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Growing Crops in Western Nebraska: Report of Experimental Substation, North Platte, Nebraska

W. P. Snyder
University of Nebraska-Lincoln

W. W. Burr
University of Nebraska-Lincoln

E. A. Burnett
University of Nebraska-Lincoln

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GROWING CROPS IN WESTERN NEBRASKA.

REPORT OF EXPERIMENTAL SUBSTATION, NORTH PLATTE, NEBRASKA.

W. P. SNYDER, Superintendent.
W. W. BURR.
E. A. BURNETT, Director.

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PEONIES AT THE NORTH PLATTE SUBSTATION.

LINCOLN, NEBRASKA
U. S. A.

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* Resigned, to take effect February 1, 1913.

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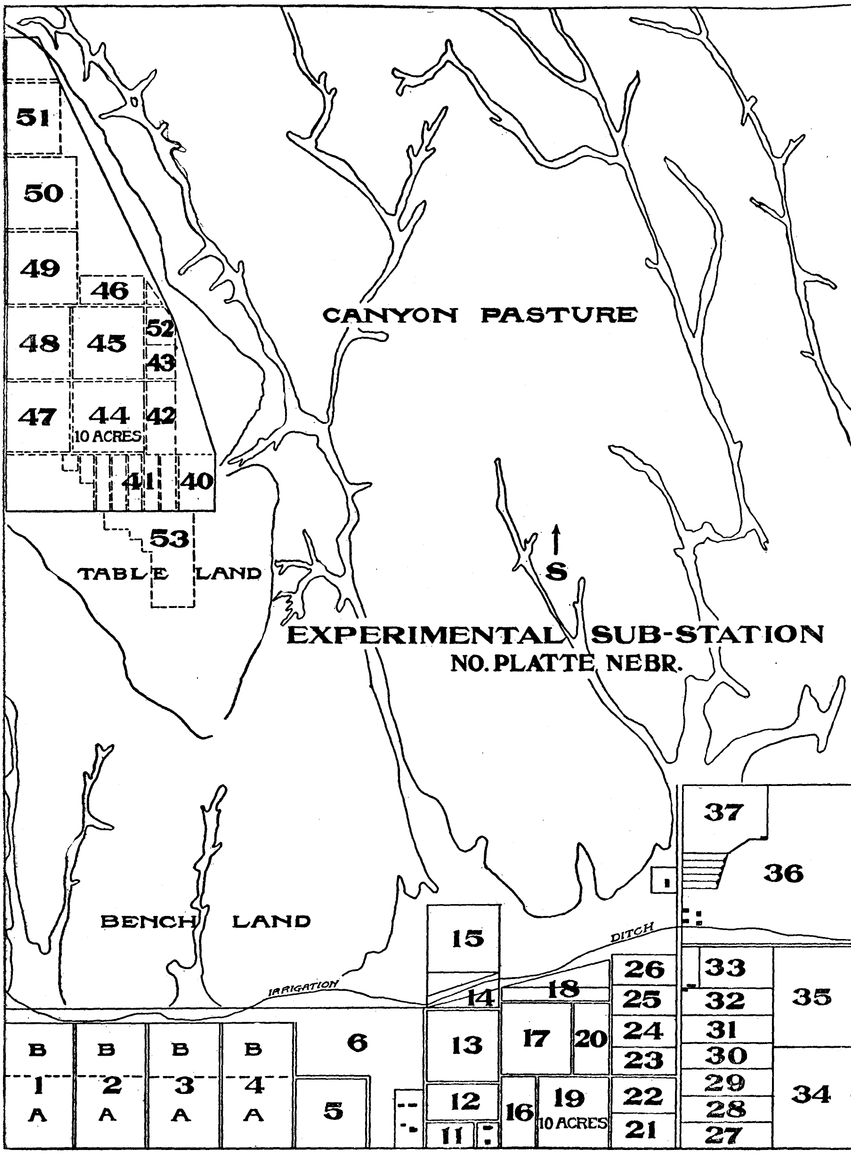

Fig. 1. Map of Substation Farm, North Platte, Nebraska.

GROWING CROPS IN WESTERN NEBRASKA.

BY W. P. SNYDER AND W. W. BURR.

INTRODUCTION.

The following pages give the results of the principal crop experiments carried on at the North Platte Experiment Substation since it was established in 1903. This report does not contain the yields from many of the experiments in crop rotation and methods of tillage. The results of these experiments will be published after more years' records have been secured. For a fuller discussion of many of the problems touched in this bulletin, we refer you to Bulletin 118, copies of which are still available.

Those who have followed the results of experiments conducted at this Station will have noticed that the yields of grains have been low during the past three seasons. In fact practically no crop was produced in 1911. In 1910 the precipitation amounted to only 10.7 inches. The moisture remaining in the soil from the preceding years enabled the crops to make a small yield in 1910, even with a very light rainfall during the growing season. However, the crops grown in 1911 had practically no stored-up moisture to draw upon and were obliged to depend entirely upon the rainfall of the season. This was not sufficient to mature crops, especially as the growing season was extremely hot and windy. The spring small grain crop was killed by drouth when it was only a few inches high. The small spring grain on summer tilled land headed out and would have made a fair crop of 10 bushels of wheat and 20 bushels of oats and barley per acre had the grasshoppers not come in from the parched prairie and fields of dead grain and eaten the grain on the summer tilled plats. Barring the injury from grasshoppers, the results of summer tillage for spring grain and for corn during the very dry years would have been quite favorable. In 1912 the spring was late and cold. Small grain made a very slow growth. During May, June, and July, when the small grain crop is made, the temperature was low and the precipitation light. The yield of small grain was therefore light. However, the rain came early enough to make a good corn crop and a fair crop of forage.

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The chief difficulty in securing satisfactory experimental data is the variation in the climatic conditions in successive seasons. In one season the spring may open warm with an abundance of moisture, and favorable weather following; the next spring often may be late with the soil cold and dry and unfavorable weather following. One season may be favorable for early seeding and another favorable for late seeding. During one season the rainfall may come at critical times and during other seasons it may not come until the crop has been injured beyond recovery. With such a variety of conditions, we feel that all that it is possible for the experimenter to do is to keep an accurate record of all the conditions and report the facts as he finds them. After a sufficient number of years during which records have been collected, certain crops and methods of tillage will undoubtedly show themselves superior to other crops and methods of tillage.

We would suggest that the reader give this bulletin careful study rather than a hasty perusal. We have endeavored to make the bulletin as brief as possible. In doing this we have frequently left to the reader the finding of explanations, in the tables giving the climatic records in the latter part of the bulletin. The following illustration of this will indicate the value of careful study rather than a casual reading. The yields for 1911 are very low where given, but are often omitted in the tables because there was no crop harvested. Brevity would not permit giving the cause of the low yields in the text in each instance. But reference to the record of the precipitation and the record of evaporation will readily explain the cause of low yields in 1911.

The past three seasons have emphasized the fact that the moisture content of the soil at seeding time, the general climatic conditions of the season, and the distribution of the seasonal rainfall, may each have as important an influence on the crop yield as the total rainfall. These seasons have also emphasized the importance of giving considerable attention to producing live stock, rather than devoting all one's energies to crop production. Live stock properly handled in connection with growing crops makes the income of the farmer more certain and the financial condition of the country more stable during the dry seasons.

GRAIN PRODUCTION.

WINTER WHEAT.

History of Yields.—Eight crops of winter wheat have been grown, and a ninth is now in the ground. The crop of 1905 was all on summer tilled land, and owing to excessive rainfall such a rank growth was produced that nearly all the crop went down and was not harvested. Some late seeding did not get as much growth in the fall, and was harvested, yielding over 30 bushels per acre.

In 1905, 10 acres was sown on Field 49 on the table. This was upon heavy sod land plowed in June. The yields varied from 31 bushels to 45.7 bushels, with an average of 42 bushels per acre. The precipitation from September 15, 1905, to July 1, 1906, was 12.97 inches.

