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Harney Branch Station

Dry Farming Investigations at the Harney Branch Station

By

L. R. BREITHAUPT, Superintendent

BURNS, OREGON

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DRY FARMING INVESTIGATIONS AT THE HARNEY BRANCH STATION BURNS, OREGON

L. R. BREITHAUPT, Superintendent

INTRODUCTION

The Harney Branch Station is maintained jointly by the State of Oregon, through the Oregon Agricultural College and Experiment Station, and the United States, through the U. S. Department of Agriculture, Office of Cereal Investigations. History of the Branch Station and descriptive matter pertaining to soil, buildings, equipment, extent, and nature of the region served, etc., is given in former publications.*

The work of the Branch Station has been planned and conducted on two general lines: (1) Experimental, (2) Service. In the first instance, the object sought is the determination of the crops which are practicable on dry land in Central Oregon; the isolation, by extensive varietal tests, of the best varieties of the best crops; improvement of the best varieties if possible; and the determination of the best methods of production through date-of-seeding and rate-of-seeding tests and experiments in soil tillage methods and crop rotations. In the second instance, service is rendered (1) by making known the results of these experiments through publications, direct correspondence in reply to inquiry, to visitors at the Branch Station and through the various agencies which now exist for the purpose of carrying the results of such work to the people it concerns. (2) By the increase of pure seed of the best and highest-yielding varieties of adapted crops and the distribution of the seed throughout Central Oregon by sale of it in moderate quantities to good farmers who grow it for seed for themselves and their neighbors.

Valuable assistance and helpful suggestions by members of the Oregon Experiment Station staff and the Office of Cereal Investigations have been given both in relation to the experimental work reported here and in the preparation of this manuscript. For this the author wishes to give full credit. Special acknowledgment is given Prof. H. D. Scudder for outlining the tillage and rotation experiments and other help given; to Prof. Geo. R. Hyslop, Mr. M. A. Carleton and Mr. C. R. Ball for valuable suggestions given on numerous occasions.

CLIMATIC DATA

Records of precipitation, temperature, evaporation, and wind velocity have been kept at the Branch Station since October, 1913. Previous to that time, records of precipitation and temperature had been kept at Burns, six miles west of the Station. A careful analysis of climatic factors is essential to the most successful crop production. It is easier to fit practice to climate than climate to practice.

PRECIPITATION

The average annual precipitation recorded at Burns for the years 1904 to 1913, inclusive, is 12.62 inches. This is somewhat higher than would

*Bulletin No. 119, Oregon Experiment Station.
Report of the Harney Branch Station 1912-14.
Farmers' Bulletin No. 800, U. S. Department of Agriculture.

have been obtained at the location of the Branch Station as indicated by comparative rainfall records since that time at the two points. Since 1913, the annual precipitation both at Burns and at the Branch Station, has been very much lower than this figure.

The five-year average yields as reported in this bulletin were produced on an average precipitation little more than eight inches per annum. This is a rather small amount of moisture for successful farming and probably less, in view of previous records at Burns, than average for the locality. The importance of good tillage, however, and the use of early-maturing and drought-resisting varieties is obvious. Low precipitation in the fall is a chief limiting factor in the production of winter grain.

FIG. 1.—FARMERS' DAY: INSPECTION OF PLOTS; BIG BASKET DINNER; STUNTS AND PROGRAM.

TABLE 1. PRECIPITATION AT THE BRANCH STATION BY MONTHS, YEARS, CROP SEASONS (SEPTEMBER 1 TO AUGUST 31) AND GROWING SEASONS (MAY TO AUGUST) FOR THE YEARS 1913 TO 1917, INCLUSIVE.

Year*	Jan.	Feb.*	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Annual	Crop season	Growing season
1913	1.55	.15	.86	.99	.25	2.93	1.99	.19	.15	1.63	1.08	2.05	13.82	12.53	5.36
1914	1.41	.59	.06	1.42	1.51	1.33	.11	.00	.34	1.39	.12	.36	8.64	11.40	2.95
1915	.84	.73	.57	.75	1.52	.30	.30	.03	.04	.03	1.16	.39	6.66	7.50	2.15
1916	.50	1.90	.35	.81	.72	.98	.84	.33	.13	.00	.25	.38	7.19	8.05	2.87
1917	.63	1.22	.58	.38	.80	.33	.19	.04	.89	.00	1.35	.62	7.03	4.95	1.36
Average....	.99	.92	.48	.87	.96	1.18	.69	.12	.31	.61	.79	.76	8.67	8.88	2.98

* Burns record.

EVAPORATION

Evaporation records have been taken from a 6-foot land pan for the past four years at the Branch Station. The results are given in Table 2. It will be noted that the rate of evaporation increases rapidly as the season advances. This indicates the necessity for mulching the soil early in order to diminish loss of moisture by evaporation. Early-maturing crops make better use of stored moisture by using it before it evaporates.

TABLE 2. ANNUAL AND AVERAGE EVAPORATION FROM A FREE WATER SURFACE FOR THE YEARS 1914 TO 1917, INCLUSIVE, BY MONTHS, AT THE HARNEY BRANCH STATION.

Year	April	May	June	July	Aug.	Sept.	Oct.	Total
1914	3.472	6.487	6.647	9.860	9.405	5.532	2.651	44.054
1915	4.352	4.971	7.714	8.820	9.036	5.871	3.525	44.289
1916	4.632	4.649	6.915	8.342	7.383	*5.948	†2.500	40.366
1917	‡1.750	5.226	7.895	10.190	8.140	5.257	3.647	42.105
Average	3.551	5.333	7.292	9.303	8.491	5.652	3.081	42.703

*Last five days hyperbolated.
†Hyperbolated.
‡Partly hyperbolated.

TEMPERATURE

The highest, lowest, and mean temperatures for the past five years are given in Tables 3, 4, and 5, respectively. In Table 6 is given data pertaining to the frost-free period. It will be seen from this that crops which require an unduly long season to mature or crops that are not frost resistant can not be grown successfully. In general, grain is not damaged until the temperature drops below 30 degrees F., though the degree of susceptibility to frost injury varies with the crop, the variety, and the stage of growth. For instance, corn or Sudan grass will frost badly when wheat will be uninjured; Mariout or Coast barley will be badly frozen when (Fig. 2) Hannchen and White Smyrna are not; and certain hardy varieties of grain or peas will withstand severe freezing while young, but are injured by much lighter frosts when in the bloom or seed-forming stage. Early maturity and ability to withstand frost are very desirable characteristics in the choice of crops and varieties, and careful attention to the date of seeding is essential.

TABLE 3. MAXIMUM TEMPERATURES IN DEGREES FAHRENHEIT FOR EACH MONTH FOR YEARS 1914 TO 1917.

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1914	48	46	67	72	86	97	97	99	88	81	64	36
1915	39	44	71	83	76	87	97	98	87	80	58	57
1916	44	47	66	79	80	93	89	93	89	77	64	52
1917	42	45	52	70	77	97	100	99	93	85	69	59
Average	44	45	64	76	80	93	96	97	89	81	64	51

TABLE 4. MINIMUM TEMPERATURES IN DEGREES FAHRENHEIT FOR EACH MONTH FOR YEARS 1913 TO 1917.

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
1913*	—13	0	8	13	26	31	34	34	26	16	10	—1
1914	—1	—5	13	22	21	21	30	28	19	19	—1	—22
1915	—26	—2	8	24	25	29	27	34	23	6	—10	—7
1916	—18	6	2	19	14	22	32	24	18	6	—14	—9
1917	—31	—23	—17	17	18	20	32	33	22	6	7	13
Period	—31	—23	—17	13	14	20	27	24	18	6	—14	—22

* Burns record; Frosted crops at Station August 18.
NOTE.– First fall frost at Station in 1912 was on August 14.

TABLE 5. MEAN TEMPERATURE IN DEGREES FAHRENHEIT FOR EACH MONTH FOR THE YEARS 1914-1917.

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Annual
1914	28	24	39	45	54	56	67	66	53	47	34	10	44
1915	15	29	40	48	49	55	62	69	52	45	31	28	44
1916	16	29	38	47	47	53	59	59	55	40	30	22	41
1917	12	20	20	40	49	56	67	67	57	45	38	36	42
Average	18	25	34	45	50	55	64	67	54	44	34	24	43

TABLE 6. DATES OF KILLING FROSTS LATEST IN THE SPRING AND EARLIEST IN THE FALL, WITH TEMPERATURES IN DEGREES F. AND LENGTH OF PERIOD IN DAYS BETWEEN FROSTS OF 29 DEGREES F. OR LESS, FOR THE YEARS 1914 TO 1917.

Year	Last frost in Spring		First frost in Fall		Period
	Date	Temperature	Date	Temperature	
1914	June 22	28	Aug. 17	28	55
1915	July 17	27	Sept. 7	29	50
1916	June 29	28	Aug. 18	27	49
1917	June 30	29	Sept. 4	29	64

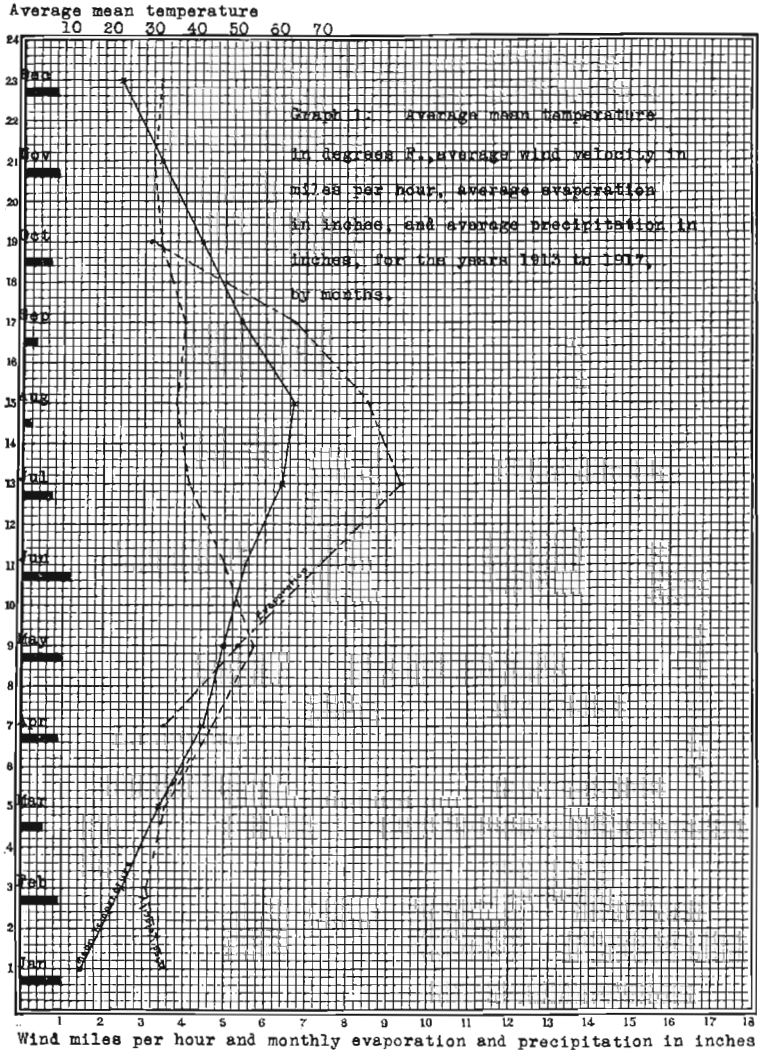
FIG. 2.—HARDINESS IN GRAIN: MARIOUT BARLEY ON LEFT, BADLY FROSTED; HANNCHEN ON RIGHT, UNINJURED.

