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Bulletin No. 132 - Minor Dry Land Crops at the Nephi Experiment Farm

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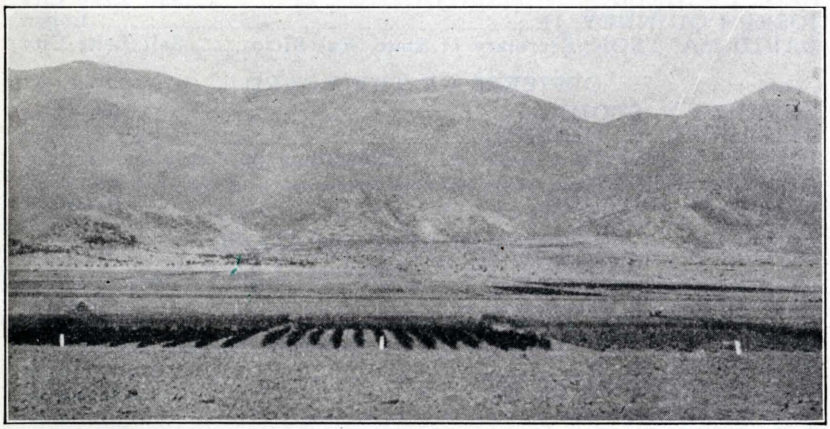
Utah Agricultural College

EXPERIMENT STATION

Bulletin 132



Minor Dry Land Crops at the Nephi Experiment Farm

By

P. V. CARDON

In Co-operation with the Office of Cereal Investigations
U. S. Department of Agriculture

Logan, Utah, March, 1914

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Minor Dry Land Crops at the Nephi Experiment Farm[1]

By P. V. CARDON

INTRODUCTION.

The investigations conducted at the Nephi substation deal primarily with cereals; other crops, such as alfalfa, peas, corn, potatoes, etc., have occupied only a secondary position in the work of this station. This necessarily has been true because the experiments are confined to dry-land practices, and the cereals unquestionably comprise the basal crops for dry-land farming as it is now understood and practiced in Utah. No crops have been found as yet which yield so profitably on the dry lands as do the cereals, especially winter varieties.

The purpose of this bulletin is to review the work done on the Nephi substation with crops other than cereals, and to point out the possible utilization of the results obtained. Both success and failure have been experienced in this work, with no truly startling results; but sufficient promising data are included in the results to warrant publication at this time. It is believed that the publication of these results will stimulate further efforts along these lines.

[1] The Nephi substation was established in 1903 by the Utah Experiment Station. From then until July 1, 1907, it was operated as one of the several "County Farms" located at various points in the State. Prof. L. A. Merrill, Agronomist of the Utah Station, directed the work from 1903 to 1905. From then until 1907 it was under the direction of Prof. W. M. Jardine, Agronomist of the Utah Station. On July 1, 1907, co-operation between the Utah Experiment Station and the Bureau of Plant Industry was effected and Mr. F. D. Farrell of the U. S. Department of Agriculture was placed in charge of the substation. He was succeeded on March 15, 1910, by the present superintendent. From the time the farm was established until July 1, 1912, at which time he was succeeded by Mr. A. D. Ellison, Mr. Stephen Boswell was foreman. From 1907 to 1912, the State of Utah was represented by Prof. L. A. Merrill, the superintendent being a representative of the U. S. Department of Agriculture.

DESCRIPTION OF SUBSTATION.

There are many thousands of acres in Utah where the results obtained at Nephi are applicable, and a comparison of the climate of any section of the State will show whether or not it is safe to apply these results. In making such a comparison, the climatological factors should be carefully considered before any conclusions are drawn. In order to allow such a comparison a description of the Nephi substation and a discussion of the climate there are given herein.

Location.

The Nephi substation is located in Juab Valley, in the eastern part of Juab County, almost in the center of the State. The Valley is about twenty miles long from north to south, and from three to five miles wide. About five miles south of the city of Nephi, a transverse ridge, called the Levan Ridge, crosses the Valley from east to west. This ridge, which is rather fan-shaped, slopes gradually in three directions from the east, where it abuts upon the base of mountains. It is from five to six miles wide, and the crest is nearly 500 feet above the Valley floor, or about 6,000 feet above sea level. Dry-farming is practiced generally over the ridge and under the system of alternate cropping and fallowing which is followed, from 150,000 to 175,000 bushels of winter wheat are produced annually. The substation comprises about 100 acres of land, situated near the top of the north slope of the Levan Ridge.

Native Vegetation.

According to old settlers of Nephi, the Levan Ridge was covered with native* "blue grass"*(Agropyron occidentalis)* as late as fifty years ago. At that time the grass was sometimes cut for hay. Later sheep grazed the ridge heavily and plants not good for forage soon began to take the place of the "blue grass." In 1903, when the substation was established, the entire ridge was covered with sage brush *(Artimesia tridentata)*.

SOIL.[2]

The soil of the Utah substation is very deep and mostly red-brown in color. The first, second, third and fourth feet of

[2] A comprehensive comparison of the soil of Juab County with that of other counties is given in Bulletin 122, Utah Experiment Station, "The Nature of the Dry Farm Soils of Utah."

*This is a wheat grass and not at all like Kentucky blue grass.

soil are comprised of clay loam, containing about 15 per cent of clay. This relatively high percentage of clay makes the soil rather difficult to handle in wet or extremely dry weather. The second and third feet of soil contain a noticeable but scattered amount of gypsum which has been washed from the extensive deposits found on the mountains to the east. The fifth, sixth and seventh feet contain a larger percentage of sand and silt, with occasional pockets of gravel. From the eighth to the tenth foot there is a stratum of rather heavy blue

Fig. 1—Native "Blue Grass" Growing in 1912 Along a Fence Row on The Levan Ridge.

clay which usually has a comparatively high moisture content. Below the blue stratum the soil alternates between a clay and sandy loam to great depths.

RAINFALL.

The average annual precipitation at, or near, the Nephi substation for the past fifteen years, 1898-1912, inclusive, has been 13.6 inches. The maximum annual precipitation during that period was 18.48 inches (in 1906) and the minimum for the same period was 9.08 inches (in 1910). During that time the precipitation was above normal six years and below normal nine years. Here, as in most sections of Utah, the months of March,

April, and May are the wettest months. June and July by far are the dryest months. Most of the precipitation from November to March comes in the form of snow.

TEMPERATURE.

The maximum and minimum temperatures are determined daily at the substation from April to October, inclusive. A maximum and minimum thermometer as well as an air thermograph are in constant use during the summer months.

The highest average mean and maximum temperatures have been recorded in July, while the lowest have been recorded in April and October. Only three months, June to August, inclusive, have been free from frosts. Table I gives the dates of the last spring and the first fall frosts during each year from 1908 to 1912, inclusive, and the number of days in the frost-free period of each year.

TABLE I.—DATES OF THE LAST SPRING AND THE FIRST FALL FROSTS, TEMPERATURE RECORDED, AND NUMBER OF DAYS IN FROST-FREE PERIOD FOR THE YEARS 1908 TO 1912, INCLUSIVE, AT THE NEPHI SUBSTATION.