In 1906, 4.5 acres was sown on summer tilled land in Fields 45 and 46 on the table. The average yield on the summer tilled land was 59 bushels per acre. The portion of Field 45 not

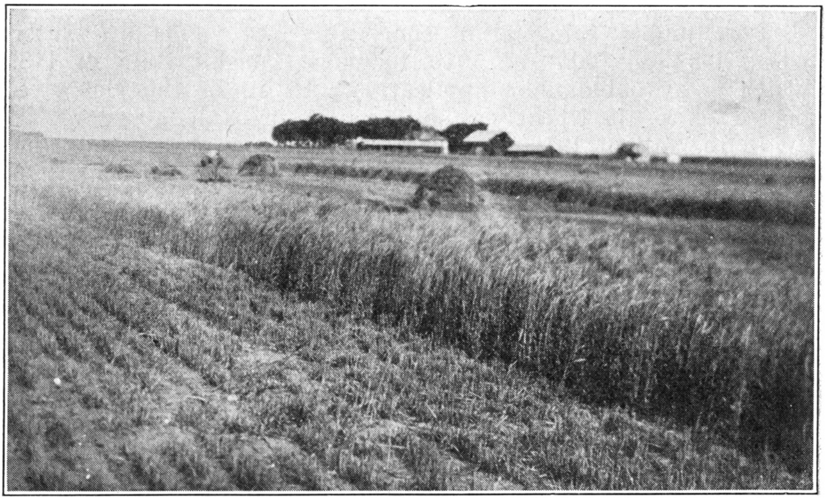

Fig. 2. Winter wheat on summer tilled land.

summer tilled yielded 24.4 bushels per acre. The precipitation from September 15, 1906, to July 1, 1907, was 13.74 inches.

In 1907, 8 acres was sown on summer tilled land in Field 13 on the bench; also about 5 acres in Field 51 on summer tilled land on the table. The average yield in 1909 was 57 bushels per acre on Field 13, and somewhat over 57 bushels for the average yield on Field 51. Field 46, which had produced 59 bushels per acre under summer tillage in 1907, was plowed and resown to wheat, yielding 20.86 bushels in 1908. The precipitation for the growing season, September 15, 1907, to July 1, 1908, was 13.65 inches.

In 1908, 10 acres of wheat was seeded on Field 5 on the bench, and also 10 acres on Field 50 on the table. Field 5 was prairie sod, broken in May and backset in August. It had stored little moisture during the summer and that part which was seeded September 21 came up badly. A 3-inch rain fell on October 19, and that part of the field which was seeded on October 22 did not appear above ground until spring The average yield on the field was 36.9 bushels per acre. Field 50, regularly summer tilled on the table, produced 37.6 bushels per acre. The precipitation from September 15, 1908, until July 1, 1909, was 15.8 inches.

In 1909, Field 19, on the bench, which had been summer tilled, was sown to wheat, and produced an average yield of 30.2 bushels per acre. The precipitation from September 15, 1909, until July 1, 1910, was 10.18 inches.

For further information concerning the yields of winter wheat between 1905 and 1910, inclusive, consult Bulletin 118, which is available upon application. In all of the yields reported above, the wheat was sown with a press drill.

In the fall of 1910, two small fields on the bench-land and several plats on the table-land were sown to winter wheat. On the table-land, wheat was sown in cornstalks, on disked small grain stubble, on fall plowed small grain stubble and on summer tilled land. There was an absolute failure of grain on all plats on the table-land. The grain in the cornstalks made only a weak stand, and very little of it came thru the winter. On the early fall plowing and summer tilled land, the stand was good and a normal fall growth resulted. There was probably some winter-killing even on the best plats. But we feel that most of the grain died in the spring simply from lack of moisture as no rain came in the spring of 1911 until late in April. On the bench-land, Field 4B (7 acres) was sown to Turkey Red wheat. This field contained the rate of seeding, manner of seeding, time of seeding, and cultivation tests of winter wheat. This field had been summer tilled during the season of 1910, but there was very little available moisture in the field at seeding time, as is shown in Table 1. There was only one rain during the entire season of 1910 sufficient in amount to get deeply enough into the soil to be held. The average yield in this field in 1911 was 13.6 bushels per acre. The lowest yield was 9.4 bushels per acre on a plat sown September 2 at five pecks per acre; the highest yield was 16.3 bushels per acre sown September 10 at one peck per acre.

Field 20 (5 acres), also on the bench-land and summer tilled during the season of 1910, was sown to different varieties of winter wheat. It was all seeded September 13 at four pecks per acre. The average yield of wheat in 1911 from this field was 7.6 bushels per acre. The lowest yield was from No. 287, which winterkilled badly, making 5.3 bushels, and the highest yield was

10.7 bushels, from Turkey Red. We note that the average yield in Field 20 was much less than the yield in Field 4B. This can be accounted for from the fact that a portion of Field 4B received flood water from a heavy rain on June 30, 1910. Probably three-fourths of Field 4B did not make a higher yield than Field 20. Had the other fourth, which was overflowed, been cut separately, it would probably have given a yield of at least 25 bushels per acre. The precipitation for the growing season (September 15 to July 1) was 6.86 inches.

In 1912 we harvested 10 acres of winter wheat grown on summer tilled bench-land and several plats of wheat grown under different methods of tillage and seed bed preparation on the table-land. A 10-acre field (Field 17), on the bench-land, contained a variety test, rate-of-seeding, time-of-seeding and manner-of-seeding test of winter wheat. This field gave an average yield of 13.3 bushels per acre in 1912. The lowest yield was 7.7 bushels per acre from Ghirka wheat sown September 19 at four pecks per acre, and the highest yield was 21 bushels per acre from Turkey Red sown October 8 at four pecks per acre. The average yield for the wheat on the table-land was 12 bushels per acre. Four plats which were summer tilled in 1911 made an average yield of 14.6 bushels per acre. Nine plats drilled in cornstalks made an average yield of 10 bushels per acre. Six plats on fall plowed grain stubble gave an average yield of 10.2 bushels per acre. The total precipitation for the growing season (September 15 to July 1) was 14.44 inches. A considerable portion of the precipitation came as snow which melted and escaped as run-off as it could not penetrate the frozen soil.

Relation of Yield of Winter Wheat to Available Water. —We do not have many comparisons of yields of winter wheat from fields summer tilled and fields cropped each year, and the yields given in Table No. 1 for the first four years were not always from adjacent fields. The comparison available now, tho from conditions not so uniform as we should desire, shows the following:

TABLE 1.—*Relation of yield of winter wheat to available water.*

Year	Yields per acre	Available water in upper 6 feet of soil at seeding time	Precipitation from Sept. 15 to July 1	Total water available during season
SUMMER TILLED.				
	Bushels	*Inches*	*Inches*	*Inches*
1907 ...	59.0	...	13.74	.....
1908	57.0	7.6	13.65	21.25
1909 ...	37.6	7.0*	15.80	22.80
1910 ...	30.2	7.6	10.18	17.68
1911	13.6	4.0	6.86	10.86
1912	14.8†	2.6	14.44	17.04
LAND CONTINUOUSLY CROPPED.				
1907 ...	24.4	...	13.74	.....
1908	24.9	2.1	13.65	15.32
1909 ...	19.0	1.1	15.80	16.90
1910	None‡	1.3	10.18	11.48
1911	None‡	1.6	6.86	8.46
1912	8.1§	2.1	14.44	16.54

* In computing the available moisture at seeding time, we have considered 7 per cent as nonavailable water, and have taken 80 pounds per cubic foot as the average weight of our soil. The hygroscopic coefficient of these soils is slightly above 6 per cent.

In these columns we have considered only the precipitation from September 15, the average seeding date, to July 1, when wheat had completed growth, or, in other words, only the entire growing season.

In computing the total available moisture no consideration was taken of the run-off from the surface of the soil during heavy rains.

† On table-land. Yield from one plat—Tillage E.

‡ These plats winterkilled badly and were reseeded to spring wheat.

§ On table-land. Average of three plats—Tillage A, B and C.