WIND

Wind velocity records have been kept for the past four years. These are given in Table 7. Wind velocities average low at the Harney Branch Station as compared with other dry-land stations. High winds occur only occasionally and for short periods, mostly in the spring and early autumn. Wind has a drying effect on the soil. A good mulch made as early in the spring as possible with the disc or spring-tooth harrow, and maintained through the summer, reduces the loss.

TABLE 7. AVERAGE WIND VELOCITY FOR THE YEARS 1914-1917 BY MONTHS, IN MILES PER HOUR.

Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Annual
1914	4.9	3.6	3.8	4.6	4.8	4.3	4.0	3.9	4.9	3.2	2.8	2.2	3.9
1915	2.6	4.3	3.1	4.7	5.6	5.1	4.0	3.4	4.1	3.8	3.4	4.3	4.4
1916	5.3	2.8	5.2	5.3	6.6	5.2	4.6	3.5	3.5	3.7	3.8	4.2	4.5
1917	1.7	1.7	2.1	4.4	5.9	5.3	3.8	3.5	3.4	2.9	2.7	2.8	3.3
Average	3.6	3.1	3.5	4.7	5.7	5.0	4.1	3.8	4.0	3.4	3.2	3.4	4.0



Graph. 1.—Average mean temperature in degrees F., average wind velocity in miles per hour, average evaporation in inches, and average precipitation in inches, for the years 1913 to 1917, by months.

EXPERIMENTAL WORK

Five full years' experimental work has been done at the Harney Branch Station. During this time there have been tested a total of 310 varieties of cereal crops, including winter and spring wheat, rye, oats, barley, emmer, winter spelt, and flax; 134 varieties of leguminous crops, including field peas, alfalfa, sweet clover, vetch, and others of less importance; 68 varieties of forage, root and miscellaneous crops; and a large number of tree and bush fruits, shrubs, shade trees, etc. Experiments to determine the proper amount of seed to sow and the best time to plant have been made with all leading crops, as well as numerous special experiments, reported later in this bulletin, including rotations and tillage.

FIG. 3.--GENERAL VIEW OF PART OF THE EXPERIMENTAL PLOTS; SPRING WHEAT VARIETIES IN FOREGROUND.

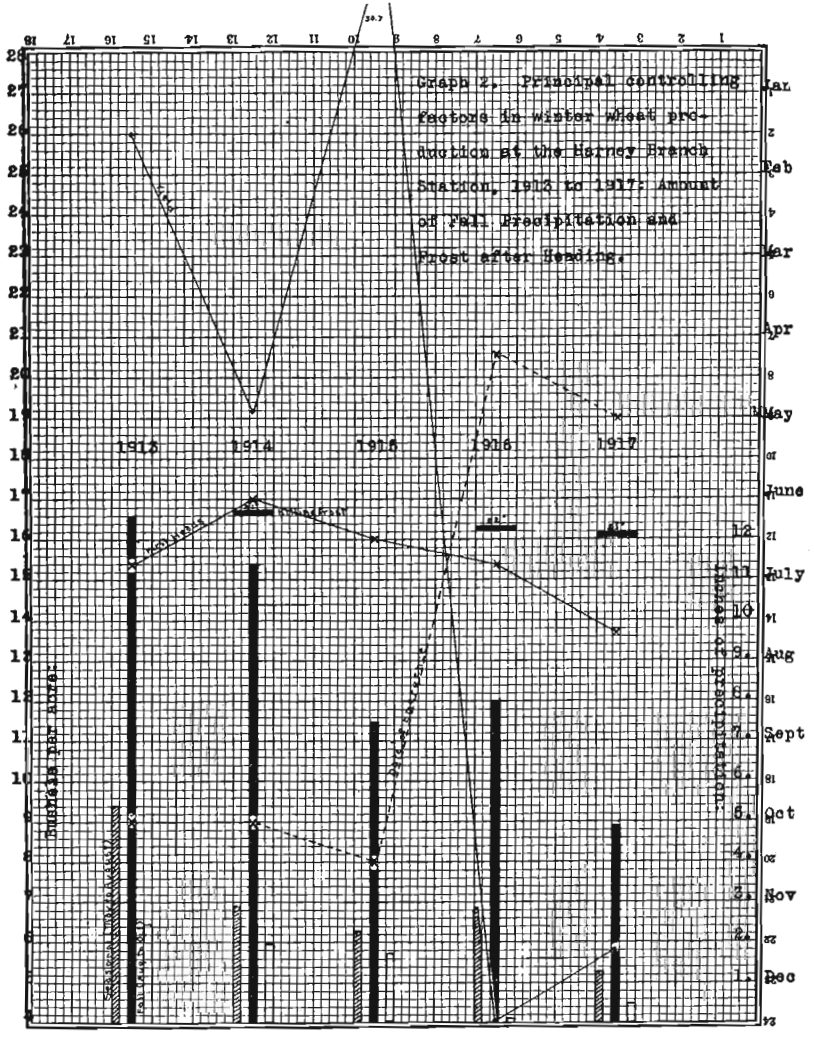
Of the crops tried, three divisions can be made: Successful; partly successful; and failures. The most successful crops are the cereals, particularly early-maturing, hardy, drought-resistant varieties of the common grains--wheat, rye, oats and barley. Winter wheat and rye are successful under certain conditions. Alfalfa seed has been fairly successful. Flax, field peas, and potatoes represent partly successful crops, while corn, Sudan grass, millet and all easily-frosted, late-maturing, or non-drought-resistant crops fail.

CEREAL CROPS

The most successful crops tested during the past five years have been cereals. Of these, spring wheat has been best, followed by spring barley, winter wheat, spring oats, spring rye, winter rye, and flax. Winter varieties of barley, oats, spelt, and emmer and spring emmer are not suitable crops.

WHEAT

Wheat is the leading cereal grown at the Branch Station during the past five years. Spring wheat exceeds winter wheat in average production.



Graph. 2.—Principal controlling factors in winter wheat production at the Harney Branch Station, 1913 to 1917; amount of fall precipitation and frost after heading.

WINTER WHEAT

A study of Tables 1 and 4, which show precipitation and minimum temperatures by months, respectively, will reveal two prime reasons why winter wheat does not average as high in yield as spring wheat, when grown year after year. These reasons are: The low rainfall in the fall many years, which makes it difficult or impossible to obtain a stand in the fall; and the frosts in June that sometimes catch the wheat in head. Instances of low fall precipitation are the years 1915 and 1916. The most striking instance of late spring frost which did serious damage to fall-sown grains was in 1914. In general, winter wheat should not be sown unless good rains come before the middle of October. It might then outyield other cereals except in seasons of heavy frost after heading has commenced.

The Turkey variety, because of its hardiness, high yield, and high milling value, is best. Where seeding can be done in early September in a moist seed bed, 30 pounds of seed per acre is sufficient. Later seeding and seeding in dry soil, requires a heavier rate. Harrowing the crop in the spring has not given increased yields ordinarily on the Branch Station.

VARIETAL TESTS

Of 37 varieties of winter wheat tested, the Turkey group, which includes the Crimean and Karkov, heads the list in point of yield. Annual and average yields for the five leading strains are given in Table 8.

TABLE 8. ANNUAL AND AVERAGE YIELD IN BUSHELS PER ACRE OF THE FIVE HIGHEST YIELDING WINTER WHEAT VARIETIES TESTED AT THE HARNEY BRANCH STATION, 1913 TO 1917.

Variety	C. I. No	1913	1914	1915	1916	1917	4-year average	5-year average
Turkey	1558	26.	19.3	30.7	4.	5.8	20.	17.1
Turkey	2223	26.2	17.	27.3	5.	.....	18.9	.....
Turkey	2998	24.2	14.	28.1	4.2	.....	17.6	.....
Crimean	1569	26.	9.3	28.9	4.4	.....	17.1	.....
Karkov	1442	22.7	12.	27.1	2.9	.....	16.2	.....
Average....	.....	25.	14.3	28.4	4.1	5.8	.....	.....

Other varieties tested: Beloglina, Local Turkey (1), Local Turkey (2), Alberta Red, Deihl Mediterranean, Pesterboden, Weissenberg, Ghirka Winter, Crimean (1437), Crimean (1432), Prohibition, Kofford, Bulgarian, Servian, Ulta Japanese, C. I. 4192, Molakov, Baeska, Purple Straw, Reita, Zimmerman, Theis, Torzova, Argentine, Armavir, Local Turkey (3), Iowa 404.

PLANTING WINTER WHEAT IN THE SPRING

Some farmers plant winter wheat in the spring. Generally this is by mistake, but sometimes because they think it will make a satisfactory yield. This generally results in great loss. To test the practicabilty of this, an experiment was planned, the results of which are given in Table 9. It will be seen that winter wheat must be sown very early in the spring or it will not head at all. But even then it does not yield as well as a good spring variety sown at the right time. These results also emphasize the importance of fall emergence for fall-sown winter wheat.

TABLE 9. YIELDS IN BUSHELS PER ACRE OF TURKEY WINTER WHEAT SOWN IN THE FALL COMPARED WITH YIELD FROM THE SAME WHEAT SOWN IN THE SPRING, AT TWO DATES, AND WITH EARLY BAART SPRING WHEAT, 1915.