Year	Date of Last Frost in Spring	Date of First Frost in Fall	Number of days in frost-free period
1908	June 22 (30° F.)_____	August 30 (31° F.)____	69
1909	May 30 (30.5° F.)_____	September 12 (30.5° F.)	105
1910	May 16 (28° F.)_____	October 5 (29° F.)_____	142
1911	May 27 (28° F.)_____	September 17 (29° F.)__	113
1912	June 16 (31° F.)_____	September 4 (30° F)___	80
Avg.	June 4 (29.5° F)_____	September 14 (29.9° F.)	102

The frost-free period varies widely from year to year, as shown in Table I, and this fact makes the production of some crops rather precarious, though no serious results have been observed at Nephi. Altitude plays a big part in the limiting of

the frost-free period, and very likely the production of crops other than cereals will not be possible at altitudes much higher than that of the Nephi substation.

EXPERIMENTAL WORK.

The experimental work with minor crops at the Nephi substation has been conducted for the purpose of determining (1) the adaptability of these crops to dry-farming, (2) the relative value of varieties, and (3) the possibility of including these crops in a cropping system which would take the place of the summer fallow. Much of the work was begun by the Utah Experiment Station as early as 1904, and, since co-operation with the U. S. Department of Agriculture in 1907, the work has been continued. Valuable suggestions have frequently been received from both Federal and State officials, and the many varieties of the different crops which have been furnished by the co-operating offices of the Bureau of Plant Industry have added materially to the importance of the experiments.

General Methods Employed.

One-tenth or one-fifth acre plats were used in most cases, although with some crops only row tests were made. Varietal tests generally were seeded on land which had been fallowed during the previous season. In such cases the land was plowed in the fall to a depth of about eight inches and allowed to lie untouched through the winter, after which it was cultivated and kept free from weeds or volunteer grain. A disk or a spike-tooth harrow, or both, were the implements most used in the cultivation of the fallow. Not until the next spring were the crops sown. Thus, they had for their use the moisture stored in the soil from the precipitation of two winters and one summer.

In some tests, however, the minor crops were sown on land that had been plowed the previous fall or in the spring immediately preceding the seeding of the crops. Under such conditions the crops had for their use only that moisture conserved in the soil during the precipitation of one winter.

Thorough cultivation was given the plats while the crops were growing and no weeds were permitted to grow. Harvesting was done at the proper time by methods similar to those

employed in ordinary farm practice. A more detailed description of the methods used in the production of the individual crops will be given in connection with the presentation of the results.

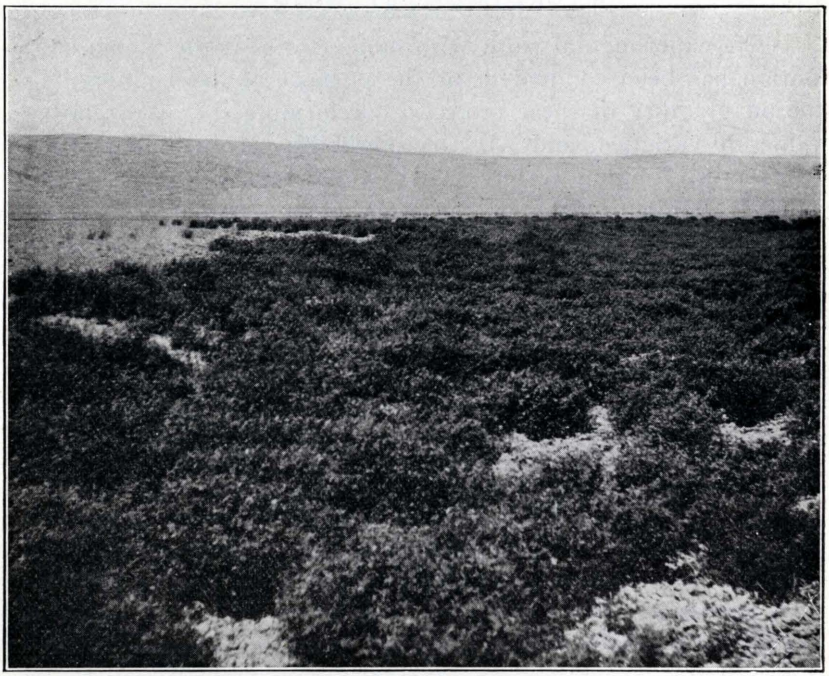

Fig. 2—Alfalfa Growing in a Swale on the Nephi Substation in 1912. This was Seeded in the Spring of 1911. There are Many Such Places in Dry Farming Areas that Might be Made Use of in This Way.

Crops Tested.

The following crops have been tested at the Nephi substation with a view to determining their adaptability to dry-land conditions: alfalfa, clover, vetch, peas, brome grass *(Bromus inermis)*, tall meadow oat grass, miscellaneous grasses, potatoes, corn, grain sorghums, broomcorn, and sugar beets.

Forage Crops.

It is believed that the production of forage crops on the dry lands of Utah will never be profitable in comparison with

the production of these crops on the irrigated lands of the State. If forage can be produced to any reasonable extent on the dry lands however, it will be of great value, regardless of the comparatively low yields obtained; for, in many sections of the State hay is hauled long distances and at great expense during the time that team work is required on the dry-farm. Aside from the fact that the hauling of hay to the dry-farm is expensive, the main objection to the practice is that the farmer often is inconvenienced in his plowing, seeding or harvesting operations by having to go for hay with which to finish his work, at a time when such a trip is undesirable. In addition to this objection there are others equally obvious, and they show the desirability of forage crop production on the dry-farm.

The results of the tests conducted with forage crops at Nephi show the possibility of forage crop production under such conditions as those which exist there.

LEGUMES FOR FORAGE.

Alfalfa.

The following tests with alfalfa were begun in 1904 on one-fifth acre plats: (1) a varietal test with Native, Turkestan and Sand Lucern; (2) a comparative test of seed from an irrigated farm and from a dry-farm; (3) a rate-of-seeding test; (4) a test of various methods of planting—drilling, cross-drilling and broadcasting; (5) a time-of-seeding test—fall, spring and at various times in the spring; and (6) cultivation tests.

The excellent condition of the seed-bed that was prepared by the substation foreman, Mr. Stephen Boswell, together with the favorable weather obtaining, caused a very high percentage germination of all the seed planted. The result was that all the plats, irrespective of the time, rate or method of seeding, contained approximately as many plants as could find space in which to grow. As a matter of fact, all the plats supported stands which were entirely too thick, and this excessive thickness of stand rendered the plats undesirable for experimental purposes.