In publishing the above table we desire to call attention to the fact that the fields were not always adjoining and the rate and time of seeding were not always the same. However, where any advantage has existed it has been to the plat not under summer tillage, and we believe that the table as a whole does not overstate the higher yields that may reasonably be expected from the summer tilled land. We consider well cared for sod, plowed at the time of the spring rains, about equal to summer tilled land.

The average yield on the summer tilled land for the past six years has been 35.4 bushels per acre; on land continuously cropped, 12.7 bushels per acre. If the yields on the summer tilled land be divided by two on account of the land being used two seasons to produce one crop, there will be two and one-half bushels annually in favor of summer tilling. The summer tilled land produced 10 bushels more than the two crops on the land continuously cropped. The cost of producing one crop on summer tilled land, considering seed and labor, is certainly very much less than the cost of producing two crops on land continuously cropped.

TABLE 2.—*Showing labor expended on summer tilling land for winter wheat.*

Year crop was harvested	Disking	Plowing	Harrowing	Precipitation Sept. 15 to July 1	Yield
1907	2	1	3	13.74	59.0
1908	3	1	3	13.65	57.0
1909	5	1	2	15.80	37.6
1910	2	1	5	10.80	30.2
1911	3	1	3	6.86	13.6
1912	2	1	5	14.44	13.3

In order to give a fair idea of the amount of work required in summer tilling, we have prepared the above table. This table shows the actual work put on the fields during the various years. The amount of work required will vary with changing climatic conditions, soil types, and other factors. The more nearly the work can be done at the right time the less the labor required, and consequently less expense. Weeds may be killed with a harrow while quite young, but it will require disking if they get older.

VARIETY TESTS.—Several varieties of winter wheat have been grown each season during the past seven years. Turkey Red and Kharkov have kept at the head of the list for first rank in yield. These two wheats have proved very similar here. The length of the growing season and the time of ripening have been practically the same. In fact any differences noted have been so minor as to come under variation of the soil on the plats. The behavior of the two wheats have been so similar under our conditions that we consider them practically the same for this locality.

TABLE 3.—*Variety test of winter wheat, grown on summer tilled land.*

Variety	Yield per acre						
	1906	1907	1908	1909	1910	1911	1912
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Turkey Red	42.3	58.4	57.4*	42.8	33.6*	10.7	13.1†
Kharkov	45.7	58.1	60.3*	39.6	33.1*	9.3	13.9‡
Beloglina	......	58.6	53.3	39.2	Thrown	out	
Turkey Red No. 287	......	......	63.3	39.0	29.6	5.3	Not grown
No. 1442	......	......	51.0	34.8	32.0	6.9	10.6
No. 1435	......	......	52.1	33.6	30.0	Thrown	out
Ghirka	......	......	......	......	33.2	7.1	7.7
No. 5145	......	......	......	......	....	7.5	11.4
No. 5147	......	......	......	......	....	6.7	11.1
No. 5158	......	......	......	......	....	7.2	14.2

* Average of four plats, different rates of seeding.

† Average for six years, Turkey Red, 36.9 bushels.

‡ Average for six years, Kharkov, 37.1 bushels.

RATE-OF-SEEDING TEST OF WINTER WHEAT.—In Table 4 are given the results obtained from different rates of seeding winter wheat for the past 7 years. This work was all done on summer tilled land where conditions were favorable for germination and where there was but little trouble from weeds. Under conditions less favorable for germination and stooling there would doubtless be a greater difference from different amounts of seed. It will be noticed from the table, under the column giving the average yield for the years 1908 to 1912, that there is but little difference shown between the thick and the thin seeding. Where the soil is well prepared and there is plenty of moisture, the wheat has stooled sufficiently on the plats thinly seeded to make up for the deficiency in the amount of seed. During the years 1911 and 1912, which were extremely unfavorable for wheat production, we obtained higher yields, as shown by the table, from seeding very light than from heavier seeding. There was a marked difference in the stand during these dry years from thin and thick seeding, the thinly seeded plats having a much smaller number of plants than the more thickly seeded plats. The higher yield from the plats thinly seeded was doubtless due to the fact that there was a smaller number of plants to use the rain that fell. The plants on the thinly seeded plats made greater development, the heads were longer and better filled. From studying the table, it would seem that thin seeding is advisable. During years when there is plenty of moisture, the stooling of the wheat has largely made up for deficiency of seed. During dry years the thin seeding has given a better development of the plants on the ground. It must be borne in mind that this work was done on summer tilled land and most of the weeds had been destroyed during the summer. Where there is danger of weeds coming in to make up for a shortage of seed, it is better to use a greater amount of seed. We follow the practice of putting on about one bushel of seed when sown in cornstalks, a less amount (probably 40 pounds) on early fall plowing, and about two pecks on summer tilled land. When there is sufficient moisture, early seeded grain will stool more than late seeded grain and consequently should be seeded lighter.

TABLE 4.—*Yield of winter wheat from different rates of seeding on summer tilled land.*

Rate of seeding per acre	Yield per acre							
	1906	1907	1908	1909	1910	1911	1912	Average
Pecks	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
5	42.1	58.4	55.7	42.6	37.1	13.9	10.2	37.1
4	40.0	59.7	58.0	40.2	31.1	14.6	13.1	36.7
3	42.0*	59.2*	57.1	42.0	33.5	14.7	10.7	37.0
2	42.3	60.2	56.0	38.2	32.7	15.4	14.8	37.1
1	......	......	....	......	......	16.3	16.5	
Av. by years	41.4	59.4	56.7	40.8	33.6	15.0	13.1	

* Estimated.

TIME OF SEEDING WINTER WHEAT.—There are given in Table 5 the results of several tests of different times of seeding winter wheat. The results do not warrant the drawing of definite conclusions but have some value in indicating the relation of the moisture content of the soil to the proper time for seeding. During years when the rainfall was high and when there were several feet of moist soil at seeding time, we obtained better results from the grain sown before September 15. There was then enough moisture in the soil to support the fall growth without leaving the soil so dry that the wheat was in danger of being winterkilled or of being killed by drouth early in the spring. During the drier years, when the soil was deficient in moisture at seeding time, later seedings have given better results. Observations in the field have led us to believe that the failure of the early seeded plats to yield well during dry seasons has not been due so much to winterkilling as to injury due to drouth early in the spring. In the spring, the driest surface soil is usually that on which the greatest growth has been produced, regardless of the method of preparing the seed bed or the moisture content at seeding time. As a result of this the plants on the late seeded plats are more vigorous and grow faster during a very dry spring than the plants on the earlier seeded plats.

We have found that a difference of very small amount of moisture in the surface few inches of the soil in the spring may make a very great difference in the yield of winter wheat. We believe that the proper time to sow winter wheat depends largely upon the amount of available moisture in the soil at seeding time. If there is considerable moisture in the soil, medium early seeding seems best. If the soil is comparatively dry, later seeding is probably advisable.

TABLE 5.—*Time-of-seeding test of winter wheat. Yield in bushels per acre.*

Year harvested		Time seeded and yield			
1909	Sod land Yield	Sept. 21 36.8	Oct. 22 40.5		
1909	Summer tilled land Yield	Sept. 14 40.9	Sept. 30 22.8		
1910	Summer tilled land Yield	Sept. 6 32.4	Sept. 15 37.1	Oct. 2 21.2	Oct. 16 15.3
1911	Summer tilled land Yield	Sept. 2 9.4	Sept. 10 13.6	Sept. 20 17.4	Oct. 3 13.1
1912	Summer tilled land Yield	Sept. 18 12.8	Sept. 28 14.9	Oct. 8 24.0	

SPRING WHEAT.