Kind of wheat	Date sown	Yield
Turkey, Winter	Fall	28.9
Turkey, Winter	Spring, March 20	12.5
Turkey, Winter	Spring, April 5	2.2
Early Baart	Spring, April 20	23.0

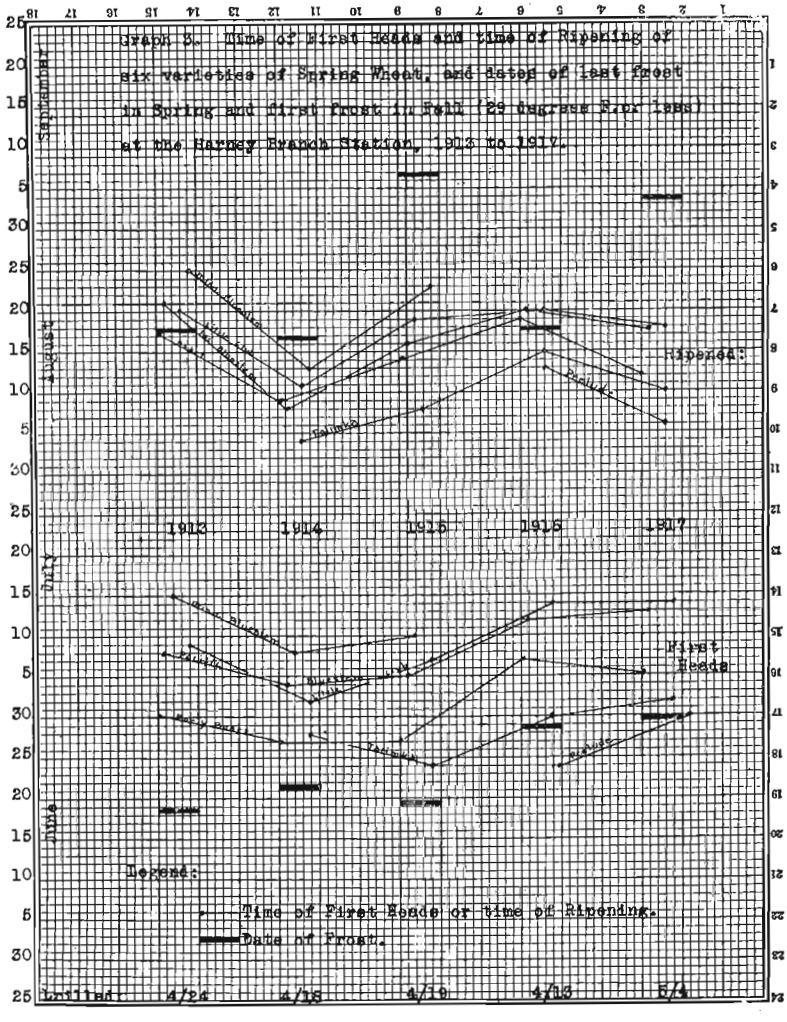
SPRING WHEAT

Spring wheat has been the most consistent grain producer of any cereal grown at the Branch Station during the past five years. The yields average higher in pounds per acre than any other crop except barley and there has been less variation in yield from year to year.

The chief problem in producing spring wheat has been found in obtaining good yielding varieties of good quality which are sufficiently early in maturity. By consulting Table 4 the reader will observe that wheat must be ripe by the middle of August in order to be safe from frost. If frosted, the wheat may be of no value for milling and the yield greatly reduced. Of course frosted wheat is just as good, and generally better, for feed than frosted barley or oats, though the hulls on these latter tend to cover up the damage to the casual observer. Danger from early fall frost can be overcome only by the use of sufficiently early varieties. Graph. 3 gives data on this point.

VARIETAL TESTS

Sixty-one varieties and strains of spring wheat have been tested during the past six years. These trials have shown that some varieties are early enough to ripen in all seasons by August 15. The Talimka, Chul, and Prelude varieties are in this class. The Early Baart, which is the leading variety in yield, has ripened in four of the five years and was practically ripe in 1916 when frost came. Because of its higher yield, high milling value, and general dependability, this variety is considered best. The Pacific Bluestem is good in yield, but ripens a few days later than the Baart. It is also a good milling variety. Being beardless, it is in favor with some farmers, but the greater danger of loss by frost and the slightly lower yield are against the Bluestem. Little Club, which has occupied a far too prominent place on the Central Oregon dry farms, has been a low yielder. It is a little later than the Pacific Bluestem and produces frosted grain about one year in two. The Durum wheats are not suitable either from the point of yield or general adaptability. In Table 10 are given the yields of the leading varieties of various classifications during the past five years.



Graph. 3.—Time of first heads and time of ripening six varieties of spring wheat, and dates of last frost in spring and first frost in fall (29 degrees F., or less) at the Harney Branch Station, 1913 to 1917.

TABLE 10. ANNUAL AND AVERAGE YIELDS IN BUSHELS PER ACRE OF LEADING VARIETIES OF SPRING WHEAT IN RESPECTIVE CLASSIFICATIONS AT THE HARNEY BRANCH STATION. 1913 TO 1917.

Class	Variety	C. I. No.	1913	1914	1915	1916	1917	5-year average
Baart	Early Baart	1697	28.3	18.2	20.5	13.4	24.5	21.0
White Australian	Pacific Bluestem	4067	32.0	16.7	22.7	12.3	17.6	20.2
Fife	Ghirka	1517	23.7	15.7	20.5	12.4	15.3	17.5
Chul	Talimka	2495	.....	11.3	26.2	11.1	21.0	.....
Preston	Erivan	2397	23.5	12.3	20.3	.....	.....	.....
Club	Little Club	4066	23.0	13.7	18.0	8.7	16.6	16.0
Bluestem	Select Hayne	3083	17.7	8.1	.....	.....	.....	.....
Polish	Polish	.....	12.7	.....	5.8	.....	.....	.....
Durum	Kubanka	2398	30.3	12.2	19.7	.....	22.8	*21.2
Unclassified	Galgolos	1354	13.2	6.0	15.7	7.3	9.0	10.0

* Four-year average. Baart, same period, 22.9. Other varieties grown: Dicklow, Red Chaff, Local Club (2), Marvel, Local "Minnesota Red," Erivan, Preston, Koola, Velvet Chaff, Fretes, Minnesota 163, Rysting, Wellman, Cole Hybrid, Power, Marquis, C. I. 2502, C. I. 2111, Theis, Aulieata, Heine Square Head, Karun, Hybrid No. 63, C. I. No. 2799-2, Yantagbay, Reita, Sonora, "Wisconsin Wonder," Chul.

RATES OF SEEDING SPRING WHEAT

On well-prepared seed beds the amount of seed to sow under dry-farming conditions is principally a matter of available moisture for crop production. There should be enough plants approximately to exhaust the moisture supply, but not so many that this supply will be exhausted before the grain is properly filled. A thin stand roots deeper and the plants tiller more, grow taller, make more and larger heads per plant and larger kernels. A heavy stand, when moisture is limited, makes fewer culms per plant, fewer heads in proportion to culms, and smaller heads and kernels.

The wheat plant adapts itself to variable degrees of competition with other plants better than most cereals. The right amount of seed to sow, however, is important knowledge. Sowing more seed than necessary is both wasteful of good seed grain, and a means of lowering yield. One consideration in deciding the proper amount of seed to sow is the relative increase rather than the actual yield obtained. In arriving at a conclusion it would be well to figure seed grain at twice the value of possible yields. For instance, if a two-peck rate of seeding gave 20 bushels per acre and four pecks also gave 20 bushels, the choice should lie with the lighter rate. If twice the amount of seed used is deducted from the respective yields, it would give a net result of one bushel in favor of the lesser rate.

Experiments in the rate of seeding of spring wheat have been conducted for the past five years. In 1913 the results were not comparable on account of soil variations, but it was estimated that the medium rate was best. Early Baart and Pacific Bluestem wheats have been used in these tests. The results are given in Table 11. These results indicate that under an eight-inch precipitation 20 pounds of good seed wheat is sufficient for an acre when seeded medium early, on a well-prepared seed bed. On a poorly-prepared, rough seed bed or when the rainfall is heavier, 30 pounds may be better.

TABLE 11. RATE OF SEEDING SPRING WHEAT AT THE HARNEY BRANCH STATION 1914 TO 1917, WITH COMPARATIVE YIELDS IN BUSHELS PER ACRE, AVERAGE YIELD AND NET INCREASE.

Pounds seed per acre	†1914	†1915	‡1916	‡1917	4-year average	*Net increase
20	15.1	29.3	10.7	15.9	17.7	17.0
30-35	16.3	22.7	12.7	17.0	17.2	16.1
60	15.4	20.3	12.5	15.3	15.9	13.9

* Twice amount of seed deducted from average yield.
† Pacific Bluestem.
‡ Early Baart.

DATES OF SEEDING SPRING WHEAT

Experiments have been made each year concerning the proper time to sow spring wheat. These indicate that Early Baart and varieties which develop similarly should be sown as near April 10 as possible in an average season. The right time to seed spring wheat is much a matter of season, but there is no advantage and probably some disadvantage, in extremely early seeding before the land is in good condition or warm enough to ger-

minate the seed. On the other hand, seeding should never be delayed beyond the middle of April if the season permits, as the crop is then delayed in maturing and lower yields and poorer quality are likely to result from the effects of hot weather or early fall frost before the grain ripens.

COMPARISON OF WINTER WHEAT AND SPRING WHEAT

It has already been stated that early-maturing varieties of spring wheat exceed the best varieties of winter wheat in average yield per acre when planting of each is done in all seasons regardless of conditions. The reasons for this have also been explained. Table 12 brings out this point. Winter wheat should be sown only when conditions are such as to insure germination in the fall.

TABLE 12. COMPARATIVE YIELDS OF THE LEADING VARIETIES OF SPRING AND WINTER WHEATS.

Class	Variety	C. I. No	1913	1914	1915	1916	1917	5-year average
Winter	Turkey	1558	26.0	19.3	30.7	4.0	5.8	17.1
Spring	Early Baart	1697	28.3	18.2	20.5	13.4	24.5	21.0

BARLEY

Both winter and spring barleys have been tested. Only the early spring varieties have yielded well.

WINTER BARLEY

Six varieties of this crop were grown in 1913, but the stands were very poor because of winter killing. The two best varieties, Tennessee Winter and Utah Winter (White Club), were sown again in the fall of 1913. The winter was unusually mild and an excellent stand survived. The plants, however, headed very early and were entirely destroyed by frost in June. Seedings were made again in 1915 and 1916 but the stand secured was very poor. The four-year average yield for the best variety, Utah Winter, for 1913-1916 is 6.4 bushels per acre. Winter barley can not be successfully grown.

SPRING-SOWN WINTER BARLEY

Experiments have been made with the Utah Winter variety of winter barley sown in the spring, very early, medium early, and at the regular time of seeding spring barley. These have given much better yields than the fall-sown winter barley and the best yields were obtained with the latest seeding. Used in this way, the Utah Winter has been a fair yielder, but still quite inferior to the best spring varieties.