No important differences were observed in the behavior of the plats seeded. The plats were clipped the first year and the clippings were allowed to lie on the ground; thus, no hay

yields were recorded. In many instances, however, a fair crop of seed was produced. At that time alfalfa hay and seed production on the arid farms of Utah was pronounced a "reasonable possibility."[3]

For several years subsequent to the time of seeding them, these plats grew with surprising vigor. Many of them yielded at the rate of a ton and a half of hay per acre from the first crop. Little growth was made after the first cutting. Those plants which grew on the border of the plats, where more feeding surface was available, were the only ones to produce a second crop, and this second growth often produced seed of good quality.

TABLE II.—ALFALFA TESTS IN 1909. YIELD PER ACRE, IN POUNDS OF DRY HAY. ALL PLATS WERE CUT ON JUNE 15.

(Fifth-Acre Plats.)

Plat No.	CROP AND EXPERIMENT	Yield per acre lbs. dry hay
154	"Turkestan"	2560
155	"Sand Lucern"	2200
156	From native irrigated seed	2620
157	From native dry-land seed	2655
161	Planted April 1, 1904	2435
162	Planted April 15, 1904	2445
163	Planted at rate of 4 pounds	2650
144	Planted at rate of 8 pounds	2775
145	Planted at rate of 12 pounds	2800
146	Planted at rate of 16 pounds	2815
147	Planted broadcast	2860
148	Cross-drilled	2990
149	Disked in fall	3045
150	No Cultivation	2865
151	Cross-disked in Spring	2915
152	Disked early in spring	2455
153	Disked late in spring	2500
135	Rate 8 pounds per acre—first crop for seed	2675
136	Rate 16 pounds per acre—first crop for seed	2310
	Average yield of plats	2660

[3] Widtsoe, J. A., and Merrill, L. A., "Arid Farming in Utah," Utah Experiment Station Bul. 91, pp. 97-99, 1905.

Table II presents the yields of these plats in 1909, five years after they were seeded. They were cut with an ordinary mowing machine, and the hay was cocked and cured in the usual manner. The weights recorded are the weights of the cured hay.

The yields of these plats, averaging 2660 pounds, or 1.3 tons, per acre after five years' growth on dry land, are remarkable; and the uniformity among the yields is surprising.

The drought of 1910, however, resulted in practical failure on these plats. A good growth was started in the spring of that year, but the continued lack of rainfall and excessive evaporation prevented further development, and the plants within the plats turned yellow and dried out. Those on the borders, however, made fair growth. The plats were cut on June 1st and the total yield for all plats was little in excess of one ton.

The plats renewed growth in the spring of 1911, but it was thought advisable to plow the crop under. This was done and now these plats are being used for experiments designed to determine the effect of alfalfa on other crops, namely, winter wheat, oats, barley and emmer, and spring oats and potatoes. After a few years, these experiments should afford some very valuable information.

A field of about four acres which was sown to alfalfa in the spring of 1912 promises to yield even more profitable returns than those plantings already discussed. A single-disk, press drill was used in seeding and the seed was sown at the rate of four pounds per acre. The ground used had been fallow for three years previous and at the time of seeding it was in excellent condition. A good stand was secured, but weeds were so numerous that the alfalfa made little growth during the first season. Early in the spring of 1913, however, the alfalfa commenced a vigorous growth. The land was then disked and harrowed in order to break the crust which had formed over its surface and to kill the weeds which had started. This cultivation left a rather desirable fine clod-mulch on the ground, besides stimulating growth, and the alfalfa is now doing nicely.

Intertillage of Alfalfa.

There were seeded in 1904 two one-fifth acre plats, on which the seed was planted in hills about eighteen inches apart, and

these hills were in rows about two feet apart. This was done for the purpose of determining the effect of such a method on alfalfa production, especially for seed. One of these plats was cut in early summer of each year and the second crop was allowed to seed, while the first crop on the other plat was allowed to seed. Neither of these plats has failed to produce a good crop of hay each year since 1904, and in favorable years a fair yield of seed has been obtained. Accurate measurements of the seed were not possible, however, because of the fact that the pods were very dry at harvest time and the handling of the crop caused the pods to drop their seed readily, thus causing considerable loss. This same difficulty was encountered in the harvest of seed produced on the borders of the other plats.

The second crop generally produced more seed than the first. The hay of the second crop, however, was shorter and more difficult to handle than that of the first crop, but it was of finer quality and it produced more seed pods. In 1909 the yields of these two plats were as follows:

Plat 166—Alfalfa in hills; first crop cut October 8; 15 pounds of seed.

Plat 167—Alfalfa in hills; second crop cut October 8; 100 pounds of seed. The first crop on this plat yielded at the rate of 1,325 pounds of excellent hay per acre.

The drought of 1910 had noticeably less effect on these plats than on the other alfalfa plats. A fair yield of hay was obtained, but the amount of seed produced was so small that it was not threshed. In 1911 the plants made good growth and the hay yield was fairly good. No seed was harvested, although a little was produced on plat 167 by the second crop. Practically the same results were obtained in 1912. Both plats were disked heavily in the spring of 1913 and now, after nine years' continuous growth, the crop is in excellent condition.

It is believed that on a more sandy soil than that at Nephi, alfalfa seed production can be made profitable by using the hill method. In fact, there are farmers in some parts of the State who, by this method, are producing alfalfa seed successfully on dry land. The hills should have a little more room than those at Nephi, about two feet in each direction, or four square feet, probably will give the best results. Mr. Sylvester Pierce

of Gunnison, Utah, spaces his hills twenty-one inches apart each way, and he claims remarkable success with this method.

Alfalfa Nursery.

The alfalfa nursery planted in 1908 by the Office of Plant Physiology and Breeding, Bureau of Plant Industry, U. S. Department of Agriculture, under the direction of Mr. Charles

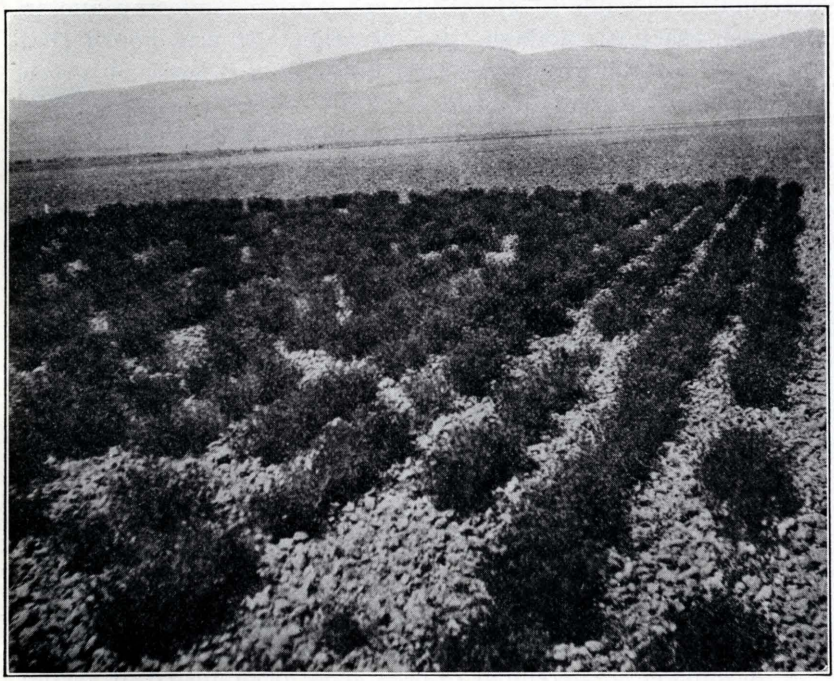

Fig. 3—Alfalfa Growing in Hills and Rows on the Nephi Station in 1912. This Alfalfa was Planted in 1904.