VARIETY TESTS.—Experiments have been conducted with a number of varieties of both soft and durum wheats. Tests have been made of the manner of seeding, the time of seeding, and the rate of seeding. We shall not try to explain the different yielding capacity which is shown by the same variety thru the various years that the tests have been carried on. These wheats, tho they generally give good yields, are not always pure varieties. The following table gives part of the results of six years' work in testing different varieties. There was a total failure of spring grains in 1911. Therefore this year does not appear in the various tables. The rate of seeding, date of seeding, preparation of the soil, and all the conditions so far as we could make them were the same for each variety. In the variety test of 1906, spring wheat was grown in a field which had been in winter wheat in 1905 and later fall plowed. Since then the variety tests have been on disked corn land on the bench.

TABLE 6.—*Variety test of spring wheats on annually cropped land.*

Variety	Yield per acre					
	1906	1907	1908	1909	1910	1912
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Black Don, durum, hard	22.8	28.6	32.5	27.2	3.5	Not grown
Velvet Don, durum, hard	23.4	29.0	30.8	25.5	2.5	5.1
Gharnovka, durum, hard	22.6	31.4	32.2	28.0	3.4	6.7
Kubanka, durum, hard	18.6	33.0	30.3	26.5	3.5	6.5
White wheat, semi-hard	......	28.0	25.9	29.1	4.4	10.1*
Red wheat, semi-hard	......	25.4	22.6	28.2	4.1	4.1
Velvet chaff	......	......	......	31.3	4.6	...
Kahla	......	......	......	33.6	4.4	6.6
Scotch Fife	......	......	......	......	....	3.0
Saragolla	......	......	......	......	......	4.5

* The higher yield from this variety this year is doubtless due to the fact that snow drifted onto this plat to a much greater extent than on any of the other plats.

No crop was harvested in 1911, as the crop was killed by drouth and hot winds.

RATE OF SEEDING.—Table 7 shows the results obtained from five years' testing spring wheat at different rates of seeding. The date of seeding, the manner of seeding, and the preparation of the land were the same for all of these plats, the only varying factor being the amount of seed used.

TABLE 7.—*Yield of durum spring wheat from different rates of seeding on annually cropped land.*

Rate of seeding per acre	Yield per acre					
	1907	1908	1909	1910	1912	Average
Pecks	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu*	*Bu*
5	28.6	32.5	22.8	2.4	7.4	18.2
4	26.4	31.7	24.6	2.9	6.3	18.4
2	17.9	23.3*	19.3	2.9	4.5	13.9
Average by years	24.3	29.2	22.2	2.7	6.1	

* Estimated.

No crop was harvested in 1911 owing to drouth and hot winds.

TIME OF SEEDING.—The results of three years' work in testing the effect of different times of seeding are shown in Table 8. It will be noted that in each of these tests we have obtained our highest yield from the earlier seeding. The weather conditions were unfavorable for germination at the time of the second seeding in 1909. Tho the climatic conditions may occasionally be favorable or unfavorable to early or late seeding, yet we feel that the earlier seeding will generally be the safer.

TABLE 8.—*Time of seeding test of spring wheat. Yield in bushels per acre on annually cropped land.*

1909	Date....... Yield......	April 1 27.9	April 10 21.7	April 20 26.6	May 3 24.1
1910	Date....... Yield.......	March 17 14.6	March 30 12.0	April 8 2.4	April 20 2.6
1912	Date....... Yield.......	April 8 6.1	April 19 4.3	April 30 None	

No crop was harvested in 1911, being killed by drouth and hot winds.

EFFECT OF PREVIOUS CROP AND TILLAGE.—It will be noted from the average yields given in Table 9 that, while the yields on the spring plowed wheat stubble average a little higher than on the fall plowed, yet during two years the spring plowed land gave lower yields than the fall plowed. The low yield given for the fall plowed plat in 1909 was due to the grain being badly killed by freezing after it was well up. The conditions for germination were not so good in the spring plowed plat as in the fall plowed plat and as a consequence the grain on the former came up very slowly and escaped the freeze. However, it is only from the results of a longer series of years that we shall be able to draw dependable conclusions. We note that summer tilled land gave larger yields three years out of five than land not summer tilled; tho only in 1908 and in 1910 was the difference sufficient to be considered profitable. The low yield in 1909 from the plat which had been summer tilled was at least partially due to freezing. This plat was so badly damaged by freezing that it would probably have been best to reseed it. During the five years, the spring wheat on summer tilled land yielded about 7 bushels more per acre than the average yield from the three other methods of tillage, but summer tilled land produced a crop only every second year.

TABLE 9.—*Effect of previous crop and tillage on the yields of spring wheat.*

	Yield per acre					
	1907	1908	1909	1910	1912	Average
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Spring plowed wheat stubble	24.5	22.7	23.0	6.8	12.8	17.9
Fall plowed wheat stubble	26.0	27.3	15.3	6.6	11.2	17.2
Disked corn stubble	24.9	25.0	15.1	7.3	5.0	15.4
*Summer tillage alternating with wheat	31.8	40.5	18.0	18.0	10.5	23.7

* The yield on the summer tilled plats should be divided by two in order to represent the annual yield. However, there is twice as much seed and much more labor required to produce two crops by ordinary methods of tillage than one crop by summer tillage.

No crop was harvested in 1911, being killed by drouth, except on summer tilled land, where a small crop would have been harvested had it not been eaten by grasshoppers which came in from adjacent fields.

NOTE—The data used in compiling Tables 9, 13, 17, and 23 are taken from the rotation and tillage work in Field 41, which is carried on in cooperation with the Office of Dry Land Agriculture Investigations, Bureau of Plant Industry, United States Department of Agriculture. Several years' results from this work are given in Bulletin 187, Bureau of Plant Industry, by Professor E. C. Chilcott.

OATS.

VARIETY TEST OF OATS.—In Table 10 are given the results from testing different varieties of oats. No tests are given for the years 1907 and 1911. In 1907 the oats were caught by a severe freeze at a critical time. Oats sown just before as well as some sown a few days later than the varieties were sown came thru the freeze with a fair stand. In 1911 the variety test as well as all other spring grain was lost from drouth. In the seven years' work given, the earlier varieties have given the best yields. The only year in which the later varieties made a favorable showing was in 1910, and then they did not yield as much as the earlier varieties. During the drier years the advantage of the earliest varieties have been even more pronounced. Of the varieties given, the Burt oat is one of the earliest and has ranked with Kherson in yield. It is a few days earlier than the Kherson. The June oat has been tried only one year. It ranks with the Burt for early maturity and gave a good yield. Kherson and Sixty Day have on the average ripened at about the same time. Their average time from seeding to harvest has been about 95 days. Texas Red and Big Four are a few days later than Kherson. Each year the varieties have been grown under similar conditions in the same field. Since 1908 the work has all been done on the table-land.

TABLE 10.—*Variety test of oats.**

	Yield per acre						
	1904	1905	1906	1908	1909	1910	1912
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Kherson	48.0	20.0	47.0	50.9	40.0	19.0	6.8
Texas Red	......	29.0	43.3	40.7	38.2	9.8	......
Sixty Day	48.0	20.0	47.8	......	36.0	15.9	8.8
Black American	......	......	......	40.9	37.0	6.8	......
Red Algerian	......	......	......	27.2	34.2	5.0	7.5
Local	29.0	24.0	24.0	......	......	......	......
Burt	......	......	......	50.7	38.2	19.0	15.8
Swedish Select	......	......	......	34.1	23.4	6.7	2.0
Siberian White	......	......	......	......	30.6	9.3	......
Olsen's	......	......	......	......	25.0	10.0	7.2
Big Four	......	......	......	......	30.0	10.8	1.5
National	......	......	......	......	25.0	11.8	......
Side oats	......	......	......	......	26.6	5.8	......
June oats	......	......	......	......	......	......	14.7
Kherson No. 459	......	......	......	......	......	......	15.9

* The variety test in 1907 was destroyed by freezing.
The variety test in 1911 was a total failure, due to drouth.

RATE OF SEEDING.—Table 11 gives the results obtained from different rates of seeding oats. All conditions were uniform except the amount of seed used. There is little difference between the average yields from 8 pecks and from 6 pecks. Where we seeded as light as two pecks we did not have enough plants on the ground and generally had trouble with weeds. This work has all been on the bench-land and on cornstalk land prepared with the disk. Usually the corn land has been top dressed with manure during the winter.