SPRING BARLEY

Spring barley has given average yields about equal to spring wheat. Varietal trials, rate-of-seedng and date-of-seeding tests have been conducted with the crops for the past five years. Varieties which resist frost well while young and mature early are best.

VARIETAL TESTS

A total of 32 varieties and strains of spring barley have been grown in these tests. The White Smyrna, Hannchen, and Coast varieties are best. There is little choice between the Smyrna and Hannchen. Both are two-row barleys. The Hannchen appears to be a slightly better average yielder, while the Smyrna produces a better quality of grain and better yields in the very dry seasons when grain sells highest. It matures early and is very hardy. It grows rather short straw and should be cut with the header. It does not appear well in the field because of the short straw and fuzzy appearance of the heads. The Hannchen is also quite hardy. It grows tall enough to bind. The Coast (common "Blue" or "California Feed") barley has averaged nearly as much in yield as Smyrna and ripens about as early, but the grain is not as good in quality and the plants are often frosted in late spring. Mariout, the earliest six-row variety grown, would be a

FIG. 4.—INCREASE FIELD OF WHITE SMYRNA BARLEY; EARLY, HARDY, AND OF GOOD QUALITY.

valuable yielder except for its susceptibility to spring frosts. Swanneck, a two-row variety, is a little late in maturing. Yields of the leading varieties of spring barley are given in Table 13.

TABLE 13. COMPARATIVE YIELDS IN BUSHELS PER ACRE OF THE FIVE LEADING VARIETIES OF SPRING BARLEY AT THE HARNEY BRANCH STATION.

Variety	C. I. No.	1913	1914	1915	1916	1917	5-year average
Hannchen	531	31.8	14.6	11.3	52.4	16.5	26.3
White Smyrna	638	27.8	22.5	17.6	36.0	19.9	24.8
Coast	690	31.5	15.6	13.4	45.4	13.8	24.0
Swanneck	187	31.2	11.0	7.1	37.6	19.9	21.3
Mariout	261	19.0	19.6	14.3	35.2	9.2	17.4

Other varieties grown: White Club (Utah Winter), Wisconsin No. 9, S. P. I. No. 19785, Black Hull-less, White Hull-less, Primus, Gutekorn, Chevalier, Hooded, Hanna, Gatami, Imperial, O. A. C. No. 21, "Two Row," Oderbucker, Manchuria, Wisconsin No. 6, Hull-less S. P. I. 3204, Wisconsin No. 13, Beldi, Local White Club, other strains of named varieties.

RATES OF SEEDING SPRING BARLEY

Experiments to determine the right amount of barley seed to plant have been made each year. In 1913 the land used for the test was so variable that no yields were recorded. It appeared that the medium rate of seeding was best that year. During the past four years, the yields have averaged in favor of the light rate. This would indicate that 25 to 30 pounds of good clean barley seed is better than larger quantities when sown on a well-prepared seed bed. The varieties used were Swanneck, in 1914 and 1915, and White Smyrna, in 1916 and 1917. These varieties tiller considerably. It is possible that more seed of the six-row varieties should be used. Where the precipitation is heavier it may be advisable to use more seed. Results of the rate-of-seeding experiments are given in Table 14.

TABLE 14. RATE OF SEEDING SPRING BARLEY EXPERIMENTS AT THE HARNEY BRANCH STATION, 1914 TO 1917, WITH ANNUAL AND AVERAGE YIELDS IN BUSHELS PER ACRE, AND NET INCREASE.

Pounds of seed per acre	1914	1915	1916	1917	4-year average	*Net increase
24 to 30	12.9	6.7	45.2	20.7	21.4	20.8
48 to 60	11.8	5.0	42.9	22.5	20.5	19.2
72 to 84	9.6	5.0	40.8	21.3	19.2	17.5

* Twice amount of seed deducted from average yield.

DATE OF SEEDING SPRING BARLEY

The right time to plant barley varies somewhat with the seasons. In general the experiments have shown that seeding should be done as near May 1 as possible. If sown very early the barley is inclined to excessive leafy growth and may also head too early and suffer serious damage by late spring frost. An instance of this occurred in 1916, when the Mariout, an early-heading variety, was badly damaged. Seeding was done that year on April 25. The stand of less frost-resistant varieties is also likely to be reduced by spring frosts when planting is done too early. On the other hand, seeding must not be later than necessary as the crop should mature as early as possible. Highest average yields are secured by seeding very close to May 1. The Hannchen variety could be sown a few days earlier.

OATS

Experiments with oats have included both winter and spring types of the crop. The early and medium-early varieties of spring oats have done best.

WINTER OATS

The Boswell variety of winter oats was seeded in the fall of 1914 and again in 1915. The stand winter-killed in 1914-15 and did not emerge until spring in 1915-16. Yields were very low. Winter oats is not a suitable crop for fall seeding. Experiments with the crop sown in early spring gave better yields than when sown in the fall, but not as good as from good spring varieties. These data are given in Table 15.

TABLE 15. EXPERIMENTS WITH BOSWELL WINTER OATS FOR THE YEARS 1915 AND 1916, BOTH AS A FALL AND EARLY SPRING SOWN CROP WITH COMPARATIVE YIELDS OF SIXTY DAY SPRING OATS.

Type and Variety	Date sown	1915	1916
Winter Boswell	Fall	8.7	3.1
Winter Boswell	March 20	17.2	.....
Winter Boswell	April 5	15.0	7.0
Spring, Sixty Day	.....	24.8	42.7

SPRING OATS

The rather cool summers of Central Oregon are favorable to spring oats, but the crop is not so drought resistant as wheat or so well suited to light soils as rye. In seasons of heavy rainfall or on soils well supplied with moisture, the crop does well; but the average yield in pounds per acre at the Branch Station is materially less than spring wheat.

VARIETAL TESTS

Thirty-two varieties and strains of spring oats have been tested during the past five years. Of these, the Sixty Day, Kherson, Rustless Selection, Silvermine, and Big Four are promising. The first two vareties are practically identical. Both are very early, with short straw and small meaty kernels. They outyield all others in very dry or short seasons. The Sixty Day (625) variety is preferable to the Kherson. The last three varieties named are mid-season varieties, growing to a medium height and having medium large kernels. They yield more straw, as a rule, and make

FIG. 5.—SPRING OATS IN VARIETAL TEST PLOTS: SIXTY DAY ON LEFT; EARLY AND THE LEADING YIELDER OF GRAIN IN SHORT DRY SEASONS.

larger yields of grain in favorable seasons than the Sixty Day. The Rustless Selection is a high average yielder and preferable to the Silvermine. The Big Four is very promising, but a few days later than the Rustless Selection. It is best suited to long, moist seasons, but seems to do pretty well under less favorable conditions.

From the standpoint of grain production the choice of varieties, therefore, is Sixty Day for short, dry seasons or soil with limited moisture supply; Rustless Selection for intermediate conditions; and Big Four for longer, wetter seasons or soils with bountiful moisture supplies. Yields of the leading oat varieties are given in Table 16.

TABLE 16. ANNUAL AND AVERAGE YIELDS IN BUSHELS PER ACRE OF TEN LEADING VARIETIES OF SPRING OATS AT THE HARNEY BRANCH STATION, 1913 TO 1917.

Variety	C. I.	1913	1914	1915	1916	1917	5-year average
Rustless Selection	724	56.2	11.2	49.4	45.0	9.3	34.2
Sixty Day	625	55.0	19.8	21.9	42.7	11.2	30.1
Big Four	.....	.....	13.7	30.8	60.6	11.0	*29.1
Silvermine	720	63.7	14.0	25.0	43.1	9.3	31.0
Kherson	459	60.7	16.9	22.3	43.1	10.5	30.7
Sixty Day	165	55.0	19.7	19.2	43.9	10.2	28.5
Black American	549	61.9	12.3	26.4	28.5	1.9	26.2
Shadeland Climax	.....	41.9	9.4	29.4	43.1	5.0	25.7
Swedish Select	134	33.1	12.8	29.4	43.7	3.8	24.5
Canadian	444	42.5	.....	24.6	20.6	1.3	*22.2

* Four-year average: Sixty Day (625) same period, 23.9: Rustless Selection 28.7.

Other varieties grown: Early Mountain, Lincoln (local), Joanette, Minnesota No. 281, Minnesota No. 295, Sensation, Big Four, Local (D. N. V.) Great Dane, White Russian, Welcome, Lincoln, Golden Rain, Victory, Banner, Early Mountain No. 2, Swedish Select (2), Siberian, Minnesota No. 26, Colorado No. 37, Quaker, Shadeland, Challenge, Burt.

RATES OF SEEDING SPRING OATS

This experiment has been made each year for the past five years. The variety used was the Sixty Day. The yields obtained indicate that one-half bushel of good clean seed drilled on a well-prepared seed bed gives the best average net yield. Under more favorable moisture conditions, heavier seeding would be advisable. The results are tabulated in Table 17.

TABLE 17. RATE OF SEEDING EXPERIMENTS WITH SPRING OATS AT THE HARNEY BRANCH STATION WITH ANNUAL, AVERAGE AND NET YIELDS IN BUSHELS PER ACRE, 1914 TO 1917.

Pecks per acre	1914	1915	1916	1917	4-year average	* Net increase
2	20.6	14.4	25.9	24.4	21.3	20.3
4	19.1	14.1	30.2	24.4	21.9	19.9
6	17.2	12.5	34.6	23.7	22.0	19.0

* Twice amount of seed deducted from average yield.
NOTE.—Four pecks estimated best rate 1913.

DATE TO SEED SPRING OATS

The best date to seed spring oats is largely a matter of season. In general best yields have been obtained with medium early seeding; as soon as the land can be prepared and the soil is warm enough to promote germination. This is generally about the middle of April. Oat seeding should follow spring wheat immediately.

RYE

Rye is an important cereal under conditions of low rainfall. As a grain producer it compares most favorably with other cereals on the lighter types of soil. On the soils adapted to wheat, oats, or barley, it does not yield so well in comparison, except when the fallow is omitted or in very dry seasons. As a hay crop it shows to particular advantage.

WINTER RYE

The problems in growing winter rye have been found to be about the same as with winter wheat—difficulty in getting the crop up in the fall—and loss from late spring frosts at the time of heading or later. Better stands are usually secured with winter rye than with winter wheat in a dry fall, but poor stands have also resulted, as in 1916. On the other hand, the crop heads earlier and is therefore more subject to frost injury. Examples of loss from frost came in 1913 when about 50 percent of the heads were destroyed, and again in 1914 when the loss was nearly complete, both in grain and value for hay. Altogether, fall rye is not as good in average production as spring rye, to which it should largely give place.

VARIETAL TESTS

Nine varieties of winter rye have been tested. These experiments have not been carried to a point where exact conclusions are possible. The Advance variety, however, which originated at the South Dakota Experiment Station, seems quite promising. Results are given in Table 18.