J. Brand, is still being studied and it is believed that some valuable information will be secured. The Office of Forage Crop Investigations is co-operating in this nursery work at present.

Seed of forty-eight varieties and regional strains of alfalfa were furnished and these were planted in 72-foot rows, in duplicate. Some marked differences in the behavior of these strains have been observed, but not one of them has failed completely. The ninety-six rows are growing vigorously in

most instances, and each will yield a good crop of hay in 1913. Since 1908 they have yielded in about the same proportion as the two hill-planted plats, 166 and 167.

Sweet Clover.

A small test with sweet clover *(Melilotus alba)* was begun in the spring of 1912. The purpose of this test was to determine the value of sweet clover as a dry-land crop and to discover practical methods of cultivation. It was hoped that this crop would prove valuable both as a source of green manure and as a forage crop.

Unfortunately, dry weather obtained for some time after the test was seeded, and poor germination was the result. Weeds were numerous and they retarded the development of those plants which did commence growth. For these reasons, the first year's results with sweet clover were unsatisfactory. A few plants continued growth in the spring of 1913, however, and it is hoped that these plants will mature some seed from which plantings can be made for further investigation.

Vetch.

This crop has not done well in any of the tests at Nephi. Small tests were begun in 1908, but no crop worthy of harvest was produced. Vetch was planted again in 1910 and 1911, but no satisfactory results were secured.

PERENNIAL GRASSES FOR FORAGE.

A number of perennial grasses have been tested at Nephi and, during the first few years of the test, there was every reason for believing that grass crops some day would be important ones as a source of forage on the dry-farms of Utah. In later years, however, they were not so promising and at present there is no grass crop that can be recommended as a profitable one for dry-farms.

Native "Blue Grass."

As previously stated, "blue grass" *(Agropyron occidentalis)* once grew on the Levan ridge in such quantities that it sometimes was cut for hay. Later, owing to over grazing of the grass by sheep, sage brush grew so rapidly that the grass

was finally "run out." Subsequent breaking of the land for dry farming purposes eliminated practically all of the small and scattered areas of grass which still survived, until at present there is very little of the native grass to be found. In those places where now it is found it appears to be making good growth and live stock seem to relish it, especially in its early stages of growth. On the farm of Stephen Boswell, just south

Fig. 4—Brome Grass Planted in 1908 and Photographed in 1909.

of the substation, there is a five-acre tract of virgin land on which "blue grass" is growing, and Mr. Boswell states that the grass furnishes good pasturage for his horses.

Some attempts have been made to obtain seed of this grass for trial on the substation, but so far no success has been met with.

Brome Grass.

Brome grass *(Bromus inermis)* has given better results than any of the other grasses tested. No difficulty was experienced in obtaining a good stand, and the grass grew well for

a few years, even without much cultivation. In 1909 one plat yielded at the rate of 550 pounds per acre, and in the same year another plat produced seed at the rate of twenty-five pounds per acre.

As the grass grew old, however, it became sod-bound and the growth made thereafter was unsatisfactory. The bunches formed prevented thorough cultivation and harvesting was

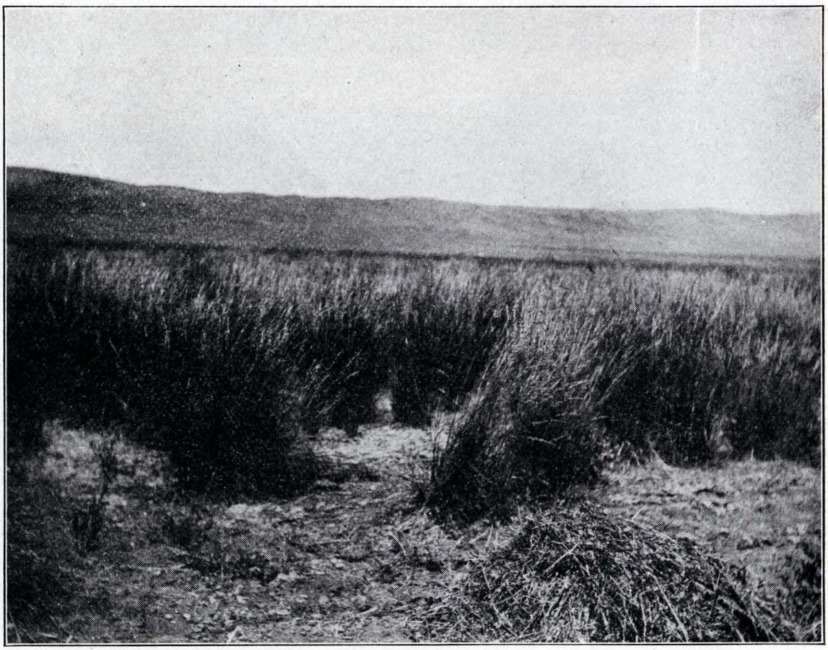

Fig. 5—Tall Meadow Oat Grass, Photographed June 20, 1909.

made difficult. In fact, after the crop becames sod-bound, it was practically worthless.

The greatest value possessed by brome grass as it grows on dry-land lies in the fact that it makes an excellent early pasture. As soon as the snow is gone in the spring, brome grass is green and, within a few days, it is high enough to be grazed. Cattle and horses apparently are very fond of the young grass, and this fact may make it desirable in some sections of the State as a pasture grass.

Tall Meadow Oat Grass.

The growth made by this grass at Nephi was satisfactory, but the hay produced was lacking in value as feed. At an early stage in its growth, the grass became wirey and tough and, as a result, the hay was not relished by live stock. The grass, also, became sod-bound and then worthless.

Miscellaneous Perennial Grasses.

The Office of Forage Crop Investigations, Bureau of Plant Industry, furnished seed of about twenty varieties of grasses, which were planted in the spring of 1909, in rows varying in length from thirty to 121 feet. In most of these rows a very thin stand was obtained; in others a fair stand was obtained, while in the seeding of *Bromus uniloides* resulted in a good stand. All of them made a fair growth in 1910, but in 1911 they were plowed under.

CORN.

