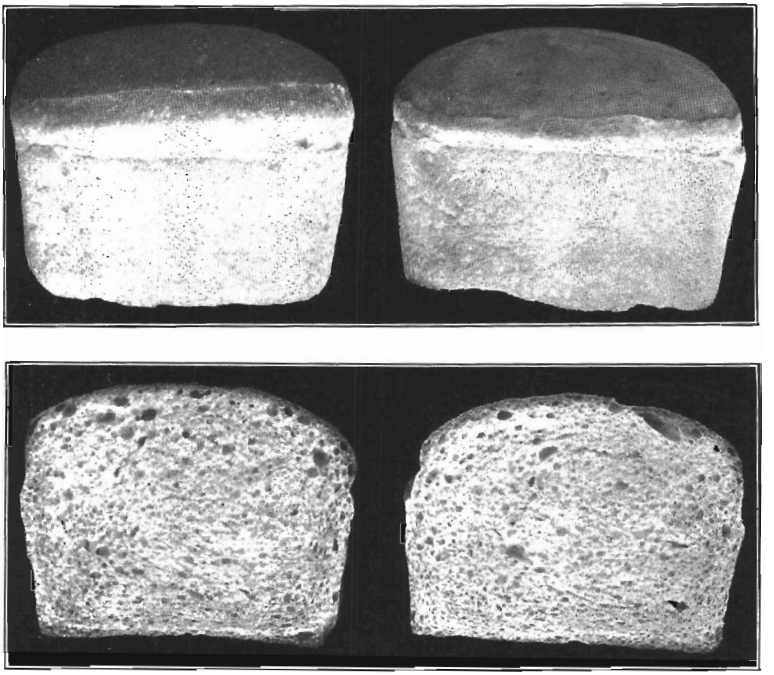

Fig. 12. Loaves and cross sections of loaves made from flinty (left) and yellowberry (right) Turkey wheat.

Table XXVI. Difference in gluten content and hardness of Turkey Wheat (Alberta Red, C. I. No. 2979) grown on early- and late-plowed land.

Early Plowing	
Yellowberry, percent	20.0
Moist gluten, percent	30.4
Dry gluten, percent	11.4
Crushing point, pounds	36.1
Weight per bushel, pounds	65.0
Moisture content, percent	9.3
Late Plowing.	
Yellowberry, percent	80.0
Moist gluten, percent	18.7
Dry gluten, percent	6.6
Crushing point, pounds	34.0
Weight per bushel, pounds	66.0
Moisture content, percent	9.7

THE USE OF PACKERS

Does it pay to pack the ground after plowing with a subsurface or surface packer? It is claimed by some that ground packed with a subsurface packer will retain more moisture than ground not packed. In Table XXVII are given the average yields of winter wheat after summer fallow on duplicate tenth-acre plots for the years 1913 to 1916, inclusive, for three dates of spring plowing each year.

Table XXVII. Average four-years yields of winter wheat, in bushels per acre, on ground packed after plowing with a subsurface packer and ground cultivated similarly but not packed.

Time of Plowing	No. of Tests.	Subsurface packed.	Not packed.
April 1	8	31.3	31.9
May 1	8	27.2	27.3
June 1	8	20.2	21.3
Average		26.2	26.8

The average four-years yield of the plots plowed April 1, May 1, and June 1, and packed with a surface or "Dunham" packer was 26.4 bushels per acre, or .4 bushel per acre less than the plots not packed as recorded in Table XXVII.

The average yield of Bluestem spring wheat after summer fallow, in duplicate tenth-acre plots for four years was 20.1 when packed with a subsurface packer and 20 bushels per acre when not packed. From these results it appears that the use of packers on the silt loam soils of the Columbia Basin is not necessary for either winter or spring wheat grown after a summer fallow.

CULTIVATION OF THE SUMMER FALLOW

How much cultivation of the summer fallow is necessary in order to conserve the maximum amount of moisture?