TABLE 18. ANNUAL AND AVERAGE YIELDS IN BUSHELS PER ACRE OBTAINED IN VARIETAL TESTS OF WINTER RYE AT THE HARNEY BRANCH STATION.

Variety	1913	1914	1915	1916	1917	5-year average
Advance	.....	.....	.....	.....	16.1	.....
Local, Selected	.....	.....	.....	.....	15.0	.....
Wisconsin Ped. No. 1	.....	.....	.....	.....	14.3	.....
Abruzzes	.....	.....	.....	.....	13.2	.....
Scout	.....	.....	.....	.....	13.2	.....
Minnesota	8.0	*1.0	17.5	1.8	12.1	8.9
Johannesrugen	.....	.....	.....	.....	11.8	.....
Petkus (No stand)	.....	.....	.....	.....	.....	.....
C. I. 178	.....	.....	17.5	.....	.....	.....

* Estimated.

SPRING-SOWN WINTER RYE

It is quite the common practice throughout Central Oregon to sow winter rye as a spring crop. In some cases this has been done long enough to have developed a semi-spring type of rye. In other cases rye of true winter characteristics is sown. In any case, examination of the fields will reveal large numbers of true winter plants which either do not head at all or make a very feeble attempt. The extent to which these winter plants produce culms depends upon the time of seeding in the spring, the amount and distribution of the rainfall, temperatures, etc. If winter rye is sown early enough in the spring, it can be expected to make fair yields. Otherwise, not. Every year thousands of acres of rye fail, or at best make

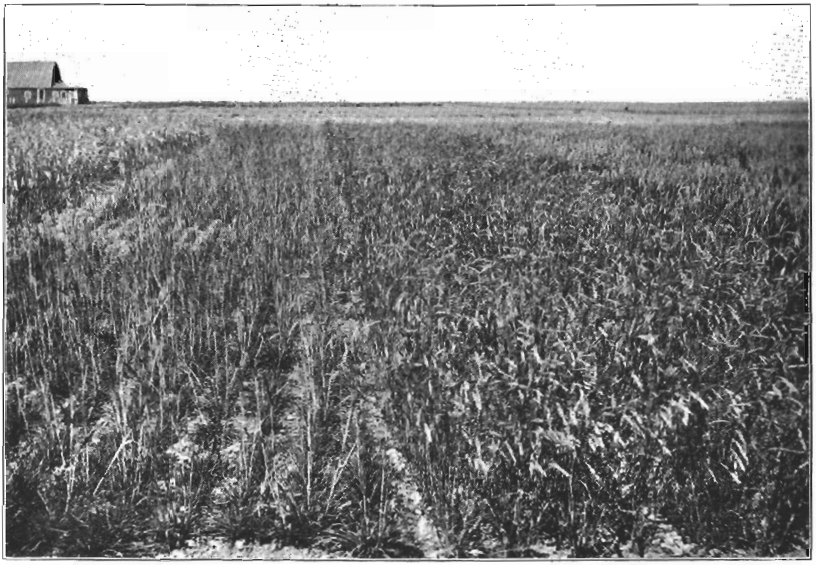


FIG. 6.—WINTER RYE ON LEFT AND SPRING RYE ON RIGHT, BOTH PLANTED SAME DAY (MAY 16); WINTER GRAIN FOR WINTER; SPRING GRAIN FOR SPRING!

mediocre yields, because of late spring seeding of winter, or semi-spring types of rye. While it may do to sow winter rye in March, if the season permits, it certainly is much better to sow spring rye at any later date. This point is brought out in Table 19.

TABLE 19. YIELDS OF WINTER RYE SOWN IN THE FALL, COMPARED WITH YIELDS OF THE SAME RYE SOWN AT THREE DATES IN THE SPRING AND WITH SPRING RYE SOWN IN THE SPRING, 1915.

Type	Date sown	Yield
Winter Rye	Fall	17.5
Winter Rye	Spring, March 20	14.8
Winter Rye	Spring, April 5	8.2
Winter Rye	Spring, May 16	1.0
Spring Rye	Spring, May 16	13.6

SPRING RYE

Spring rye has been on trial for three years. It has proved better in average yield than winter rye, being more dependable and consistent. The crop has not yielded as much grain per acre as spring wheat, but is better for hay. It is early maturing and hardy. The straw is not quite so tall as winter rye and the grains are usually smaller. It is a valuable crop for light soils and probably the best cereal for the second crop after fallow.

FIG. 7.—SPRING RYE SOWN MAY 1. THIS TENTH-ACRE PLOT YIELDED AT THE RATE OF 32.3 BUSHELS PER ACRE.

VARIETAL TEST

Five varieties of spring rye were grown in 1915. Of these one known as S. P. I. No. 26101 proved to be the best. This variety only has been continued during the past two years. Yields of this variety are given in Table 20.

TABLE 20. YIELDS IN BUSHELS PER ACRE OF S. P. I. NO. 26101 SPRING RYE AT THE HARNEY BRANCH STATION FOR THE YEARS 1915 TO 1917.

Variety	1915	1916	1917	3-year average
S. P. I. No. 26101	13.6	15.2	13.5	14.1

Note: Early Baart Spring Wheat average same period, 19.5 bushels.

RATES AND DATES OF SEEDING SPRING RYE

No experiments have been conducted to determine these matters exactly. Thirty pounds of seed is a good quantity to sow on well-prepared land when moisture is limited. Under very favorable conditions 45 pounds per acre is probably better.

Seeding should be done about the middle of April for best yields, though the crop will mature if sown considerably later.

COMPARISON OF WINTER RYE AND SPRING RYE

It is easier to obtain a stand of spring rye than of winter rye, and there is little danger of loss from late spring frost. It yields more consistently. When both crops are planted every year regardless of conditions, spring rye will most certainly produce the highest average yield. This is brought out in Table 21. The two types of rye should be used in conjunction. The winter rye should be sown in the fall only when the soil is moist, or it may be sown in March when it is possible or desirable to do so. The spring rye should be used for regular spring planting.

TABLE 21. YIELDS OF WINTER AND SPRING RYE COMPARED.

Type	1913	1914	1915	1916	1917	1915-17 3-year average	5-year average
Winter	8.0	* 1.0	17.5	1.8	12.1	10.5	8.9
Spring	.....	.....	13.6	15.2	13.5	14.1	....

* Estimated.

EMMER

Both winter and spring emmer have been tested at the Branch Station, but neither is promising. Tests of emmer were discontinued after 1916.

WINTER EMMER

This crop was grown as a fall-sown crop until 1916. It was not hardy enough to survive the winters satisfactorily, though somewhat hardier than winter barley. It matured very late. The four-year average yield, 1913 to 1916, is 15.6 bushels per acre, 32 pounds per bushel. Sown experimentally, in the spring, at different dates, winter emmer was an entire failure. It is more nearly true to type than any other winter cereal so far tested. To induce it to head at all requires very early spring seeding, and then very few culms will be thrown up. This indicates the futility of planting the crop unless a good growth can be secured in the fall.

SPRING EMMER

This crop was grown for five seasons ending with 1916, the last four seasons upon fallow. It has shown no superiority over other cereals in any way. It has not seemed as drought resistant, nor frost resistant, as good varieties of the more common cereals, and has not averaged nearly as well in yield. It matures rather late and the grain is generally of poor quality. The four-year average yield, 1913 to 1916, is about 18 bushels per acre of 32 pounds per bushel, less than half the average yield in pounds per acre of Early Baart spring wheat for the same period.

SPELT

Only winter spelt has been experimented with at the Branch Station. The Red Winter variety was grown in 1915 and 1916, both as a fall- and early spring-sown cereal. It is not hardy enough to survive the winters when sown in the fall. As a spring-sown crop it is better. It is a possible crop for early spring seeding, but hardly a practical one. Results are tabulated in Table 22.

TABLE 22. YIELDS IN BUSHELS PER ACRE (32 POUNDS PER BUSHEL) WITH RED WINTER SPELT AT THE HARNEY BRANCH STATION, 1915 TO 1916.

Date seeded	1915	1916	2-year average
Fall	*30.6	*10.0	20.3
Spring, March 20	35.0	†18.1	†26.5
Spring, April 3	31.2	16.2	23.7

* From plants which emerged in spring after stand winter killed.
† Calculated from 1915 ratio, 35.0:31.2.
Note: Sixty Day oats yield, same period, 32.3 bushels.

FLAX

Experiments with flax have been conducted each of the past five years. These tests have indicated that flax may be grown with some success under the conditions which have prevailed. The seed sells for about twice as much per pound as wheat. This makes it a better crop to transport. When yields of flax average about one-half that of wheat, the crop may be practical. This has not been the case at the Branch Station.

The crop does best on a mellow, firm soil, with considerable fertility and high moisture-holding capacity. It is not suited to light soil or to soils of low organic content likely to crust. It is not very tolerant of alkali. Because of the flax-wilt disease, it is necessary to treat the seed. It is also best to grow the crop on the same land only at intervals of several years. The use of a good variety is important. The time of seeding is very important in obtaining good yields.

FIG. 8.—FLAX IN THE VARIETAL TEST.

VARIETAL TESTS

Sixty-two varieties and strains of flax have been tested at the Branch Station. Of these, the best variety in point of yield and general adaptability seems to be the Nova Rossick. This variety has been grown only since 1915. Yields of some leading varieties are recorded in Table 23.

TABLE 23. YIELDS IN BUSHELS PER ACRE OF NINE LEADING FLAX VARIETIES AT THE HARNEY BRANCH STATION, 1913 TO 1917.

Variety	C. I.	1913	1914	1915	1916	1917	5-year average
Sel. Russian N. D. 1215	3	....	3.4	....	3.5	7.5	....
N. D. Resistant No. 144	8	....	....	....	*	7.9	....
Primost	12	8.6	3.8	5.9	2.1	5.7	5.2
N. D. Resistant No. 114	13	....	4.2	....	2.1	6.1	....
Russian	17	....	3.8	....	....	....	....
Russian	19	....	3.2	....	3.0	9.6	....
Lethbridge Golden	23	....	....	5.7	*	8.6	....
Nova Rossick	27	....	....	7.1	2.6	12.3	†7.3
Smyrna	30	....	....	5.2	*	....	....

* Failure.
† Three-year average.

RATE OF SEEDING FLAX

These experiments have been made during the past four years. Like other such tests, the results indicate that the lighter seeding is best. This, in the case of flax, is 10 pounds per acre, which is sufficient on a well-prepared seed bed under conditions such as have prevailed during the time of the tests. Under more favorable circumstances it might be advisable to use 15 pounds per acre. These results are given in Table 24.