Experiments with corn have been conducted since 1904 and fair yields of both grain and stover have been produced in favorable years, while in unfavorable years the crop has been a practical failure. The results of the experiments indicate that even under the best conditions the corn crop on the dry-lands of central Utah is most valuable as a source of forage. The altitude, cool nights and lack of summer rainfall are factors which limit the production of corn in this section, but since some stover can be produced, especially in favorable seasons, the corn crop as a dry-farm possibility should not be overlooked. It should be stated here that a few farmers in the vicinity of the substation have found the production of corn on their dry-farms rather profitable. Mr. Thomas Smith grows a crop of corn each year and he states that he is well satisfied with the yields obtained. His land is almost directly east of the substation, about a mile distant and very near the base of the mountains. Owing to a rather high percentage of sand, the land can be worked early in the spring and it warms up readily, causing the crop to make a reasonably rapid growth. The corn stalks generally are short but the ears usually fill out well. Mr. Smith has grown both flint and dent corn and he has furnished seed to the substation, but the results obtained on the two farms have never been comparable. Under such

conditions as those found on the Smith farm, corn production may be made profitable on dry lands in other sections of the State.

The results obtained from the corn experiments on the substation were more promising previous to 1909 than they have been since that time. Jardine reported[4] the following yields per acre for 1904, 1905, and 1906:

1904		1905		1906	
Bu. Corn	lbs. Stover	Bu. Corn.	lbs. Stover	Bu. Corn	lbs. Stover
12.78	740	----	1050	10.50	675

No corn was grown in 1907, but after that year the following results were obtained from corn grown in rotation with wheat. In 1908 17.5 bushels of corn and 630 pounds of stover per acre were produced. Only stover was produced in 1909, and the yield per acre was 1240 pounds. The 1910 corn test was nearly a total failure, only forty pounds per acre being the total yield. The 1910 results were duplicated in 1911, while in 1912 the average yield of two plats was 1455 pounds of stover per acre. A few ears, partly filled, were included in the crop of 1912, but the grain was of no value. Stover yields such as those produced in 1912 would be profitable, could they be duplicated each year, but it is doubtful whether this can be done in years with exceptionally dry spring months.

Previous to 1912 the corn was planted in hills three feet apart, in rows which were about forty-two inches apart. In 1912, however, an ordinary grain drill was used and the seed was drilled in rows about three feet apart. This was accomplished by stopping up the spouts not desired for use. This method is believed to be the most practical one for use on heavy lands, as it will result in a fine quality of stover, which, as stated, is the most valuable part of the crop produced. Then, too, this method is economical, and it can be practiced with little disturbance of the soil and consequent loss of moisture, while the distance between the rows permits of ample cultivation.

GRAIN SORGHUMS.

Some work with grain sorghums has been done on the substation in recent years, but the results obtained do not justify

[4] Jardine, W. M., "Arid Farming Investigations," Utah Experiment Station, Bul. 100, pp. 141-147, 1906.

the recommendation of this crop as one for the dry lands of this State. There seems to have been no suffering for the want of moisture, but the crop apparently is not adapted to conditions at this altitude, especially the late springs and cool summer nights. Some seed has been produced but not in profitable amounts, and it seems to have a low percentage germination. Work with this crop is being continued and it is hoped that some day it may be established in this region as it is highly valuable as a forage crop.

BROOMCORN.

The results obtained from the tests with broomcorn largely are the same as those obtained from the tests with grain sorghums. The Dwarf broomcorn has given the best results, but no brush of good quality has been produced. Work with this crop, also, is being continued.

SUGAR BEETS.

It is very doubtful whether sugar beets will ever be a profitable crop on the dry lands of Utah when commercially considered. The highest yield produced by this crop at the substation was 3944 pounds per acre in 1909. Whether sugar beets will prove to be valuable in rotation systems, remains to be determined.

PEAS.

Sixteen varieties of peas secured through the Office of Forage Crop Investigations, Bureau of Plant Industry, were planted in small beds in the spring of 1908. That fair yields were produced from some of these, is shown in Table III, where the results of the test are presented.

Some complete failures are reported in Table III, but it will be noticed that nine varieties produced yields which were far from discouraging. One variety, S. P. I. No. 21289, yielded at the rate of 737 pounds of seed and 1213 pounds of vines per acre. Some other varieties yielded very nearly as high.

The one-tenth acre plat of peas following wheat in rotation has yielded at the following rate per acre during the period of test: 1908, 220 pounds of seed and 1080 pounds of vines; 1909, 1050 pounds of vines and no seed; 1910, 35 pounds of vines and no seed; 1911, failure; 1912, 135 pounds of seed and 375 pounds

TABLE III.—RESULTS OF ROW TESTS WITH LEGUMES—1908.

(Rows one rod long.)

S. P. I. No.	NAME	No. of rows	Dates				Stand	Yield Per Acre		Remarks
			Planted	Up	Bloomed	Harvested		Grain	Vines	
11195	Medium Dark (grass)	13	4/25	5/22	6/30	*	p	----	----	
11196	Large Brownish "	13	"	5/16	6/26	8/17	ex	384	1731	
11197	Largest White "	13	"	5/23	6/27	"	p	384	866	
11198	Medium White "	13	"	5/22	6/30	"	p	576	789	
11199	Medium White "	13	"	5/20	6/28	*	f	----	----	
16130	Golden Vine (Can.)	13	"	5/17	6/30	8/17	f	384	1289	
17006	Jomardi (Canada?)	7	"	5/22	7/1	*	f	----	----	a vetch
19389	Franch June (Canada)	7	"	5/15	"	8/17	ex	714	1072	
20467	Solo (Canada)	6	"	5/16	6/28	*	g	----	----	
19709	Gray Spring (Canada)	6	"	"	"	*	g	----	----	
19785	Blackeye Marrowfat (Canada)	7	"	5/17	"	8/17	g	535	1608	
19786	Marrowfat "	10	"	5/22	6/30	*	vp	----	----	
19788	Potter "	13	"	5/18	7/2	*	p	----	----	
20465	Kapital "	13	"	5/20	6/30	*	p	----	----	
21288	India "	13	"	5/17	6/28	8/12	g	577	769	greenish seeds
21289	India "	11	"	5/15	6/23	7/22	ex	737	1213	speckled "
21290	India "	13	"	"	6/30	8/12	ex	519	1020	yellow "

*Failed because of drought.

All peas harvested within a day or two of the time of ripening.

of vines (average of two plats). The lowest yields recorded were due to drought, either in early spring or during the summer. Where the peas were able to make a good growth in the spring, the drought of summer had no serious effect upon them; while a weak spring growth invariably resulted in failure, or near failure.