In these tillage experiments, three methods of cultivating the summer fallow have been used: (1) no harrowing, (2) light harrowing, and (3) heavy harrowing or weeding. In the first method, the fallow is not harrowed. Weeds are disked or hoed off before forming seed. In the second method, one harrowing is given immediately after plowing and the fallow given no further cultivation, except the disking or hoeing off of weeds before they form seed. In the third method, the ground is harrowed twice immediately after plowing, and later, when weeds have started, given a third harrowing. Sufficient weeding is also done with a Kimball harrow or a bar weeder to keep the plots free from weeds. This usually requires two and sometimes three cultivations.

Table XXVIII gives the yields obtained for each of these three dates of spring plowing, April 1, May 1, and June 1. The yields recorded in Table XXVII are average yields for the four years 1913-1916, inclusive.

Table XXVIII. Average four-years yields, in bushels per acre of winter wheat grown after summer fallow given three methods of cultivation.

Time of Plowing.	No Harrowing.	Light Harrowing.	Heavy Harrowing and Weeding.
	bn.	bu.	bu.
April 1	25.6	30.2	33.5
May 1	25.3	27.4	27.2
June 1	21.8	22.3	21.0
Average	24.2	26.6	27.2

Comparing the yields of the plots plowed on April 1, it will be observed from Table XXVIII that the average yield of the plots where the summer fallow was given heavy harrowing and weeding exceeds the average yield of the plots given light harrowing by 3.3 bushels per acre and exceeds the average yield of the plots given no harrowing by 7.9 bushels per acre. For the later dates of plowing, there is little difference in the average yields obtained from the three methods of fallow treatment. Cultivation of the summer fallow is apparently useless if the ground is so dry when plowed that no weeds or volunteer grain will grow.

HARROWING VS. NOT HARROWING WINTER WHEAT IN THE SPRING

Does it pay to harrow winter wheat in the spring? Considerable data on this quesion have been obtained and are presented in Table XXVIII. In the spring-plowing tests, the yields are the average yields for the four years 1915 to 1916, inclusive, for the fall-plowing tests, the yields are the average yields of four plots each year for the three years 1914 to 1916, inclusive.

Table XXIX. Average yields of winter wheat in bushels per acre, on plots harrowed in the spring and on plots not harrowed.

Time of Plowing.	No. of Tests.	Harrowed.	Not Harrowed.
		bu.	bu.
April 1	4	29.9	33.5
May 1	4	27.0	27.2
June 1	4	22.5	21.0
Fall	12	26.0	27.7
Average		26.4	27.4

The harrowed and unharrowed plots were adjacent in all cases. The harrowing of the winter wheat was done at a time in the spring when it was thought the cultivation would do the most good. The ground was usually quite hard and badly cracked at the time of harrowing.

From the data presented in Table XXIX, it appears that spring harrowing of winter grain is not a profitable practice. In some instances, however, it might prove beneficial to harrow winter wheat in the spring. If the stand is thin or irregular and there are many weeds that can be

killed by harrowing, the spring cultivation would undoubtedly be a benefit. Except for weed eradication, the spring harrowing of winter wheat usually is not necessary or desirable. On the dry lands of Montana and Utah, the harrowing of winter wheat in the spring has not given increased yields.* If winter wheat is harrowed in the spring, careful observation should be made to ascertain if the weeds are being destroyed and that the grain is not being injured.

ROTATION EXPERIMENTS

Can the crop production of the Columbia River Basin be increased or made more profitable by the adoption of some crop-rotation system whereby the present large area devoted to summer fallow can be reduced or eliminated? Encouraging results bearing on this question have been obtained in the crop rotation experiments on the Branch Station. Most of these experiments, however, have not been carried on for a sufficient length of time to warrant a detailed discussion of the results. It requires considerable time to get reliable data on the value of different rotation systems. A summary of the results obtained, and a brief discussion of them, will be of some value at this time, as it will indicate, in a general way, the progress made.

Table XXX. Summary of results obtained in Rotation Experiments for the years 1913 to 1916, inclusive.