TABLE 24. YIELD OF FLAX IN BUSHELS PER ACRE IN RATE-OF-SEEDING EXPERIMENTS AT THE HARNEY BRANCH STATION, 1914 TO 1917.

Pounds of seed per acre	1914	1915	1916	1917	3-year average	*Net increase
10	....	6.7	4.6	12.0	7.8	7.5
15	4.5	6.7	5.6	10.9	7.7	7.2
20	....	....	3.8	8.2	....	....
25	....	5.7	3.4	7.0	5.4	5.0
35	3.2	....	....	....	....	....

* Twice weight of seed deducted from average yield.

DATE TO SEED FLAX

Experiments during the past five years have shown that the best time to seed flax is about May 1. It is better to sow a little later than this than earlier. When flax is sown very early, as the first part of April, there is much danger of loss of the stand by spring frost. This occurred in 1916 with both April 1 and April 15 seeding. On the other hand, if seeding is delayed till the last of May or the first of June, the crop is exposed to hot weather during growth and is also liable to be caught by early fall frosts before it is mature. This occurred in 1916, slightly in the case of May 15, but disastrously in the case of the June 1 seedings.

The importance of correct date of seeding with flax is brought out in Table 25, which can well be studied in conjunction with Table 4, showing minimum temperatures.

TABLE 25. DATE OF SEEDING FLAX EXPERIMENT IN 1916, WITH DATE OF EMERGENCE, DATE OF MATURING, AND YIELD IN BUSHELS PER ACRE, FOR EACH DATE.

Date of seeding	Emerged	Ripe	Yield
April 1	4/23	*8/22	3.7
April 15	5/ 1	*8/22	5.6
May 1	5/17	8/ 9	7.5
May 15	5/28	8/19	6.0
June 1	6/10	†(?)	.5

* Very thin stand as result of spring frost and consequent delayed maturity.
† Practically wiped out by fall frost while immature.

OTHER CEREALS

Experiments have been made with a number of cereal crops which have not been found adapted to conditions at the Branch Station. These will be considered briefly.

CORN

This crop was carried in varietal trials for four years. Thirty-five varieties, including the earliest varieties obtainable, were tested. During this time, no variety more than reached the roasting ear stage; and in but two seasons of the four did any develop beyond the tassel. The ears were very small and the growth of stalk dwarfish.

Corn requires a fairly long frost-free season. Even the most optimistic seedsmen do not advertise their earliest varieties as maturing in less than 70 days. A glance at Table 6 will show that it would be necessary for a variety of corn to ripen in 50 days at the Branch Station and be able to choose the time automatically in order to adapt itself to seasonal variations. Or, it will be necessary to produce a frost-resistant kind of corn which will thrive under a low mean temperature.

GRAIN SORGHUMS, ETC.

Eleven varieties of grain sorghums, proso, hog millet, etc., and nine varieties of quinoa were tested during the first years of experimental work. These are all easily frosted. No seed matured and what growth was made was dwarfish and spreading.

MILLETS

Two varieties of Kursk millet were tested. This millet is hardier than corn and sorghums but still subject to frost injury. It was not practical either for hay or seed.

BUCKWHEAT

This crop is extremely sensitive to cold. It failed entirely in three years' trial.

FORAGE AND SEED CROPS

The principal forage and seed crops experimented with have been the legumes: Alfalfa, field peas, and sweet clover. It must be remembered in this connection that the cereals, notably rye, are valuable forage crops as well as grain producers.

LEGUMINOUS FORAGE AND SEED CROPS

Of the legumes tested for hay production, alfalfa, field peas, and sweet clover have given best, but hardly flattering, returns. In production of seed, alfalfa is best.

ALFALFA

Experiments with alfalfa in 28-inch rows have been made both as a hay and seed crop, and as a pasture crop for hogs. A large number of varieties have been tested for hardiness, productivity, etc. Experiments have been conducted to determine the proper spacing for seed production; and the effectiveness of the inoculation of alfalfa.

FIG. 9.—PART OF THE ALFALFA VARIETAL TEST. THE TWO THRIFTY-LOOKING ROWS AT THE LEFT-CENTER OF THE PICTURE ARE BALTIC.

VARIETAL TESTS

Forty-three varieties, strains, and selections of hardy alfalfas are on trial. The most frost resistant are the Grimm, Baltic, Cossack, and Semipalatinsk varieties. The first three of these are "variegated" (Medicago media) strains of alfalfa believed to be natural hybrids of the common alfalfa (Medicago Sativa) with the hardy wild, yellow-flowered (Medicago Falcata) alfalfa of which the Semipalatinsk is an example. On several occasions during the past five seasons, these varieties have been observed to pass through frosts practically uninjured whereas common strains were badly nipped or even frozen back to the ground.

FIG. 10.- ALFALFA AFTER AN EARLY SPRING FROST. TO THE LEFT OF THE CAMERA CASE IS MARTIN'S ACCLIMATIZED (COMMON) AND ON THE RIGHT, BALTIC.

Thus far there has been little winter-killing among any of the varieties on trial, though this sometimes occurs in the Central Oregon country according to some of the more experienced alfalfa growers. The superiority of the Grimm and Baltic in this respect has been established beyond all question by various investigators.*

Such advantages in yield of hay or seed as have been shown in the tests have been in favor of the Baltic variety.

SEED PRODUCTION

The experiments in alfalfa seed production have indicated that, with the right variety, given the proper spacing between rows, and between plants in the rows, there is a fair possibility of the crop being successful. The chief difficulty, so far encountered, is in getting the crop ripe before the first fall frost. A fair crop of seed has "set" every season during the five years, but the crop has been lost in two of the years by frost in August. This can only be controlled satisfactorily by means of an earlier-maturing strain. An attempt has been made in this direction that has met with some success in the first-year trial. If a good hay- and seed-producing type can be established which will ripen the seed 10 days earlier than ordinary strains, it will add much to the possibilities of this crop. Experimental results on varieties and spacing tests are given in Tables 26 and 27.

* Bureau Plant Industry Bulletin 169—"Variegated Alfalfa."
Bureau Plant Industry Bulletin 209—"Grimm Alfalfa——."
Bureau Plant Industry Bulletin 185—"Cold Resistance of Alfalfa——."

TABLE 26. ANNUAL AND AVERAGE YIELDS OF ALFALFA SEED IN POUNDS PER ACRE OBTAINED WITH FIVE VARIETIES OF ALFALFA AT THE HARNEY BRANCH STATION, 1913 TO 1917, AND 1917 YIELD OF A SPECIAL SELECTION.

Variety	1913	1914	1915	1916	1917	5-Year Average
Martin's Acclimatized	85.0	*7.5	115.	†Failed	94.0	60.3
Baltic	100.0	12.5	110.	Failed	137.5	72.0
Dakota Diamond	80.0	5.0	18.	Failed	62.5	33.0
Grimm	117.5	2.5	16.	Failed	54.0	38.0
Turkestan	120.0	10.0	15.	Failed	37.5	38.5
Select Baltic (white flowered)	.....	.....	....	.....	262.5	.....

* Frosted most of seed in August.
† Frosted the seed in August.

FIG. 11-A. FIG. 11-B.

ALFALFA IN SPACING EXPERIMENT.

This broadcast plot is too thick; it made a yield of only 4 pounds of seed per acre.

This plot is better: Rows 5½ feet apart and plants 1½ feet apart in the row. It yielded 108 pounds of seed and 1370 pounds of straw per acre.

SPACING EXPERIMENT

This experiment was seeded in 1915. In 1916 the seed crop frosted but the straw weights were recorded. These are reported in Table 27. In 1917 both straw and seed weights were recorded. While there are apparent discrepancies in these results, which should be checked by further experiment, it is significant that the correct spacing of alfalfa, on dry land, under light rainfall, is an important consideration whether the product desired be hay or seed.

TABLE 27. YIELDS OF STRAW AND SEED IN A SPACING EXPERIMENT WITH BALTIC ALFALFA AT THE HARNEY BRANCH STATION.

Spacing	1916		1917	
	Pounds Seed	Pounds Straw	Pounds Seed	Pounds Straw
36 in. x 36 in.	Failed	1700	99	2530
36 in. x thick (unthinned)	Failed	1500	74	1080
66 in. x 18 in.	Failed	300	108	1370
36 in. x 18 in.	Failed	480	35	580
Broadcasted	Failed	50	4	65
98 in. x 36 in.	Failed	400	50	620

HAY PRODUCTION

Yields have been light in these tests. The average acre yield has been hardly one half ton per acre. One cutting only has been secured. Except where more moisture than an eight-inch precipitation is available, alfalfa hay does not give much promise, though the experiment reported in Table 27 indicates that yields may be increased by more careful spacing of plants. The quality of the hay has never been good, owing to dust gathered in harvesting. Where there is partial sub-irrigation or seepage water available, the crop will make higher yields.

PASTURING EXPERIMENTS

Pasturing experiments were conducted for two seasons. Shoats were turned on the alfalfa and given a supplemental ration of grain. These tests did not return any profit for the pasture, after the grain was paid for. The alfalfa was not relished owing to its rather woody growth, unlike the tender shoots in a well-watered field. To keep the animals from breathing considerable dust is a problem. Sheep would probably utilize the alfalfa under these conditions to better advantage than hogs.

INOCULATION

Alfalfa does not become inoculated naturally on the soil of the Branch Station, or at least only after a number of years. A test of various methods of inoculation gave the largest number of nodules with the U. S. Department of Agriculture pure culture.

FIELD PEAS

Field peas have been given a rather extensive trial during the past five years. The crop is grown in double rows 35 inches apart. The rows are spaced by closing 3 of every 5 drill holes in an ordinary grain drill. One bushel of seed per acre has been the best rate of seeding. The seed is drilled 3 to 4 inches deep, about the first of April. Cultivation is given to destroy weeds.

The crop has not given satisfactory results. In only one year, 1913, the yields approached those of the cereal crops. On the average the yields of seed have been about one third that of spring wheat, while hay yields have also been rather too low in comparison with other hay crops. The use of peas in rotations with grain has not given satisfactory results. This is discussed further in the paragraphs on rotation following.

The chief difficulties experienced in field pea production have been low rainfall, frost in July and August, and the depredations of the red spider. The crop does best in cool seasons with considerable moisture. Extreme drought and hot weather as in 1915 and 1917 are decidedly against it. There are a number of varieties which will withstand severe freezing in the spring; in fact, such varieties as Kaiser and Grey Winter have passed through temperatures as low as 20 degrees F. without apparent damage to the vegetative growth. The immature seeds of all varieties tested, however, are destroyed by the lightest frosts. Such damage occurred in July, 1914, 1915, and 1916. Some damage also resulted

from August frost in 1916. Red spiders gave a small amount of trouble in 1916 and destroyed the crop in 1917. Aside from spider damage, however, there would have been very light yields in 1917, owing to drought.