The main problem connected with the production of field peas on dry-land is the time of planting. The crop can be

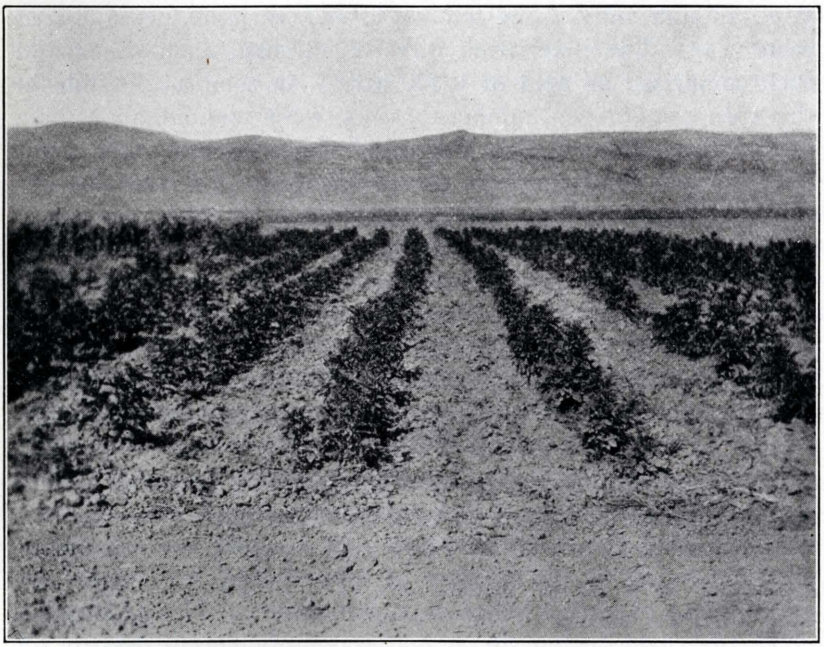

Fig. 6—Potatoes in 1912.

grown, if it can be planted in time to permit the plants to make good spring growth, but, where a heavy soil, such as that at Nephi, is used, this is difficult, especially when the spring months are dry. The clay prevents early working of the soil, owing to the stickiness of it, and planting is delayed necessarily until rather late. Then, if dry weather follows, the crop produced is not a profitable one. This difficulty is hard to overcome, even if a drill is used in planting; but with the use of a drill the best results have been obtained.

Potatoes.

Rather extensive tests with potatoes have been conducted on the substation since 1908. These tests have comprised both varietal and cultural tests, and a study of the results presented herein will be instructive.

VARIETAL TESTS.

Twenty-five varieties of potatoes have been tested since 1908, though only from ten to fifteen varieties were tested each year. The plats used directly adjoined each other and each comprised an area of 1/120 acre. As soon as possible in the spring a known number of sets were planted about five inches deep on each plat, the sets being placed in hills about thirty inches apart, in rows three feet apart. In 1908 the sets were planted by means of a spade, while in all other years they were planted in furrows made by a hand plow. Where the plow was used, the entire plat was plowed and every third furrow was planted, this being covered by the plow on its next round. This method was found to be very satisfactory in that it left the soil in excellent condition. The plats were harrowed immediately after planting, at right-angles to the direction of the furrows. Within ten to fifteen days thereafter, depending upon the season, the plants had emerged above ground and, as soon as it was reasonably certain that no more would appear, they were counted. By dividing the number of plants growing by the number of sets planted, the percentage germination of each variety was determined. The cultivation given the plats during the season was sufficient to destroy all weeds and keep the ground surface in a loose condition.

The tubers were harvested late in the fall, after the death of all or most of the vines, a plow being used for the purpose. The total yield of each plat was weighed, and then the tubers were separated into marketable and non-marketable sizes and the percentage of each size determined. All tubers were then stored in pits, i. e., they were buried in clean straw covered with soil which was heaped up above the surface of the ground in order to allow perfect drainage of water from the pit. The tubers remained in the pit all winter and were not taken out until planting time in the spring. At this time the soundness

and general condition of the tubers were noted for purposes of comparison.

The varieties tested in 1908 were grown on land which had produced a crop of wheat in 1907, while in other years, except 1912, the varieties tested were grown on land which had been fallow during the previous season and which was in a very desirable physical condition at the time of planting. The amount of soil moisture present at that time, however, was not always sufficient to meet the requirements of the sets planted and poor germination was the result. In 1912 the varieties were grown on old alfalfa land, the moisture of which had been reduced to a minimum at the time of plowing in the previous summer (see above).

When the spring months were dry, the surface soil would lose much of its moisture by the time all danger of frost was past and planting was made possible and, as a result, a poor stand of potatoes was obtained. Under such conditions the plants, being widely scattered, would develop few but large tubers (often only one) and thus the total yield would be small. If the spring months were wet and a good stand was obtained, a fair number of tubers would be produced in each hill, but the size attained by them would depend entirely upon the precipitation of the summer months.

The names, source and annual and average yields of the varieties which have been tested at Nephi during 1908 to 1912, inclusive, are presented in Table IV.

Table IV shows that the highest yields were obtained in 1909, when the varieties averaged 100.2 bushels per acre; while the 1910 yields were the lowest, averaging only twenty-eight bushels per acre. It shows further that four varieties, Irish Cobbler, Early Michigan, GreenMountain and Early Bird, have averaged during five years, 1908 to 1912, inclusive, 44, 58, 56, and 51 bushels per acre, respectively, about one-third the average production on the irrigated lands of Utah during the same period. Other varieties which have given good results since their introduction in 1909 are, Willard, White Peerless and Early Eureka. Of these, White Peerless has proved most satisfactory. Most of the other varieties listed in the table were tested only during one or two-year periods, and for this reason their yields are not of great importance at this time.

TABLE IV.—NAMES, SOURCE AND ANNUAL AND AVERAGE YIELDS OF POTATO VARIETIES TESTED AT THE NEPHI SUBSTATION DURING 1908-1912, INCLUSIVE.

Variety	Source	Yield in Bushels Per Acre.								
		1908	1909	1910	1911	1912	1908 1909	1908 1910	1908 1911	1908 1912
Irish Cobbler	Mitchell, S. D.	46	112	18	24	36	79	59	45	44
Early Breakfast	"	52	134	34	56	--	93	77	69	--
Early Michigan	"	37	138	28	48	38	88	68	63	58
Early Ohio	"	32	89	4	--	--	61	42	--	--
Carmen No. 3	"	49	78	10	--	--	64	46	--	--
Green Mountain	"	38	118	54	48	23	78	70	65	56
Early Bird	"	44	106	26	58	19	75	59	58	51
Willard	"	35	74	--	--	--	55	--	--	--
White Ohio	"	47	--	--	--	--	--	--	--	--
Garrett	Nephi, Utah	48	98	16	--	--	73	54	--	--
Willard	" (Paxman)	--	99	30	38	40	--	--	--	--
White Peerless	" "	--	98	36	74	37	--	--	--	--
Early Eureka	Logan, Utah	--	59	34	36	28	--	--	--	--
Early Acoma	Akron, Colo.	--	--	--	36	--	--	--	--	--
Thorobred	"	--	--	--	50	38	--	--	--	--
Cal. Russet	"	--	--	--	22	32	--	--	--	--
Potentate	"	--	--	--	6	--	--	--	--	--
White Ohio	Bureau Plant Industry	--	--	--	--	36	--	--	--	--
Early Ohio	"	--	--	--	--	40	--	--	--	--
Pearl	"	--	--	--	--	30	--	--	--	--
Sombres Extra Early	"	--	--	--	--	40	--	--	--	--
Rural New York	"	--	--	--	--	26	--	--	--	--
Early Potosky	"	--	--	--	--	46	--	--	--	--
Early Manistee	"	--	--	--	--	18	--	--	--	--
Acme	"	--	--	--	--	16	--	--	--	--

All of the varieties were in good condition when taken from the pit each spring. They were sprouted only to a very slight extent and they were very firm, in most cases. The White Peerless variety has shown keeping qualities superior to those of any of the other varieties tested.