TABLE 11.—*Yield of oats from different rates of seeding.*

Rate of seeding per acre	Yield					
	1907	1908	1909	1910	1912	Average
Pecks	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
8	45.1	50.9	73.0	17.0	19.0	40.8
6	48.3	48.8*	71.0	23.0	18.3	41.9
4	46.6	42.6	69.6	16.9	14.4	38.0
2	22.5	25.8*	41.6	15.2	14.0*	23.8

* Estimated.
No crop was harvested in 1911, owing to a severe drouth which killed the crop.

TIME OF SEEDING.—In Table 12 are given three years' results from different times of seeding oats. Two years out of three, early seeding has given best results.

TABLE 12.—*Time-of-seeding test of oats. Yield in bushels per acre.*

1909	Date.......	April 1	April 10	April 20	May 3
	Yield.......	42.3	38.2	59.3	66.0
1910	Date.......	March 17	March 30	April 8	April 20
	Yield.......	15.4	11.9	9.3	7.7
1912	Date.......	April 8	April 19	April 30	
	Yield.......	22.0	21.8	15.0	

No crop was harvested in 1911, owing to drouth which killed the crop.

EFFECT OF PREVIOUS CROP AND TILLAGE.—In Table 13 are given five years' results from four different methods of preparing the seed bed for oats. The lowest average yield shown is from spring plowed oat stubble, altho this method gave better results three years out of five than either fall plowed oat stubble or disked corn land. In 1912 the difference is quite marked and the yield is slightly higher than on summer tilled land. The prolonged winter of 1911-1912, with the abnormally heavy snows, left the soil in this section quite badly run together and baked. This condition has not previously occurred to the same extent since the station was established. Disking was hardly sufficient to prepare either fall plowing or cornstalk land for seeding. Deeper tillage was needed. The table shows that three years out of the five, summer tilled land has given the highest yields. If, however, we divide the yield of the summer tilled plats by two, to represent annual yield, the average yield for these plats is the lowest of any in the test.

TABLE 13.—*Effect of previous crop and tillage on the yield of oats.*

	Yield per acre					
	1907	1908	1909	1910	1912	Average
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Spring plowed oat stubble.......	30.0	34.4	31.3	12.2	18.7	25.5
Fall plowed oat stubble.........	36.0	68.5	24.1	11.8	10.6	30.2
Disked corn stubble.............	40.6	43.5	22.5	11.8	6.6	31.2
Summer tillage alternating with oats..........................	30.0	82.3	46.3	23.4	18.4	40.1

No crop was harvested in 1911, owing to drouth, except on summer tilled land, where a small crop would have been harvested had it not been eaten off by grasshoppers which came in from adjacent fields.

NOTE—The data used in compiling Tables 9, 13, 17, and 23 are taken from the rotation and tillage work in Field 41, which is carried on in cooperation with the Office of Dry Land Agriculture Investigations, Bureau of Plant Industry, United States Department of Agriculture. Several years' results from this work are given in Bulletin 187, Bureau of Plant Industry, by Professor E. C. Chilcott.

BARLEY.

VARIETY TESTS.—From further tests with various varieties of barley it would seem that the common 6-rowed barley is the best variety we have grown. This is in accordance with our previous report. Table 14 gives results of some tests made in 1909, 1910 and 1912. These yields are very low, due not alone to the fact that the rainfall has been insufficient but also to the method of tillage. During two of these years, the barley has been grown as the third consecutive small grain crop on the field. It has entered into a rotation where winter wheat is followed by oats, and the oats followed by barley. This is, even under the most favorable weather conditions, a very poor practice. A cultivated crop—such as corn, sorghum in rows, or potatoes—or summer tillage should come between the small grain crops. During the third year (1912) the barley followed oats as the second small grain crop.

TABLE 14.—*Variety test of barley.*

Variety	Yield per acre		
	1909	1910	1912
	Bu.	*Bu.*	*Bu.*
Common..................................	21.4	7.4	15.8
Manchurian..............................	19.2	4.4	
Black...................................	18.6	4.6	14.0
Beardless...............................	15.2	5.4	8.5
Hulless.................................	9.2	4.3	

No crop was harvested in 1911, owing to drouth.

Rate of Seeding.—Table 15 gives five years' work in testing the different rates of seeding common barley, and three years' work for hulless barley. This indicates that seeding six pecks of common barley per acre has given better results than either more or less seed, tho other rates of seeding have given much better results during some years. Four pecks seems to be the best rate at which to seed hulless barley.

Table 15.—*Yield of barley from different rates of seeding.*

Rate of seeding per acre	Kind	Yield per acre					
		1907	1908	1909	1910	1912	Average
Pecks		*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
8	Common	40.8	25.2	17.2	7.4	15.8	21.3
6	Common	40.1	27.0	19.6	6.6	18.7	22.4
4	Common	38.1	23.5	16.0	8.1	12.3	19.6
2	Common	34.9	17.7	16.6	5.5	11.0	17.8
6	Hulless	21.9	12.0	......	3.5	......	....
4	Hulless	21.8	12.3	......	4.3	.....	....
2	Hulless	18.6	11.3	......	3.1	......	....

No crop was harvested in 1911, owing to drouth. Comparisons are not strictly accurate, except between varieties grown in the same years.

Time of Seeding.—Table 16 gives the results of three years' trials of different times of seeding barley.

Table 16.—*Time of seeding barley. Yield in bushels per acre.*

1909	Date	April 1	April 10	April 20	May 3
	Yield	41.0	32.3	44.2	37.4
1910	Date	March 17	March 30	April 8	
	Yield	18.5	16.2	8.9	
1912	Date	April 8	April 19	April 30	
	Yield	19.6	19.8	Failure	

No crop was harvested in 1911, owing to drouth.

Effect of Previous Crop and Tillage.—Table 17 gives the results of growing barley on ground prepared by four different methods, namely, spring plowed barley stubble, disked corn stubble, fall plowed barley stubble, and summer tilled land. Some advantage is shown in the table by fall plowed barley stubble over spring plowed. Either of these methods has given better returns than disked corn stubble. It is a question, however, if the average increase from plowing has paid for the extra amount of labor. The results for 1909 show a very low yield on fall plowed barley stubble, and a very little increase on summer tillage over either spring plowing or disked corn land. The freeze that so seriously affected the wheat plats before mentioned badly damaged barley on the fall plowed plat and the summer tilled plat. The average increase in yield for the four years due to summer tilling is 13.1 bushels per acre above the best of the other three methods. This increase in yield, with the lessened expense of summer tilling for one crop instead of growing two crops on continuously cropped land, may be enough to make summer tilling profitable.

TABLE 17.—*Effect of previous crop and tillage on the yields of barley.*

	Yield per acre					
	1907	1908	1909	1910	1912	Average
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Spring plowed barley stubble	39.0	19.6	21.5	13.7	20.8	22.9
Fall plowed barley stubble	40.0	43.3	10.4	12.5	14.6	24.1
Disked corn land	30.6	24.9	21.5	7.9	12.3	19.4
Summer tillage alternating with barley	39.0	67.7	23.8	26.0	20.0	35.2

No crop was harvested in 1911, owing to drouth, except on summer tilled land, where a small crop would have been harvested had it not been eaten by grasshoppers which came in from adjacent fields.

NOTE—The data used in compiling Tables 9, 13, 17, and 23 are taken from the rotation and tillage work in Field 41, which is carried on in co-operation with the Office of Dry Land Agriculture Investigations, Bureau of Plant Industry, United States Department of Agriculture. Several years' results from this work are given in Bulletin 187, Bureau of Plant Industry, by Professor E. C. Chilcott.

SPRING EMMER.

Spring emmer has been grown at the Station as a grain feed each season since the Station was established. It makes a very good feed, and can be fed to horses without grinding. When fed to hogs, it should be ground.