VARIETAL TESTS

Seventy-eight varieties of peas have been grown in the varietal tests. Seed yields with some of the leading varieties are given in Table 28. The average hay yield for the period 1913 to 1917 is about nine-tenths ton per acre.

TABLE 28. ANNUAL AND AVERAGE YIELD IN BUSHELS PER ACRE OF EIGHT LEADING VARIETIES OF FIELD PEAS AT THE HARNEY BRANCH STATION, 1913 TO 1917.

Variety	1913	1914	1915	1916	1917	4-Year Average	5-Year Average
Clamort	29.2	2.3	4.2	4.0	Failed	9.9	7.9
Grey Winter	22.1	10.1	4.0	3.0	Failed	9.8	7.8
Cossack	26.4	5.5	3.2	3.0	Failed	9.5	7.6
Wellwood	21.6	5.6	5.7	3.0	Failed	9.0	7.2
Kabilya	22.6	4.1	4.2	4.0	Failed	8.7	7.0
Peluschka	22.6	3.2	5.5	1.0	Failed	8.1	6.5
Kaiser	20.7	1.8	4.5	4.0	Failed	7.7	6.2
Carleton	21.3	1.8	4.5	2.0	Failed	7.4	5.9

FIG. 12.—LAMBS IN PEAS. (HOGS BEYOND IN RIGHT-CENTER.) EITHER SHEEP OR HOGS UTILIZE PEAS TO GOOD ADVANTAGE.

FEEDING EXPERIMENTS WITH PEAS

Hogging-off field pea experiments were made for four years. Sheep were used in the same way two years. These experiments, while giving excellent returns on the feed available for the animals, did not give satisfactory weight increase per acre. The gains are partly due to the animals having made use of a considerable part of the vines. Better results were obtained on green peas than after the vines were dry, particularly with sheep. These data are summarized in Table 29.

TABLE 29. FEEDING EXPERIMENTS IN THE FIELD ON FIELD PEAS WITH HOGS AND SHEEP AT THE HARNEY BRANCH STATION, 1913 TO 1916.

Stock	Grain in weight in pounds per acre				Average
	1913	1914	1915	1916	
Hogs	175	102	92	119	122
Sheep	.....	.....	85	171	128

INOCULATION OF PEAS

One of the arguments in favor of growing peas is that they add available nitrogen to the soil by means of nodule-forming bacteria. The experiments at the Harney Branch Station have shown that it is necessary to inoculate the seed to secure these nodules on the roots. This has been done most successfully by means of the U. S. Department of Agriculture pure culture, or by wetting the seed with water in which soil from land known to have grown inoculated peas, has been stirred.

SWEET CLOVER

This crop has been grown experimentally for three years. The white-flowered biennial variety is superior to the yellow biennial. Rows 28 inches apart gave better yields than rows 14 inches apart. Two or three cuttings are obtained the second year after seeding. The first year's growth has never been sufficient to harvest. Seeding was done upon summer fallow for the first two years. This requires that the land be used three years to produce one year's crop, as the plants die after the second summer. The last year, seeding was done upon disked sweet clover stubble. Results are given in Table 30. Considering the length of time the land is occupied and that two or three cuttings must be made, these yields are not high. The same argument, as for other legumes, is advanced in favor of the crop—that of being a benefit to the soil. The plant makes a vigorous rooting system. Inoculation is necessary.

TABLE 30. ANNUAL AND AVERAGE YIELDS OF WHITE-BLOSSOM SWEET CLOVER HAY IN TONS PER ACRE AT THE HARNEY BRANCH STATION, 1915 TO 1917.

1915	1916	1917	3-Year Average
2.0	1.7	1.5	1.7

OTHER LEGUMES

A number of varieties of horse beans, vetch, chick peas and Swiss peas have been tried out. The horse beans made yields somewhat less than field peas and were subject to the same difficulties. Of the vetches, Sand (Hairy or Winter) vetch was best. It gave very light hay yields, however, about one-fourth ton per acre as an average on summer fallow. As a seed crop it made yields averaging about 120 pounds per acre. Seeding about April 1 is better than in the fall. The chick peas were very easily frosted and failed entirely. Swiss peas yield somewhat less seed than field peas and are of little value as forage.

OTHER FORAGE AND SEED CROPS

Non-leguminous forage and seed crops tested include rape, grasses, Sudan grass, sunflowers and oil seed plants. These are discussed briefly in the paragraphs following.

RAPE

Experiments were made with Dwarf Essex rape for three years. Planting was done in three-foot rows and the crop cultivated. The plants are quite easily frozen while young and good stands are difficult to secure. Hogging-off tests in 1914 and 1915 showed a loss, after allowing for the grain fed as a supplement. The crop produces a fair amount of forage but the quality is poor, not being so rank and succulent as rape on moist, rich soil. The animals do not seem to eat it readily.

GRASSES

Fifteen varieties of grass have been grown but without practical success. Western rye (Slender Wheat) grass gave more promise than any other.

SUDAN GRASS

This crop is not sufficiently hardy to succeed at the Branch Station. In three years' trial it failed to make sufficient growth to harvest. Rye is a far better hay crop.

SUNFLOWER

Sunflowers require a fairly long season to mature seed. Ripe seed has been obtained in only one year in the past five. The plant is, however, quite frost resistant and vigorous, and may have value as a fodder or silage crop. The yield of green fodder in 1917, cut when the plants were just past full bloom, was about 10 tons per acre. Successful attempts in siloing the crop have been reported from Colorado. Horses at the Branch Station ate the fodder readily and cows ate it with relish when shredded.

OIL SEED PLANTS

Nine oil seed crops were tried in 1917. The only ones which arrived at maturity were hemp and **Lallemantia iberica.** The hemp proved to be very hardy, though also very late in maturing. It is the only plant yet grown at the Station which has withstood very low temperatures while the seed is immature, without apparent damage. The yield of seed was 220 pounds per acre.

The **Lallemantia iberica,** a crop now in the experimental stage, from which it is hoped to develop a good drying oil, proved to be quite hardy, drought resistant and early. It produced at the rate of 420 pounds of seed per acre.

ROOT CROPS

POTATOES

Thirty-three varieties of potatoes have been grown in varietal tests. The best varieties are early or medium early in maturing. The short seasons are unfavorable, and yields vary greatly from year to year according to the length of the frost-free period. The tubers are frequently too small for market. Yields of two leading varieties are recorded in Table 31.

TABLE 31. ANNUAL AND AVERAGE YIELDS IN BUSHELS PER ACRE OF TWO LEADING VARIETIES OF POTATOES AT THE HARNEY BRANCH STATION, 1913 TO 1917.

Variety	1913	1914	1915	1916	1917	5-year Average
Six weeks (Geer)	85.2	5.1	31.3	20.4	91.0	46.6
Netted Gem	81.6	3.5	27.7	21.6	100.0	46.9

OTHER ROOT CROPS

Sugar beets, mangel wurtzels, rutabagas, turnips and carrots have been grown on the dry land. Of these, the mangels gave highest yields. Difficulty has been experienced in obtaining a stand because of late spring frosts. In 1915 a yield of 12.85 tons per acre was obtained with the best variety of mangels, the Colossal Half-Sugar. In 1914 the root crops were killed by frost when in the five-leaf stage and in 1916 when just beginning to emerge. Later seedings did not grow to harvestable size.

COMPARATIVE YIELDS AND ACRE VALUES OF CROPS

In Table 32 is given a summary of average yields and acre values of leading varieties of principal crops tested at the Branch Station during the past five years. These yields are given in both bushels and pounds per acre. The values are based on what the writer considers about average Central Oregon farm prices during the period of experimentation. Except alfalfa seed, all crops listed were grown after summer fallow. The labor and seed cost of production for cereals under this method has been about $10.00 per acre. Field peas would cost somewhat more because of the higher value of the seed. Alfalfa seed will cost about $6.00 per acre per year under the methods used.

TABLE 32. COMPARATIVE ACRE YIELDS AND ACRE VALUES OF HIGHEST YIELDING VARIETIES OF PRINCIPAL CROPS GROWN AT THE HARNEY BRANCH STATION, 1913 TO 1915.

Variety	Crop	Bushels	Pounds	Price*	Value
Early Baart	Spring wheat	21.0	1,260	$1.50	$18.90
Hannchen	Spring Barley	26.3	1,262	1.25	15.77
Turkey (1558)	Winter Wheat	17.1	1,026	1.50	15.39
Rustless Selection	Spring Oats	34.2	1,094	1.35	14.77
Baltic	Alfalfa seed	1.2	72	20.00	†14.40
No. 26101	Spring Rye	14.7	882	1.50	12.35
Nova Rossick	Flax	‡7.3	409	3.00	12.27
Red Winter	Spelt	26.5	848	1.35	11.45
Kubanka	Durum Wheat	11.4	684	1.50	10.26
Clamort	Field Peas	7.9	474	§1.65	7.82
Spring Emmer	Emmer	18.0	576	1.35	7.77
Minnesota	Winter Rye	8.9	498	1.50	7.47
Black Winter	Emmer	12.5	500	1.35	6.75

* Per cental. † Annual. ‡ Three-year average. ‖ Spring sown. § Feed value of seed.

ROTATION EXPERIMENTS

Twenty-nine rotation experiments, ranging from continuous cropping to eight-year rotations, are under way. The crops used in these experiments are winter and spring wheat, oats, barley, rye, flax, field peas, potatoes, sweet clover and alfalfa. As yet the results are incomplete. It may be said, however, that such returns as are available indicate the necessity of the bare fallow one year in two for profitable grain production. The use of cultivated crops as summer fallow substitutes has not been practical because these crops themselves were unprofitable. So far the only plan which has given a little promise as an alternative to the fallow-grain method is in the use of spring rye for hay on disked grain land in a fallow-grain-rye hay rotation. Possibly, what might be called an "optional three-year rotation" in which the third year would be devoted to a grain or cultivated crop when the soil contains abundant moisture at planting time in the spring, but would be fallowed when there is little moisture at that time, could be used to better advantage from the standpoint of total production than either the rigid two-year or three-year systems, though the amount of crop from a piece of land would be much more variable from year to year. Under more favorable conditions the opportunity to increase production through crop rotations would be better.

Some preliminary results of this work are recorded in Table 33. It must be remembered that cost of production is an important consideration, as well as yield. The cheapest of these is the fallow-grain method. While the yield of wheat is larger in the fallow-wheat-peas rotation, this gain is offset by the low yield of peas and higher costs of production.