	Yield, bushels per acre				
Crop and Cropping Method.	1913	1914	1915	1916	Ave.
Spring Wheat.					
After summer fallow	21.2	19.2	16.9	39.3	24.1
After field peas, spring disked	20.5	17.9	16.1	40.3	23.7
After potatoes, spring disked	23.0	18.5	16.3	36.3	23.5
After corn, spring disked	12.2	15.0	12.0	38.8	19.5
After barley, fall plowed	17.3	14.8	8.5	35.6	19.0
After spring wheat, fall plowed	8.9	12.5	4.9	34.7	15.2
After alfalfa and fallow	....	....	....	25.4	....
Winter Wheat.					
After potatoes, disked	20.0	20.1	15.1	30.4	21.4
After peas turned under	11.4	22.6	13.8	31.3	19.8
After corn, disked	9.0	15.8	16.0	27.7	17.1
Spring Barley.					
After summer fallow	49.4	27.3	21.8	72.5	42.7
After peas turned under	33.7	23.7	21.8	65.0	36.0
After corn, spring disked	1.6	23.5	29.6	78.5	33.3
After spring wheat, fall plowed	28.5	19.4	19.4	57.1	29.8
After barley, fall plowed	1.0	21.0	6.4	63.0	23.8
After oats, fall plowed	....	....	17.0	69.8	....
After alfalfa and fallow	....	....	....	49.8	....
Spring Oats.					
After corn, spring disked	....	....	16.7	74.5	....
After alfalfa and fallow	....	....	....	64.2	....

*Cardon, P. V., Tillage, and Rotation Experiments at Nephi, Utah. U. S. Dept. of Agr. Bull. 157.

Atkinson, A., and Nelson, J. B., Winter Wheat. Mont. Agr. Exp. Station Bull. No. 100.

Table XXX—(Continued)

Crop and Cropping Method.	Yield, bushels per acre 1913	1914	1915	1916	Ave.
Corn.					
After peas turned under	3.8	13.2	21.2	37.0	18.8
After rye turned under	4.0	13.1	22.0	27.8	16.7
After barley	2.5	14.5	19.0	29.9	16.5
After wheat	2.2	10.6	16.2	31.8	15.2
After manure and fallow	....	17.5	18.5	31.0	*22.3
After sweet clover turned under.	. . .	. . .	17.0	30.0	. . .
Field Peas					
After field peas	24.0	19.0	9.0	27.4	19.8
After spring wheat	10.5	9.8	11.8	30.8	15.7
Potatoes.					
After barley	68.0	41.1	73.0	146.6	82.2
After wheat	66.0	39.8	63.0	145.0	78.4

*Average yield for only 3 years.

Table XXX shows the average four-years yields of wheat, barley, oats, corn, field peas, and potatoes, grown after different crops. The yields are averages of several plots each year in the different rotations.

The following points are brought out in Table XXX:

1. The highest yields of spring wheat have been obtained after summer fallow. They are nearly as high, however, after field peas and after potatoes. After corn, the spring wheat yields have been 4.6 bushels per acre less than after summer fallow. The lowest yields of spring wheat were obtained when wheat followed wheat. After spring barley, the spring wheat yields have been nearly as high as after corn. After peas, potatoes, and corn, the ground was double disked as a preparation for wheat. After wheat or barley, the ground was fall plowed.

2. The yields of winter wheat, which are all after some crop, are lower, in most cases, than those of spring wheat. This was partly due to the fact that a good stand of wheat was not always obtained on account of dry weather in the fall. It is likely that considerable difficulty will frequently be experienced in getting good stands of winter wheat in any rotation where the wheat immediately follows another crop. A good stand of winter wheat might be obtained if sown on well-cultivated fallow, while a poor stand might result if sown on ground which had been cropped the same season. A spring grain, therefore, probably would be better adapted to a rotation where the ground is cropped two or more years in succession.

3. The highest yields of spring barley also have been obtained after summer fallow. On disked corn ground, barley has averaged 9.4 bushels an acre less than after summer fallow. After a green manure crop of peas, the yields have been 6.7 bushels an acre less than after fallow.