The winter emmer so far as we have tested it has not proved hardy for this section. Two very fair crops were harvested in 1907 and 1908, but since then it has not withstood the winter sufficiently to warrant growing it. This year we are trying Buffum's Improved winter emmer.

RATE OF SEEDING.—The crop of 1907 was on corn land, twice double disked in the spring. The crop of 1908 was on land which had been in rowed-cane, and cultivated. The land was double disked in the spring. The crop of 1909 was grown on land which had been in oats the previous year, and was double disked twice in the spring. The table shows that seeding 6 pecks per acre has given the highest yield of any rate of seeding.

TABLE 18.—*Yield of emmer from different rates of seeding.*

Rate of seeding per acre	Yield per acre*					
	1906	1907	1908	1909	1912	Average
Pecks	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
8	23.5	42.9	52.5	33.2	20.7	34.5
6	27.8	45.4	52.6	36.6	17.5	35.8
4	23.0	35.8	50.8	33.6	10.7	30.8
2	18.7	25.1	44.3	34.2	10.2	16.5

* Forty pounds considered a bushel.
No crop was harvested in 1911, owing to drouth.

TIME OF SEEDING.—Table 19 gives the results obtained from three years' tests of different times of seeding emmer. Two years out of the three, the earliest seeding gave the best results. Tho the climatic conditions may occasionally be unfavorable, we feel that early seeding is generally best.

TABLE 19.—*Time of seeding emmer. Yield in bushels per acre.*

1909	Date	April 1	April 20	May 3
	Yield	38.6	41.5	33.1
1910	Date	March 17	March 30	April 8
	Yield	20.7	7.8	3.8
1912	Date	April 8	April 19	April 30
	Yield	11.0	7.1	Failure

No crop was harvested in 1911, owing to drouth.

BROADCASTING COMPARED WITH DRILLING GRAIN.

During the past several years, tests have been conducted to determine the comparative yields obtained from seeding small grain broadcast and covering with a harrow, and by sowing with the press drill. All conditions were identical for the plats being compared, excepting the manner of seeding. During each season the oats, spring wheat, and emmer have been on corn stubble prepared by disking. The barley has been on fall plowed wheat stubble and the winter wheat on summer tilled land. The average results as shown in Table 19 indicate that drilling increased the yield of spring wheat 3 bushels per acre, of barley 7.2 bushels per acre, of oats 1.8 bushels per acre, and of emmer 8.9 bushels per acre. Only two years' results are given from broadcast seeding winter wheat. Previous to 1911 the winter wheat had come thru with such a comparatively poor stand that we had each year disked the plat and reseeded to a spring grain. However, after the season of 1910, which showed that a thin stand might be an advantage during dry years, the broadcast plat has been left. In the spring of 1911 the broadcast seeding was estimated as only 15 per cent normal stand. In 1912 it was about 25 per cent normal stand. Had the work been done on other than summer tilled land, the weeds would have come in and used part of the moisture, which would have kept the plants from maturing so well. However, the weeds did not bother to any extent, and the plants matured quite normally. The fact that there was a smaller number of plants to use the water was a benefit. It is not safe, however, to use the two years' work shown in the table, in determining the comparative merits of broadcast seeding and drilling winter wheat. If each year the broadcast seeding had been allowed to stand, we know that a much greater difference in favor of drilling would have been shown for winter wheat than for any of the spring grains.

TABLE 20.—*Broadcasting compared with drilling small grain.*

Crop	Year	Yield per acre		
		Method of seeding		Increase from drilling
		Broadcast	Drilled	
		Bu.	*Bu.*	*Bu.*
Spring wheat	1908	20.0	29.6	9.6
	1909	17.0	27.2	10.2
	1910	Failure	2.4	2.4
	1912	5.0	5.9	0.9
				Av. 5.7
Barley	1908	17.7	27.7	10.0
	1909	8.8	17.7	8.9
	1910	3.3	7.4	4.1
Av. two each	* 1912	6.9	13.3	6.4
				Av. 7.3
Oats	1908	50.6	52.5	1.9
	1909	40.0	68.2	28.2
	1910	16.3	18.2	1.9
	1912	18.6	21.6	3.0
				Av. 8.7
Emmer	1908	46.2	52.6	6.4
	1909	22.0	40.6	18.6
	1910	17.2	24.6	7.4
	1912	18.9	22.2	3.3
				Av. 8.9
Winter wheat	1910	*	33.2	
	1911	12.1	13.9	1.8
	1912	17.1	14.6	—2.5

* Came thru the winter with such a poor stand that the plat was disked and reseeded to spring wheat.

RELATIVE YIELDS OF SPRING GRAINS.

For several years, carefully conducted tests have been made to determine the relative yields of the several spring small grains. During each season this test has been on disked corn stubble. The seed has been sown with a press drill on well prepared land. The yield is given in pounds, since the number of pounds produced indicate much more nearly the feeding value than the number of bushels. Any of these grains may be fed to any farm stock, but the hulless grains will produce much the best results when fed to hogs. Emmer is a good substitute for oats as horse or calf feed. Wheat has a feeding value about 10 per cent higher than corn. It is probable that the relative feeding value per pound of these grains does not vary greatly if the hull is excluded. The results indicate that durum wheat and barley produce more feed per acre than any of the other grains.

TABLE 21.—*Comparison of yields of oats, barley, hulless barley, emmer, and durum wheat, grown under similar conditions.*

	Yield per acre in pounds						
	1907	1908	1909	1910	1912	Average	
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Bushels*
Kherson oats	1,442	2,044	960	500	214	1,032	32.3
Common barley	2,226	2,284	1,390	886	329	1,423	29.6
Hulless barley	1,436	1,658	870	454	118	907	15.1
Emmer	1,718	2,024	1,026	828	114	1,142	28.6
Durum wheat	1,788	1,772	1,192	876	127	1,151	19.2

CORN.

VARIETY TESTS.—Variety tests of corn have been conducted during the past eight years. The number of varieties or strains grown each year has ranged from 10 to 35. The variation in yield has been from almost a failure to 52 bushels per acre. The rank of the varieties that have been grown each year has not been the same for all years, but each season the Substation Calico, which is a medium-sized corn, has been among the leading varieties and, on the average, may be considered one of the best. There is no other variety that has proved its superior. From all the results of these tests it seems evident that the varieties which have been grown in this part of the state for several years and properly selected are superior to those brought in from places having different climatic conditions. Varieties brought from very far east or south have been adapted to a longer growing season and more rainfall. When these varieties are tried here they usually have either failed to mature or given chaffy corn. Generally, they make ranker growth of stalk and foliage and have the appearance of good producers, but if the grain is weighed they will fall below the native corn. Varieties brought in from some distance to the north or west have been adapted to a shorter growing season, a higher elevation, or less rainfall than we have here. They are small varieties and tho they have always matured early and made solid corn they do not give a satisfactory yield because they are small. Our aim is to select a medium-sized ear of corn (7 to 8 inches long) with kernels rather broad, shallow, and smooth. We do not object to even a flinty appearance. Varieties having deep kernels will mature late and will give chaffy corn, excepting in abnormally favorable seasons. Farther west the type should be smaller and more flinty.

MANNER OF SEEDING.—The results of planting corn with a lister and with a surface planter are given in Table 22. These tests have all been on fall plowed land. Four years out of five gave decided results in favor of planting with the lister; the fourth year was very much in favor of the surface planting, but this was on account of a good stand having been secured with the planter, while a very poor stand was obtained with the lister. A count of the stalks on the plats showed that the surface planted corn had 1,894 stalks to 1,141 of the listed corn.