The average percentage germination in 1909 was 91; in 1910, it was only 35; in 1911, it was 76; while in 1912, it was 90. The average percentage germination for the four years, 1909 to

Fig. 7—Potatoes Grown at the Nephi Substation in 1909 on a Plat That Produced Wheat in 1908. Yield of Tubers, 85 Bushels Per Acre.

1912, inclusive, was 73, i. e., the number of sets of every 100 planted which produced plants. The number of tubers per plant, as stated previously, varied with the season.

In 1908, the tubers were small, only about fifteen per cent being of marketable size. This was the case, presumably because of the fact that the potatoes were grown on land which had produced a crop of wheat the year previous and the fact that the seed potatoes were produced on irrigated lands may

have had some influence. In 1909, however, the tubers were of high quality and from 90 to 95 per cent of them were of marketable size, having a cash value of $30 per acre at the time of harvesting. In 1910, 86 per cent of the tubers produced were marketable, while in 1911, 83 per cent of the crop was of marketable size. The yields of these two years were not profitable from a commercial standpoint, but they were sufficiently large to meet the requirements of the ordinary farmer. Only a very small percentage of the potatoes produced in 1912 were marketable, owing to the fact that they grew on land which had been cropped to alfalfa for seven years previous, and which, consequently, was low in moisture content. The stand of this year was very good, and a large number of tubers grew in each hill, but there was not sufficient moisture present to properly develop them.

CULTURAL TESTS.

The cultural tests with potatoes were planned to determine the best rate and depth of planting, the relative value of seed produced on irrigated and dry land, the relative value of different sizes of seed, and the effect of callousing on the germination of the seed piece. Some of these tests have been made each year since 1909, while others have been conducted for only one year. All were planted at the same time in the spring of each year as were the varietal tests, and the subsequent treatment was identical. The variety, White Peerless, was used in all cultural tests, except where otherwise stated.

Rate of Planting.

In the rate-of-planting test with potatoes conducted during 1909 and 1910 sets were planted 9, 12, 15, 24, and 36 inches apart in rows 2, 3, and 4 feet apart. The tests were now in triplicate. The percentage germination, yield per acre and per cent of marketable tubers produced in each row, together with the two-year average for each rate, are presented in Table V. The wide differences in yields for the two years are due to seasonal conditions, 1909 being a very favorable year, while 1910 was very unfavorable, owing to drought. The yields of 1910 are not important, but they are given here for the purpose of showing extremes in yield and to show a fair average of what might be expected in normal years.

The highest total yields were obtained by planting in rows two feet apart with the hills nine inches and twelve inches apart —the highest rate of planting. It will be noticed, however, that in 1909, the year of highest yields, the per cent of marketable tubers was comparatively low in the yields from the highest rate of planting. The highest yields with the highest per cent of marketable tubers were produced from rows and hills planted two to three feet apart each way, in 1909. A very high per cent of all the tubers produced in 1910 were marketable, owing to very poor germination.

TABLE V.—PERCENTAGE GERMINATION, YIELD PER ACRE AND PER CENT OF MARKETABLE TUBERS GROWN FROM SETS PLANTED AT DIFFERENT RATES ON THE NEPHI SUBSTATION DURING 1909 AND 1910.

(Average of Triplicate Test.)

Distance Between Rows	Distance Between Hills	Germination			Yield Per Acre			Marketable tubers		
		1909	1910	Aver.	1909	1910	Aver.	1909	1910	Aver.
(ft.)	(in.)	(%)	(%)	(%)	(bu.)	(bu.)	(bu.)	(%)	(%)	(%)
2	9	77	19	48	135	6	72	10	95	53
2	12	97	22	60	135	4	70	20	98	59
2	15	90	14	52	122	3	62	25	100	63
2	24	98	9	54	106	1	54	60	70	65
2	36	92	19	56	96	2	49	80	100	90
3	9	85	40	63	101	9	55	15	90	53
3	12	86	29	58	108	6	57	25	95	60
3	15	89	35	62	90	5	48	35	98	62
3	24	95	36	61	76	3	40	60	98	79
3	36	89	52	71	94	2	48	80	75	78
4	9	94	19	52	79	3	41	25	97	61
4	12	86	12	49	76	2	39	25	99	62
4	15	77	19	48	83	3	43	50	100	75
4	24	91	23	57	66	2	34	60	100	80
4	36	86	25	56	66	2	34	80	98	89

The rate-of-planting tests with potatoes were far less extensive in 1911 and 1912 than in the two years previous. Only three rates were used, 18, 24, and 30 inches apart in rows three feet apart. From the results obtained in 1909 and 1910, these rates seemed to be the most practicable for future work, so all

others were discontinued. It was in the spring of 1911 that the Office of Horticultural Investigations, Bureau of Plant Industry, first co-operated in the potato work at Nephi, and that co-operation still exists. The most important data obtained from this test during 1911 and 1912 are reported in Table VI, which gives the results of each year and the average for the two.

TABLE VI. — PERCENTAGE GERMINATION, YIELD PER ACRE AND PER CENT OF MARKETABLE TUBERS GROWN FROM SETS PLANTED AT DIFFERENT DISTANCES IN THE ROW ON THE NEPHI SUBSTATION DURING 1911 AND 1912.

Distance Between Hills	Germination			Yield Per Acre			Marketable Tubers		
	1911	1912	Aver.	1911	1912	Aver.	1911	1912	Aver.
(in.)	(%)	(%)	(%)	(bu.)	(bu.)	(bu.)	(%)	(%)	(%)
18	78	90	84	68	28	49	82	10	46
24	84	85	85	52	22	37	88	15	52
30	91	94	93	52	24	38	81	17	49

The highest average yield was obtained from the rows in which the sets were placed eighteen inches apart; but the per cent of marketable tubers produced in these rows was lower than in the case of the 24-inch rate of planting, which, however, gave the lowest yields.

The results of the four years indicate that sets placed about twenty-four inches apart in rows three feet apart will give the highest yield of marketable potatoes, under conditions like or similar to those at Nephi. The distance between the rows is sufficient to permit of thorough cultivation, and the distance between the hills is enough to allow proper development of the tubers.

Depth of Planting.

Sets were planted at four different depths, in triplicate, in 1909 and 1910, namely, 4, 6, 8, and 10 inches. In 1911 and 1912 the 10-inch planting was not made. The annual and average percentage germination, the yields per acre and the percentage of marketable tubers grown from sets planted at these depths during 1909 to 1912, inclusive, are given in Table VII.