4. Spring oats were not introduced in the rotation experiments until 1915. Satisfactory yields of oats have always been obtained at the Branch Station on disked corn ground. In 1916, 8 plots of spring oats after fallow yielded 95 bushels an acre, while 8 adjacent plots of the same varieties on spring disked corn ground yielded 90 bushels an acre, or a difference of 160 lbs. an acre in favor of the fallow ground.

5. The corn yields reported in Table XXX are low because the crop was practically a failure in 1913, so far as grain production was concerned. The yields of the stover for the four years have averaged about 1½ tons an acre. The yields of corn have been a little higher after a green manure crop than after any other method tried, but not enough higher to justify the use of green manure.

6. The highest yields of field peas were obtained when this crop was grown continuously on the same ground. The yields of the field

Fig. 13. A field of Early Baart spring wheat grown from Branch Station Seed by Mr. Ray Ragsdale near Grass Valley, Oregon. See letter on page 43.

peas after wheat for the first two years were low. The peas grown in this rotation were the Marrowfat variety. They have been grown in rows 7 inches apart and have been given no cultivation. Where the peas were grown continuously, they have been sown in double rows 35 inches apart, and cultivated.

7. Yields of wheat, oats, barley, and corn were obtained in 1916 on ground which grew alfalfa in 1913 and 1914 and left fallow in 1915. The yields obtained were lower than the yields of either of these crops grown in any other rotation, as is shown in Table XXX.

TRIALS BY FARMERS

Cooperative trials by farmers have been confined to the growing of new and improved varieties of field crops. No attempt has been made to get data from farmers on tillage or rotation methods. The following excerpts from letters from farmers will indicate, in a general way, the success they have had with the varieties of crops recommended and distributed by the Branch Station.

CROOK COUNTY

Ashwood, Ore., Feb. 4, 1917.

"We were more than pleased with the results of the barley (beardless) we got from you. I sowed it on almost the highest land in the country here near the timber; and from 125 lbs. we threshed 225 bushels, machine measure. . . . . I have sold quite a lot locally. Everybody said it was the best barley they ever saw."

ROY E. DARBY.

Redmond, Ore., Feb. 2, 1917.

"The oats (Sixty Day) I got from you did the best of any I had, yielding on alfalfa ground 61½ bu. per acre. In 1915 it yielded 59½ bu. per acre. In 1916 on poor ground it yielded 35½ bu. per acre, while Swedish Select on the same ground yielded only 28½ bu. I sold seed to a neighbor for dry-land seeding. He told me it yielded 46 bu. per acre, machine measure."

W. R. LAWSON.

Bend, Oregon, Feb. 3, 1917.

"The oats (Kherson) produced very satisfactorily. The barley (Svanhals) was not a success. Neither the oats nor the barley had a fair show."

W. W. ORCUTT.

Roberts, Oregon, Feb. 3, 1917.

"In regard to the spring emmer seed I received from you will say that I was more than pleased with the results. I have tried emmer here on a small scale for the past three years—am sure it will do well here on my place."

JOEL NEWTON.

GILLIAM COUNTY

Arlington, Oregon, Feb. 6, 1917.

"We planted 80 acres of the Carleton field peas. They averaged us 605½ lbs. an acre of good seed. We did not get over half of the seed. The peas left on the ground fed and fattened $575 worth of hogs which were sold, and 40 head of hogs ran in the field all of the fall. There is lots of seed on the ground for feed.

"We had 65 acres of ground which we summer-fallowed and then seeded to peas for two years in succession. The ground was then seeded to wheat without summer fallowing and produced 4 bushels to the acre more than the wheat on summer fallow ground.

"The Carleton peas have always been the best variety for us.

"At the present prices of hogs and grain, I believe there is more money in hogging them off than in raising the crop for seed. We tried "sheeping" them off, but it was not as successful as hogging them off.

"The only sucessful way we can harvest the peas is with a header equipped with lifter guards. We can not get all of the peas with the header, but by turning into the field a band of hogs after heading, we save the seed left on the ground, as hogs fatten by running in the fields and gathering the peas."

Plateau Farming Company, By C. E. Van Winkle.