TABLE 22.—*Corn listing versus surface planting.*

Year	Surface planting	Listing	Increase from listing	Increase from surface planting
	Bushels	*Bushels*	*Bushels*	*Bushels*
1906	15.5	25.8	10.3	
1908	20.7	26.7	6.0	
1909	38.2	29.1	....	9.1
1910	16.3	24.8	8.5	
1912	19.2	22.6	3.4	

EFFECT OF PREVIOUS CROP AND TILLAGE ON YIELD OF CORN.—During the past six years, careful tests have been made to compare the yields of corn on spring plowed corn stubble, fall plowed corn stubble, spring plowed small grain stubble, fall plowed small grain stubble, and land summer tilled each alternate season. The corn was planted with a lister. The results are given in Table 23. Only five years' results are given. In 1911 there was a very light crop, which was cut for feed, not being worth husking. The averages of the five years show that of these five methods corn following corn on spring plowing has given the highest yields. The table shows very little difference either in any particular year or in the final average between spring plowing and fall plowing small grain stubble for corn. As a general thing there is more time to do the plowing in the fall. When the lister is used and the ground is to be plowed, fall plowing is better, for it will settle and list easier than spring plowing. We do not have in this same field (41) a comparison of listing the corn into small grain stubble without plowing. In another field (49) on the table we have such a test, but have only three years' results. In this rotation corn is listed into small grain stubble without any preparation. In 1910, only one-half ton of fodder per acre was made and no corn. This was the only plat that failed to make corn. In 1911 and in 1912 it made the lowest yields. This work is in Field 41 on the table-land. The yields should not be compared with those from the bench-land.

Cultivation of Corn.—We have several years' data on cultivating corn to different depths and on late cultivation. This work has given such contradictory results that we have not tabulated it. Two years out of four late cultivating with one horse was an advantage, the other two years it caused an actual loss. We hold the opinion that the increase came from the fact that the late cultivation destroyed weeds to such an extent that it more than overcame the damage done by breaking the corn roots. The work with cultivating at different depths has not given any results worth using. The checks seldom agree in the same field. The main thing in cultivation seems to be to keep the corn free from weeds.

TABLE 23.—*Effect of previous crop and tillage on yield of corn. Field 41.*

	Yield per acre					
	1907	1908	1909	1910	1912	Average
	Bu.	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
Corn following corn on spring plowing	28.7 *	38.6	29.0	8.9	34.1	27.9
Corn following corn on fall plowing	27.7 *	24.6	31.6	6.2	39.9	26.0
Corn following spring grain on spring plowing	19.9 †	24.0	25.8	4.6	26.0	20.1
Corn following spring grain on fall plowing	19.1 †	27.1	26.1	2.6	26.1	20.2
Summer tilling alternating with corn	17.9 *	38.2	25.0	21.9	35.1	27.6
Average by years	22.6	30.5	27.5	8.8	32.2	

* Results from one plat only.

† Average of 9 plats.

FORAGE CROPS.

CANE.

Our experiments during eight years confirm our belief that cane (sorghum) is the chief forage plant where alfalfa cannot be grown successfully. In 1911, when spring small grain was an entire failure, and when 50 acres of corn was put into a 130 ton silo, a ten-acre field of cane following oats gave 11 tons of forage. The average yield during the last eight years has been 4 tons per acre. In experiments in wintering cattle, the cane proved to be worth fully as much per ton as a good quality of Platte Valley prairie hay. The Early Black Amber is one of the best varieties, and matures here.

KAFIR.

Kafir is a very good forage, probably fully as valuable per ton as cane. It is usually grown in rows, tho it does well seeded thickly. The chief objection to raising it is that it does not mature seed this far north and the seed shipped in is often low in its germinating power. It is hoped that the date of maturing may become earlier when it is selected with this purpose in view, but thus far there has been but little Kafir seed produced on the Substation farm.

MILO.

Milo has been grown in tests with cane and Kafir, but does not have nearly the feeding value of either of the other two. The seed, however, is valuable as a grain for feeding stock. This character of the plant is being developed with the idea that it may take the place of corn in the extreme western part of the state.

BROME GRASS.

During the first few years after this Station was established, when the rainfall was much above the normal, brome grass (*Bromus inermis*) gave very satisfactory results in forage and seed production. During years when rainfall has been about the normal or lower than the normal the yield of both seed and forage has been unsatisfactory. As a pasture grass we think it is not as productive as the native grasses during dry seasons. We have had a great deal of difficulty in getting a stand during dry years. We believe it has some value for seeding down fence rows and turn rows, but we doubt that it has any value for seeding in fields for hay, seed, or pasture under our conditions, except possibly during series of wet years.

ALFALFA.

This is the most valuable forage crop that can be grown in the valleys. It is a question as to the profit in raising it on the table-land. One field on the table-land on the Substation farm was seeded to alfalfa in 1902. This field made at least two fair cuttings (probably an annual yield of 1.5 to 2 tons per acre) each season up to and including 1909. In 1910 there was not sufficient alfalfa to pay for cutting, tho there was some growth. Many of the plants winterkilled during the very dry winter which followed and during the early part of the summer. The killing was so severe that the main portion of the field was plowed. A small tract adjoining this field, which is a little lower and which received some surplus water from the higher lands, lived thru and has made some hay each year. It would have afforded considerable pasture for hogs. One thing noted on the table-land was that as fast as the weaker alfalfa plants were

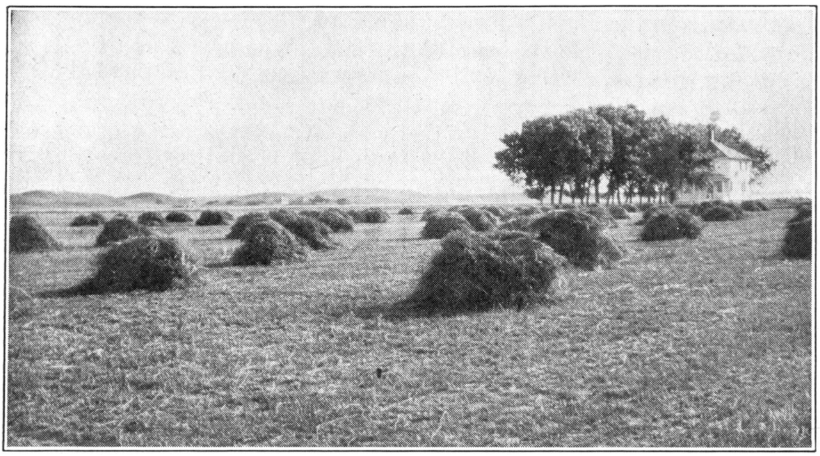

Fig. 3. Alfalfa in the shock.

killed weeds would come in after each rain to compete with the remaining plants for what moisture there was. It may be that cultivation, if started early and continued, would have been beneficial.

Some farmers in the western portion of the state, on the driest lands, are successfully growing alfalfa in rows by cultivation. They have found it very profitable when a good seed crop is produced, and recommend it even for hay. Where there is some lower land, on the table-land farms, that will receive flood water, we would recommend sowing a sufficient acreage of alfalfa to at least afford pasture for hogs.

On most of the valley lands, where the sheet water is not more than thirty feet below the surface, alfalfa does well, giving from three to four cuttings each season, of a ton or more each, per acre. The only trouble experienced on these lands has been in getting a stand during the drier years. Where sheet water is fifteen feet or more from the surface, we feel that it is hardly safe to sow the alfalfa until most of the weeds have been gotten rid of by tillage and plenty of moisture is available in the first three or four feet of the surface soil.

In Table 24 we are giving the yield from a field of alfalfa on the bench land where the sheet water is 20 to 25 feet below the surface. The yields are given for each cutting for the past seven years. This field was seeded in 1905.

TABLE 24.—*Annual yield in tons of alfalfa from each cutting, from Field 11 on the bench-land, seeded 1905.*

Year	First cutting	Second cutting	Third cutting	Fourth cutting	Fifth cutting	Total yield for year
1906	.50	.71	.75	.84	....	2.80
1907	1.80	1.76	1.22	1.46	....	6.24
1908	1.70	1.80	1.40	....	....	4.90
1909	2.23	1.61	1.42	1.12	....	6.38
1910	1.88	1.42	1.43	.77	....	5.50
1911	1.94	.88	1.34	1.53	.45	6.14
1912	1.79	1.73	1.85	1.11	.30	6.78
Av. annual yield	....	....	....	....	....	5.75

For results of feeding alfalfa to cattle, see Bulletin 117. For results of feeding alfalfa to hogs, see Bulletins 99, 121, 123, and 124. For results of feeding alfalfa to colts, see Bulletin 130.