TABLE VII.—PERCENTAGE GERMINATION, YIELD PER ACRE AND PER CENT OF MARKETABLE TUBERS GROWN FROM SETS PLANTED AT DIFFERENT DEPTHS ON THE NEPHI SUBSTATION DURING 1909 TO 1912, INCLUSIVE.

Depth Planted	Germination					Yield Per Acre					Marketable Tubers				
	1909	1910	1911	1912	Aver.	1909	1910	1911	1912	Aver.	1909	1910	1911	1912	Ave.
in.	%	%	%	%	%	bu.	bu.	bu.	bu.	bu.	%	%	%	%	%
4	73	28	87	96	71	74	10	74	22	45	50	85	78	15	57
6	99	53	92	98	85	67	15	44	32	40	50	98	77	15	60
8	100	70	87	100	89	68	21	58	30	44	65	98	86	15	66
10	90	69	--	--	80	63	11	--	--	37	70	98	--	--	84

It will be noticed that the highest average yield of marketable tubers was produced in the rows planted eight inches deep, about the ordinary depth of plowing. The 4-inch plantings gave a higher average total yield, but the per cent of marketable tubers was lower.

It is advisable, whenever practical, to plant the sets deep enough to place them in moist soil; otherwise, poor germination will result, unless rain falls soon after planting. For this reason, the depth of planting will depend largely upon the condition of the soil and the season. It is not advisable to plant at depths less than four inches or greater than ten inches, because moisture is seldom nearer the surface than four inches, while a ten-inch planting makes digging difficult.

Irrigated vs. Dry Land Seed.

The variety White Peerless, grown on dry land in 1908, was planted in 1909 in three rows alongside of three rows of the variety Early Eureka, grown under irrigation at Logan, Utah. Seed of both these varieties, produced under both irrigated and dry land conditions in 1909, was planted in 1910. In each year the treatment of the two varieties was identical. The results of this test are reported in Table VIII.

TABLE VIII.—PERCENTAGE GERMINATION, YIELD PER ACRE AND PER CENT OF MARKETABLE TUBERS GROWN AT THE NEPHI SUBSTATION IN 1909 AND 1910 FROM SEED TUBERS OF TWO VARIETIES PRODUCED THE PREVIOUS YEAR ON DRY AND IRRIGATED LAND.

Variety and Source	Germination			Yield per acre			Marketable tubers		
	1909	1910	Av.	1909	1910	Av.	1909	1910	Av.
	%	%	%	bu.	bu.	bu.	%	%	%
Early Eureka from dry land	----	50	50	----	34	34	----	98	98
Early Eureka from irrigated land	77	67	72	59	40	50	90	85	86
White Peerless from dry land	85	43	49	79	40	60	80	95	88
White Peerless from irrigated land	----	64	64	----	40	40	----	90	90

It will be noted that in the case of the Early Eureka variety, the irrigated seed gave a higher yield than did the dry-land seed, though the per cent of marketable tubers was higher in the latter case. In the case of the White Peerless variety there was practically no difference in the two kinds of seed. These results indicate that the source of seed, whether dry-land or irrigated,

has little effect upon the yield produced the next year under dry-land conditions.

Large vs. Small Seed.

A test of the relative value of large and small seed potatoes was made only in 1910, a very unfavorable year to potato production; hence the results obtained are of little value. Sets were cut from large potatoes and small ones and one row of each was planted in the same manner as were all the other tests. There were seventy sets of the small seed and sixty-two sets of the large seed planted. The time of coming up and the time of blooming was the same in both cases, and both rows were harvested the same day, October 24th. The test is summarized below:

	Per Cent Stand	Yield Per Acre	Per Cent Marketable
Small seed ____	73	54 bu.	95
Large seed ____	55	34 bu.	83

In this test the small seed was better in every respect than the large seed. It is not known whether the large seed used was produced on poorer and less prolific plants than the small seed, nor is it known whether whole tubers, which often were used as small seed, had any influence on the resultant yields.

Calloused vs. Freshly-cut Sets.

This test was conducted only in 1910. Some sets were allowed to stand after cutting until the cut surface had become well calloused, and these were compared with sets which were cut just previous to the time of planting. One row of each was planted, each row containing seventy sets. Subsequent treatment was identical. The test is summarized below:

	Per Cent Stand	Yield Per Acre	Per Cent Marketable
Calloused seed___	37	20 bu.	95
Freshly-cut seed_	45	24 bu.	85

These results slightly favor the freshly-cut seed in both stand and yield per acre, but the calloused seed produced a larger percentage of marketable tubers, owing perhaps to a thinner stand. It is believed to be advisable to plant the sets as soon after cutting them as possible.

SUMMARY.

The Nephi substation comprises about 100 acres of dry-land located near the top of the north slope of the Levan Ridge, in Juab County, almost in the center of the State.

A certain "blue grass" *(Agropyron occidentalis)* once grew on the Levan Ridge but at the time the substation was established in 1903 the ridge was covered with sage brush *(Artimesia tridentata)*.

The soil of the substation is largely a clay loam, of great depth. The relatively high percentage of clay, about fifteen per cent in the surface foot, makes the soil difficult to handle in wet or extremely dry weather.

The average annual precipitation for 1908 to 1912, inclusive, was 13.6 inches. Most of this fell during the winter and early spring months.

Only three months, June to August, inclusive, have been free from frosts, and the average frost-free period for 1908 to 1912, inclusive, was 102 days.

Cereals comprise the major crops in the work of the substation, but considerable work has been done with minor crops, such as alfalfa, clover, vetch, grasses, corn, peas, potatoes, grain sorghums, etc.

Several varieties and regional strains of alfalfa have been tested under different methods of cultivation since 1908. In some tests as much as 1½ tons of hay per acre was produced. The best results have been obtained from plats planted in rows and hills. In this manner seed production has been reasonably satisfactory.

Tests with sweet clover *(Melilotus alba)* have only begun, and the results of the first year were unsatisfactory, owing to weed troubles.

Small tests with vetch were made in 1909, 1910, and 1911, but no satisfactory results were obtained.

Of the perennial grasses tested, brome grass *(Bromus inermis)* has given the best results, but even this grass has not proved to be desirable in some respects, mainly because of its habit of becoming sod-bound after a few years of growth. It is hoped that the native "blue grass" will be made to produce profitably and serve also for pasture purposes.

Corn has proved most valuable as a forage crop, owing to the fact that the bulk of the crops which have been produced has been stover. Climatic conditions have limited greatly the production of any seed corn.

Grain sorghums and broomcorn apparently are not adapted to conditions at Nephi. Grain sorghums have produced some seed, but it has been low in germination. Dwarf broomcorn has produced some brush, but it has been of poor quality.

Peas have produced reasonably well and this crop promises to be one of importance to dry-land agriculture in Utah.

Twenty-five varieties of potatoes have been tested since 1908, and most of these have given fair yields during that time. The variety White Peerless has proved most satisfactory from the standpoint of both yield and keeping qualities. The cultural tests with potatoes indicate that sets placed about twenty-four inches apart in rows three feet apart will give the best results. The depth of planting seems to depend upon the condition of the soil at planting time.