Arlington, Oregon, Feb. 10, 1917.

"The Carleton field peas which we got from your Station did extra well. We had no way of estimating how much they produced to the acre, but we can recommend them for this locality."

BERT EVANS.

Blalock, Oregon, Feb. 1917.

"I received 67 lbs. of Sixty Day oats from you in 1914. I sowed this on summer fallow and harvested 15 sacks. The following spring the seed was sown too thick but produced an average crop. The past season 1916, I threshed out 60 bu. per acre (ground measured). The oat is of average quality, but I must say that it is a good yielder."

J. H. SMITH.

KLAMATH COUNTY

Dairy, Oregon, Jan. 10, 1917.

"The seed for Turkey wheat and spelt you sent me the fall of 1915 was completely lost, owing to the frost last spring and sumer. All other grains were lost in the Dairy district, except in a few favored spots. I lost all of my Swedish Select oats except a gallon. I planted 65 acres to Swedish Select oats last season as I considered it to be the best for this section. It is the best stooling oats I know of here. The frost hit it when it was in the milk stage and I had to cut it for hay. For straight grain production, however, the Kherson seed I got from you yields the best, but is hard to sell on the market." R. D. BROWN.

Merrill, Oregon, Jan. 5, 1917.

"The Kharkov winter wheat referred to averaged 20 bu. on fallow land; on old stubble land it was a failure; have grown the wheat for 2 years. I have no seed for sale at present but Kharkov is the best wheat here." N. C. SWANSON.

LAKE COUNTY

Summer Lake, Oregon, Feb. 5, 1917.

"Both Minn. 23 and 13 corn did very well two years ago. I did not have any of your seed last year. The corn will do well in this locality in a normal year and will produce, I believe, 30 to 40 bu. per acre on dry land. The emmer and beardless barley did not produce anything."

GEO. H. DETWILER.

Fort Rock, Oregon, Feb. 1917.

"Push field peas in our country, they are the coming legume here, no doubt." HAROLD H. WILCOX.

MORROW COUNTY

Ione, Oregon, March 1, 1917.

"That White Smyrna barley is sure good. It has no equal in this section. The yield was 71¾ bushels per acre."

A. B. STRAIT.

Heppner, Oregon, Feb. 12, 1917.

"I have grown White Canada field peas, planting in double rows 36 inches apart, which were planted on spring plowing April 17th, harrowed when first showing thru the ground and again when 6 to 8 inches high, and cultivated with a garden cultivator once. Threshed with blank concaves—cracked a good many. Threshed out 19½ bu. per acre by weight on a two-acre plot. I think the best corn for our section, near the foothills, is Minn. 23." BURTON H. PECK.

Morgan, Oregon, Aug. 20, 1916.

"I planted fifty lbs. each of Marquis and Talimka No. 2495 in the center of a field of Bluestem. The yield was as follows: Bluestem 5 sacks, Talimka 6 sacks, and Marquis 7 sacks. I consider this very good as this land was not summer fallowed and the ground was so foul with mustard that I had to wait until late before plowing it."

GEO. B. WHITCOMB.

Ione, Oregon, March 2, 1917.

"I did not get a very good stand of the Turkey wheat I got from you and the worms ate considerable of it. It made 18 bushels to the acre of grain that tested 62½ lbs. to the bushel.

"The Mariout barley made 45 bushels to the acre and is of very good quality. Other barley close by made 40 bushels but was sown a month earlier. I sowed the Mariout barley on the 28th of April, which was very late."

JOHN NOLAN.

SHERMAN COUNTY

Wasco, Oregon, Feb. 3, 1917.

"Marquis did not do very well in 1915. From 75 lbs. of seed I raised about 520 lbs. of wheat of very poor quality. In 1916 I raised 42½ sacks from 2 sacks of seed or 8½ sacks per acre on spring plowing. This was of very good quality, testing 63 lbs. per bu. and 36½ percent gluten. I am well pleased with the wheat. It does not shatter and stands up well. I shall sow all of the seed I have.