TABLE 33. PRELIMINARY RESULTS OBTAINED IN ROTATION EXPERIMENTS FOR THE YEARS 1913 TO 1917.

Crop	Crop Sequence	1913	1914	1915	1916	1917	Average Yield	Average Annual Return
Spring Wheat	Continuous	3.3	13.9	4.9	10.8	3.9	7.4	7.4
Spring Wheat	Fallow-Wheat	14.8	15.7	17.7	7.5	14.0	14.0	7.0
Spring Wheat	Peas-Wheat	12.7	16.3	4.5	10.8	3.0	9.5	*7.0
Spring Wheat	Fallow-Peas-Wheat	15.0	16.1	9.0	17.5	7.3	13.0	*6.8
Spring Wheat	Peas-Fallow-Wheat	15.3	16.0	19.0	15.0	14.0	15.9	*7.1
Peas	Wheat-Peas	9.5	3.1	3.5	6.7	0.0	4.6	*7.0
Peas	Fallow-Wheat-Peas	9.5	2.3	3.6	11.7	0.0	5.3	*7.1
Peas	Wheat-Fallow-Peas	15.0	1.8	9.1	11.0	0.0	7.4	*6.8

* Covers returns from all crops in the rotation.

TILLAGE EXPERIMENTS

Sixteen methods of soil preparation for wheat on the summer-fallow basis are being tried out. Only one year's yields have been secured from these experiments. These results indicate that it is important (1) to work the land as early in the spring as possible; (2) to harrow early plowed land immediately after plowing; (3) to keep the weeds off of the fallow; and (4) to plow stubble early in the spring. If the land can not be plowed, it should be worked with the disk or springtooth as early as possible and plowed later. Fall plowing may offer better opportunity to distribute labor but has the disadvantage of making the fallow more difficult to keep clean.

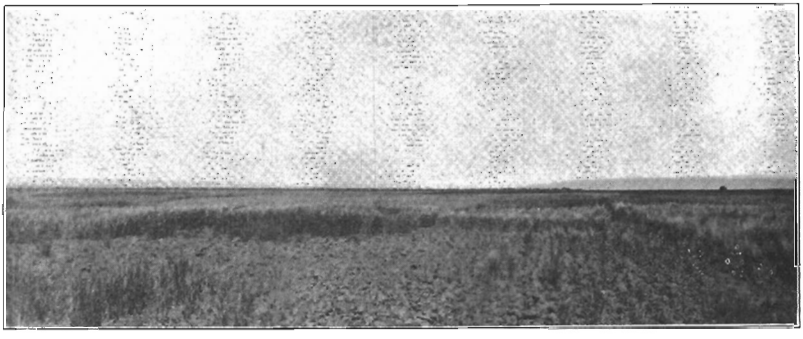


FIG. 13.—"SLICK SPOTS": NOT SUITABLE LAND FOR DRY-LAND GRAIN FARMING. ALFALFA SEED IS THE ONLY CROP WHICH HAS NEAR PAID ON SUCH LAND.

EXPERIMENTS WITH "SLICK SPOTS"

The Branch Station tract is "blessed" with a considerable number of "slick spots" varying in size from a rod across to several acres in area. These spots contain a slight excess of alkali and a deficiency of organic material. As a result the soil "runs together" and forms "slick spots" on which the annuals do not grow at all, or at best very feebly. Different treatments of this soil have shown that the liberal use of manure will do much to correct the condition, but it requires much manure and the yields are not as good after treatment as from soil which does not need correction. Without a reasonably heavy precipitation or until water can be applied, this type of land can hardly be developed profitably through grain farming, though the land can be greatly improved if the owner's resources hold out.

Sweet clover does better than the cereals or peas on such land when no manure is used. The crop is hardly profitable in itself, however, and can only be looked upon as a means of reclaiming the land.

Alfalfa sown thinly for seed and handled at the minimum of expense, offers the only means of utilizing this land with a fair chance of getting returns on the labor involved. A yield of 110 pounds of first-grade seed

per acre was obtained in 1917 from four acres of Baltic alfalfa on this type of land. To obtain a stand is difficult; but when accomplished, expenses are quite low in comparison to any scheme that involves plowing and seeding for each crop, and the returns are more certain.

HOME IMPROVEMENT EXPERIMENTS

BUSH FRUITS

Without irrigation, none of the bush fruits did well, though gooseberries and currants have survived and produced a little fruit in favorable seasons. Blackberries, dewberries, raspberries, Loganberries, strawberries and grapes soon died out after growing the first season. This was due to the short season, which did not allow the vines to become matured and the consequent damage by cold, though they were well mulched with straw for protection. With a little irrigation, rhubarb does well, while currants and gooseberries may be grown with some success.

TREE FRUITS

The experiments with tree fruits were made upon well-cultivated fallow land without irrigation. Water was used in setting the trees and a high percentage of all trees planted grew the first season. The fruits selected for planting were the hardiest varieties obtainable of all the common temperate fruits. In all, 24 varieties of apples; 11 of crab apples; 6 of pears; 7 of plums; 11 of hybrid plums; 2 of prunes; 2 of sand cherry; the Compass cherry; 4 of cherry; 7 of peach; 4 of apricot and 3 of quince, were tested during the years 1913 to 1917. Several trees of each variety were planted. As the less hardy kinds were killed out, those which had survived were used to fill in.

The results of this experiment are presented in Table 34, where all varieties which have survived are listed with data to show comparative hardiness. From this it will be seen that only certain varieties of apples, crab apples, pears, plums and the Compass cherry have survived. Late spring frosts and early fall frosts contributed to the death of the less hardy, while many others succumbed to cold in winter, partly because of the immature condition of the wood as a result of short growing season. Of those which have survived, four varieties stand out as distinctly superior in hardiness; the red Siberian crab apple, the Surprise plum, the Kaga hybrid plum and the Compass cherry. By planting these, one or two additional varieties of the hardiest crab apples and a few of the hardiest and best apples, such as Yellow Transparent and Duchess, where a little irrigation can be given, a small home orchard might be grown.

TABLE 34. KINDS AND VARIETIES OF FRUIT WHICH SURVIVED IN AN EXPERIMENT WITH TREE FRUITS ON DRY LAND AT THE HARNEY BRANCH STATION, 1913 TO 1917, WITH THE NUMBER OF TREES PLANTED AND THE NUMBER ALIVE DECEMBER 15, 1917.

Kind	Variety	Planted	Alive
Apples	Yellow Transparent	15	1
Apples	Duchess	19	2
Apples	Wealthy	26	6
Apples	Alexander	2	1
Apples	Wagner	5	1
Apples	Red June	9	1
Apples	Malus Sp. 30327	2	1
Apples	Malus Sp. 27108	1	1
Pears	Bartlett	12	3
Pears	Seckle	7	1
Crab Apples	Red Siberian	10	9
Crab Apples	Yellow Siberian	10	4
Crab Apples	Martha	5	3
Crab Apples	Transcendant	8	5
Crab Apples	Whitney	6	3
Crab Apples	Florence	2	1
Crab Apples	Hyslop	7	1
Plums	Surprise	12	9
Plums	Wolf	3	1
Hybrid Plums	Kaga	3	2
Hybrid Plums	Hanska	9	3
Hybrid Plums	Sansota	8	1
Hybrid Plums	Cheresota	8	1
Compass Cherry	Compass Cherry	16	11

SHRUBS

FIG. 14.--THE NATIVE CURRANT (LEFT) AND NATIVE ROSE (RIGHT) MAKE VERY PRETTY SHRUBBERY WHEN GIVEN A LITTLE CARE.

A number of shrubs have been tested. The best of these for border, or mass planting, are the native rose (sweet brier) and native wild currant. These are hardy and very decorative when used as indicated. Of the flowering shrubs tested, the common yellow rose, purple lilac, the red and white Tartarian honeysuckles, Siberian pea tree, a Chinese barberry and a Chinese flowering peach are most promising. It is essential that some irrigation be given the shrubs in order to obtain a vigorous growth.

SHADE TREES

Several kinds of shade trees in considerable numbers have been tested. These have included the elms, Black locust, box elder, Russian olive, Norway, Russian and other poplars; balm, juniper, pine, Laurel-leaved Golden, English and other willows. From these experiments it is evident that the growing of shade trees is difficult in such an exposed location as the Branch Station. Difficulty has been found in obtaining trees which will grow throughout the summer without injury from frost and also be uninjured by cold in the winter.

Of the trees tried, the Russian olive, Laurel-leafed willow and Russian poplar are the hardiest and best. With good care it may be possible to grow one or more of these kinds successfully.

LAWN

It is not difficult to have a lawn wherever some irrigation can be given. Kentucky blue grass, sown with white clover, makes a very good lawn. This grass is very hardy and will withstand considerable mistreatment, such as being allowed to dry out, etc. The clover will not survive long unless the lawn is kept well irrigated, but makes a quicker start and a better first-year lawn.

SERVICE

The ultimate value of agricultural experiment work depends upon the use made of it by the people in the region to which it applies. When a certain fact has been established, that particular thing is then beyond the experimental stage and ready for practical application. In the degree and rapidity with which the application is made, lies the value of the experiments. For these reasons it is desired to render such service, beyond the actual experimental work, as will enable the people of Central Oregon to profit by the work at the Branch Station as completed. Two lines of service are available to all who believe in better farming.

EXPERIMENTAL RESULTS AVAILABLE

The experimental results are available through the publications from the Branch Station; by correspondence; by personal visit to the Station, and through the various agencies of the Oregon State Agricultural College and U. S. Department of Agriculture. These results are now sought and put to practical use by a large number of good farmers. All are welcome and invited to do likewise.

PURE SEED AVAILABLE

It is the practice at the Branch Station to increase good and high-yielding varieties as soon as the experiments show which these are. In this way, those who wish to obtain a start of better varieties can secure good, pure seed at a moderate charge. At present, the seed of nearly all varieties recommended in this bulletin is available at the Station in sufficient quantity to enable any farmer to plant a seed field. Last year several tons of this seed were shipped by parcel post. The buyers were progressive farmers in every Central Oregon county. Some of it went to similar territory in neighboring states. A few of these men now have seed for sale. The station tries to keep in touch with this seed so that those who want it may be advised of the nearest supply. In another year or two these supplies will be more abundant. The reports of yields in this bulletin should convince any practical man of the advantage in planting only the best. It means higher yields and better quality, which in turn means more prosperity for the individual and the neighborhood.

FIG. 15.—INCREASE FIELDS: WHEN THE EXPERIMENTS HAVE SHOWN CERTAIN VARIETIES TO BE SUITABLE, THE SEED IS INCREASED SO THAT PROGRESSIVE FARMERS WILL BE ABLE TO SECURE A START OF IT.