"I raised 18 sacks of Hannchen barley from one sack of seed. I am well pleased with it and will sow it this year."

C. C. HUCK.

Klondike, Oregon, Feb. 12, 1917.

"I raised 59 bushels of Early Baart wheat on 2 acres. It beat Bluestem seeded at the same time and on just as good summer fallow. The Bluestem made about 21 bu.

"I got some Minn. 13 corn from you—sowed it on spring plowing. It did well, some of it grew 8 feet high and had pretty good ears although I planted it too thickly. I planted 2 other kinds of corn but the Minn. 13 was far the best."

L. J. ANDREWS.

Moro, Oregon, Feb. 1917.

"I have grown field peas for nearly 10 years on a small scale. I have used them mostly for sheep feed, but also for hog pasture. I have always planted the peas with a grain drill in rows 8 inches apart. Usually I cut the peas when nearly ripe and thresh only enough seed for my own use and feed the balance to sheep. I have also sown peas on spring plowing, pastured them off with sheep and seeded to winter wheat or spring oats. I think a spring grain does better following peas. Have not noticed any diference in yields of grain after peas and after summer fallow."

T. B. SEARCY.

Grass Valley, Oregon, Jan. 31, 1917.

"Planted 6 sacks of Kharkov wheat on about 15½ acres of ground. I harvested 336 sacks (50.5 bu. per acre). The average yield of the rest of the field which was planted to common Turkey wheat was 29 bu. per acre. The Kharkov, however, was planted on the best ground. I sowed 180 acres of Kharkov last fall.

I sowed 400 lbs. of Early Baart spring wheat on about 9 acres, a part of which was shallow ground. Harvested 115 sacks, averaging 146 lbs. per sack (32.7 bu. per acre). My spring Bluestem wheat on better ground averaged 30 bu. per acre. Will sow 59 or 60 acres to Early Baart next spring. I sold the Early Baart I raised to neighbors, except what I need for seed."

RAY RAGSDALE.

Grass Valley, Oregon, Feb. 4, 1917.

"The corn I got from you has done real well both years I have raised it. Last year I raised both N. W. Dent and Minn. 23. I liked the latter variety better so that was all I planted this year. I estimate that it made 20 bu. per acre last year and between 25 and 30 bu. this year. I don't know of any one around here who has raised better corn."

T. M. ROLFE.

Moro, Oregon, Feb. 1917.

"I tried five varieties of field peas in 1916—Lima, Bangalia, Cavalier, Kaiser and Carleton. Planted 18 acres in all on ground which grew wheat in 1915. Seeded with a grain drill in double rows 42 inches apart. I raised 100 sacks of all varieties. The Carleton and Lima yielded the highest. Am going to grow only Bangalia next year because it is a better pea to handle than the other varieties. Sold all of my seed at 4 to 4½ cents per pound."

B. F. PEETZ.

Wasco, Oregon, Feb. 2, 1917.

"I received from you last year 5 sacks of Swanneck barley and 1 bushel of Early Baart wheat. I sowed this on pasture which I disked in the fall of 1915 and again in the spring of 1916 and then sowed the five sacks of barley and got 86 sacks in return. I am going to sow this barley on summer fallow this spring and think I can make good. It is a beautiful white berry and threshes nicely. The Early Baart was sown on the same ground but only had room for 40 lbs. of seed. From this I harvested 6½ sacks. It is a beautiful berry—much larger than Bluestem. I am also going to sow this seed on summer fallow this year. I like the wheat."

ARNOLD BUHMAN.

Kenet, Oregon, Sept. 17, 1916.

"On 9 acres I threshed 226 sacks of Sixty Day oats, averaging 84 lbs. per sack (65½ bushels per acre). On 6 acres I got 96 sacks of your beardless barley weighing 118 lbs. per sack (39 bu.). From 5 acres of Bluestem spring wheat I got 54 sacks weighing 141 lbs. per sack, (25½ bu. per acre)."

H. H. WHITE.

Kent, Oregon, Jan. 18, 1917.

"Received 1 sack of Sixty Day oats from your Station in the spring of 1915. From this I raised 20 sacks on spring plowed ground in a dry year. In the spring of 1916 I planted about 15 acres of summer fallow and raised 430 sacks averaging 92 lbs. per sack (82 bu. per acre). Some common oats in the neighborhood yieleded 22 sacks per acre."

GUY L. HOSKINSON.

WASCO COUNTY

Tygh Valley, Oregon, Feb., 1917.

"The field peas (Carleton) which I received from you made an excellent growth. On an old alfalfa sod that had been in corn the year previous I threshed 35 bushels per acre. I think at least one-tenth of the mature peas shelled out in harvesting."

A. A. BONNEY.

Tygh Valley, Oregon, Feb. 3, 1917.

"I think that Sixty Day oats will make the best crop of oats in dry years. I am going to plant field peas on summer fallow this year for hay and seed. I have about 800 lbs. of seed and my idea is that field peas are better than corn for this part of the country."

H. S. WOOLSEY.

Dufur, Ore., Feb. 8, 1917.

"The Koola wheat did execeptionally well, but the straw was not strong enough to hold up the heads this season, so that it lodged a great deal. Of the peas you sent, the Carleton did much the best yielding nearly twice the amount per acre as the Kaiser."

C. F. GALLIGAN.

Dufur, Oregon, Feb. 7, 1917.

"I have used your Sixty Day oats and Kharkov wheat for one season. The results were very satisfactory. The Kharkov yielded between 45 and 50 bu. and 2½ acres of Sixty Day oats yielded 74 sacks. These grains yielded with the best grains of other varieties. I wish to test them further."

IRL DAVIS.

Bakeoven, Oregon, Jan. 15, 1917.

"Have had good luck with the Alberta Red wheat. It averaged 25 bushels this year and much of it was frosted in blossom. My Carleton peas made about 15 bushels, after I had wasted a good many in harvesting. Have depended upon peas for hog pasture during harvest for two years and have been surprised at the amount of feed they can get from it."

J. R. FLEMING.

SUMMARY

The work of the Moro Branch Station has been continued along four general lines: (1) Varietal testing, (2) improvement of field crops, (3) crop rotation experiments, and (4) tillage experiments.

The normal annual precipitation at Moro is 11.6 inches. The average precipitation for the growing season (March to July inclusive) for the years 1911 to 1916, inclusive, was 4.37 inches.

The average evaporation from a free-water surface for the seven months, April to October, inclusive, is 44.24 inches.

The lowest temperature recorded in six years was 10 degrees below zero; the highest 103 degrees. The highest average mean temperature for six years was for the month of August, 67.4 degrees; the lowest average mean temperature for the same period was for January, 28.4 degrees

The average frost-free period at Moro for six years was 154 days. The latest spring frost (32 degrees) for these years was on May 27; the earliest autumn frost occurred on Sept. 3.

Forty-four varieties of winter wheats have been tested at the Branch Station. Those of the Turkey or Crimean group have given the highest yields. Argentine, Kharkov, Alberta Red, and Armavir, have exceeded the yield of the local Turkey wheat from 15 to 18 percent for an average of four years. A ten percent increase in the yield of winter wheat in Sherman County would amount to at least 15,000 bushels annually.

Time of seeding tests with Turkey winter wheat indicate that the safest time of sowing is between October 10 and October 25. Under ordinary conditions, the best rates of sowing Turkey winter wheat have been from 45 to 55 lbs. of seed per acre. When sowing in dry ground or late in the fall the rate of sowing should be increased.

Seed of Turkey wheat grown at Moro for five years has given slightly higher yields than seed of the same variety obtained from other localities.

The highest yielding spring wheat varieties at the Branch Station have been Koola, Talimka, Early Baart and Karun. These have exceeded the yield of the Bluestem variety from 14 to 26 percent for a four-years average.

The average yield of Bluestem wheat sown early (March 28) has exceeded the average yield of the same variety sown late (April 23) by 5.5 bushels per acre. The highest yield per acre for the early sowing was obtained with the drill set at 8 pecks; for the late sowing, with the drill set at 3 pecks.

The highest-yielding winter barley varieties have been Texas Winter and Maryland Winter.

Of the sixty varieties of spring barley tried at the Branch Station, the Mariout, White Smyrna, and Hannchen have given the highest four-years average yields. Trebe, a variety tried only in 1916, gives promise of being a very valuable variety.

The highest-yielding oat varieties have been Siberian and Sixty Day.

Emmer and spelt have not given as high yields as barley and oats.

Based on ten years average prices in Portland on December 1, and on the yields of the highest-yielding varieties at the Branch Station, the acre-value of the cereals would be as follows: Winter wheat, $31.88; spring wheat, $31.78; winter barley, $31.40; spring barley, $33.06; spring oats, $28.21; winter spelt, $24.52.

Of the field-pea varieties tested, Lima, White Canada, O'Rourke, Solo, and Carleton have given highest yields. The four-years average yields of these varieties have been about 22 bushels per acre. Field peas grown continuously on the same ground for five years averaged 18.8 bushels of seed per acre.

Yields of spring wheat after field peas have been nearly as high as after a summer fallow.

Alfalfa and Sweet Clover grown in rows are promising forage crops for the Columbia Basin uplands. No way has yet been found by which profitable yields of alfalfa seed can be obtained on the Branch Station soils.

Several varieties of vetch have been tried. Hairy vetch, sown in the fall, has given best results.

No perennial grass has been found that shows indications of being better than alfalfa or sweet clover for a forage crop.

The leading corn varieties have been Walla Walla White Dent. Minn. No. 13, Northwestern Dent, and Brown County Yellow Dent.

The highest yielding potato varieties have been Green Mountain, Pearls, and Early Rose.

A great many cultivation methods have been tried for growing wheat under the summer-fallow system. So far, the results of these experiments indicate that:

1. Fall disking, if the stubble is not heavy, is not profitable.
2. If plowing is done early, spring disking is of doubtful value if the stubble is short.
3. Spring disking increases the yield of winter wheat if plowing is deferred in the spring.

4. A farmer loses from one to two bushels of wheat per acre (depending upon the season) every week his ground is left unplowed after the first of April, if the ground has not been well-disked and all plant growth destroyed.

5. Ground plowed in the fall with a moldboard plow will give slightly higher yields than ground plowed in the fall with a disk plow.

6. Early-fall plowing, when the ground is dry, will give as high yields as late-fall plowing, when the ground is wet.

7. Plowing deep (8 to 9 inches) will not give higher yields of spring wheat after summer fallow than plowing shallow (4 to 5 inches).

8. Yellow berries in Turkey wheat are more prevalent on ground plowed late, without being disked before plowing, than on ground plowed early in the spring.

9. Subsurface or surface packers do not increase the yield of either winter or spring wheat after summer fallow.

10. Allowing weeds to grow in the summer fallow reduces the wheat yields.

11. Harrowing winter wheat in the spring is of no benefit unless it destroys weeds. With normal wheat stands, no increase in yields has been obtained when winter wheat has been harrowed in the spring.

In the rotation experiments, the highest yields of spring wheat have been obtained after a summer fallow. Spring wheat yields after field peas and potatoes have been nearly as high as after summer fallow. Following corn, spring disked, the yields of spring wheat have been 4.6 bushels per acre less than following summer fallow.

In no case where a crop has been turned under for green manure, has there been a significant increase in the yields of the following crop of small grain or of corn.

The yields of spring wheat, oats, barley, and corn, in 1916, on ground which grew alfalfa for two years and which was left fallow one year, were not as high as on ground which had been alternately cropped to grain and left fallow.

Cooperative trials are reported by farmers who obtained seed from the Branch Station. These trials indicate that the highest yielding varieties at the Branch Station, when grown by farmers, will give equally favorable results over a large dry-farming area.

OUTLINE, With Page References for
DRY FARMING INVESTIGATIONS AT THE SHERMAN COUNTY BRANCH EXPERIMENT STATION, MORO, OREGON

(Degree of indentation denotes subordination.)