ROTATION AND TILLAGE METHODS.

PLANS OF EXPERIMENTS.

In order that the reader may have some knowledge of the experiments being carried on, we have inserted Tables 25 and 26, which give the plan of the experiments conducted in Fields 41 and 49 on the table-land. This work is being carried on in co-operation with the Office of Dry Land Agriculture, Bureau of Plant Industry, United States Department of Agriculture. The purpose of the work is to determine the effect of crop sequence and soil tillage. The plats are two rods wide by eight rods long, making one-tenth acre, and are arranged in groups or rotations of from two to six each. The number of plats in a rotation represents the number of years required to complete one cycle in a rotation.

The crop that is shown on each plat in the diagram for Field 41 is the crop that was grown on that plat in 1910. The crops rotate from year to year. Each plat retains the same letter constantly, but the crops move in the rotation from Z toward A. As an example, take rotation No. 45. In this rotation the oats on plat A moves to plat C in 1911 and to plat B in 1912, and back again to plat A in 1913. Corn follows the oats and rye follows the corn. All the other rotations follow this same plan.

There are some plats which grow the same crop continuously. For example, in Series 4 there is a plat marked A Barley S. P. Barley is grown on this plat each year on spring plowing. The plat above marked B Barley F. P. grows barley each year on fall plowing. Opposite these plats in Series 5 are two plats. One is marked C Barley and the other D, summer fallow. On these two, summer tillage and barley alternate each year. There are also four plats that grow wheat, four that grow oats, and four that grow corn continuously after the same preparation as indicated for the barley. In Field 49, check plats, winter wheat, A, B, and C, and all plats in Series 6, A to R, are continuously under the same methods and crops.

The rotations are arranged so that each is different from every other rotation in only one particular. A fair example is given by rotations 1, 2, and 3. In these three rotations wheat is grown on fall plowing, spring plowing, and disked corn stubble. Rotation 5 is the same as these excepting that corn is replaced by summer tillage. In rotations 9 and 4 the sequence is changed. The changes permit a perfect system of checking thruout all the rotations.

TABLE 25 ROTATIONS AND TILLAGE METHODS

NORTH PLATTE NEBR.
FIELD 41. 1910

S.P. SPRING PLOWING
F.P. FALL PLOWING
Disced in PREPARING for SEEDING

A OATS	A OATS F.P.	A OATS	A CORN S.P.	A CORN S.P.		
B CORN F.P. 45	B CORN F.P. 6	B CORN F.P. 46	B WHEAT Disced 16	B WHEAT Disced 14		
C RYE	C BARLEY Disced	C COWPEAS	C PEAS F.P.	C RYE F.P.		
A CORN S.P.	A CORN S.P.	A CORN S.P.	D OATS	D OATS		
B WHEAT Disced	B WHEAT Disced	B CORN F.P.	B BARLEY F.P.	D FALLOW		
C BROME 41	C ALFALFA 42	C WHEAT Disced	A BARLEY S.P.	C BARLEY	A CORN S.P.	
D BROME	D ALFALFA	A WHEAT F.P.	B WHEAT F.P.	D FALLOW	B WHEAT Disced	
E BROME	E ALFALFA	B FALLOW 8	A WHEAT S.P.	C WHEAT	C FALLOW	
F OATS F.P.	F OATS F.P.	C OATS	B OATS F.P.	D FALLOW	D OATS	A OATS F.P. 40
A WHEAT F.P.	A WHEAT S.P.	A BARLEY S.P.	A OATS S.P.	C OATS	A OATS S.P.	B WHEAT F.P.
B CORN F.P. 4	B CORN S.P. 9	B CORN S.P. 7	B CORN F.P.	D FALLOW	B CORN F.P. 47	A CORN F.P. 49
C OATS Disced	C OATS S.P.	C OATS S.P.	A CORN S.P.	C CORN	C CANE S.P.	B WHEAT Disced
A OATS S.P.	A OATS F.P.	A OATS F.P.	A OATS F.P.	A OATS	A OATS S.P.	A OATS F.P.
B CORN S.P. 2	B CORN F.P. 1	B CORN F.P. 3	B CORN F.P. 43	B CORN S.P. 50	B CANE S.P. 48	B FALLOW 5
C WHEAT S.P.	C WHEAT Disced	C WHEAT F.P.	C WHEAT F.P.	C FALLOW	C WHEAT S.P.	C WHEAT

TABLE 26.

ROTATION AND TILLAGE METHODS. FIELD 49, 1912

A RYE F.P.	A RYE F.P.	A SUMMERTILL	A PEAS F.P.	A OATS DISCED	A W. WHEAT F.P. 10" P
B Sp WHEAT	B W. WHEAT	B W. WHEAT	B W. WHEAT	B W. WHEAT DISCED 105	B W. WHEAT F.P. 7" P
C CORN S.P. 15	C CORN F.P. 20	C CORN F.P. 28	C CORN F.P. 16	C POTATOES F.P.	C W. WHEAT F.P. 3" P
D OATS DISCED	D OATS DISCED	D OATS DISCED	D OATS DISCED	A OATS DISCED	D W. WHEAT F.P. 16" P
W. WHEAT CHECK	A CORN F.P.	W. WHEAT CHECK	A SUMMERTILL	B CORN F.P. 106	E W. WHEAT F.P. 15"
A PEAS F.P.	B OATS DISCED 104	A CORN F.P.	B OATS	C POTATOES DISCED	F W. WHEAT F.P. 3"
B Sp WHEAT 17	C W. WHEAT F.P.	B W. WHEAT IN CORN 103	C CORN F.P. 18	A OATS DISCED	G W. WHEAT F.P. 7"
C CORN S.P.	A W. WHEAT IN CORN 113	C OATS DISCED	D W. WHEAT DISCED	B SUMMERTILL 107	H W. WHEAT F.P. 10"
D OATS DISCED	B CORN NO PREPARATION	A PEAS F.P.	A RYE F.P.	C POTATOES	I W. WHEAT F.P. 10" P
A SUMMER TILL	A SUMMERTILL 114	B OATS 97	B OATS 26	A Sp WHEAT DISCED	J W. WHEAT F.P. 7" P
B Sp WHEAT 18	B W. WHEAT	C CORN F.P.	C CORN F.P.	B OATS DISCED 108	K W. WHEAT F.P. 3" P
C CORN S.P.	A SUMMER TILL 115	D W. WHEAT IN CORN	D W. WHEAT DISCED	C POTATOES F.P.	L W. WHEAT F.P. 15" P
D OATS DISCED	B RYE	A CORN F.P.	A W. WHEAT IN CORN 110	A W. WHEAT DISCED	M W. WHEAT F.P. 15"
A OATS DISCED	A W. WHEAT F.P.	B W. WHEAT IN CORN 102	B CORN F.P.	B OATS DISCED 109	N W. WHEAT F.P. 3"
B CANE S.P. 120	B W. WHEAT E.F.P.	C OATS F.P.	A W. WHEAT IN CORN 111	C POTATOES F.P.	O W. WHEAT F.P. 7"
C SUMMERTILL	C W. WHEAT E.F.P.	A SUMMERTILL	B CORN F.P.	A OATS DISCED	P W. WHEAT F.P. 10"
D W. WHEAT	D SUMMERTILL	B W. WHEAT 101	A CORN F.P. 112	B W. WHEAT DISCED 131	Q W. WHEAT DISCED
E CORN F.P.	E W. WHEAT	C OATS F.P.	B W. WHEAT IN CORN	C POTATOES DISCED	R W. WHEAT DISCED

F.P.—FALL PLOWING. S.P.—SPRING PLOWING. E.F.P.—EARLY FALL PLOWING. DISCED, IN PREPARING FOR SEEDING. P—PACK.

Altho we have at present six years' results on rotations, and have used in this bulletin some of the results, yet we believe that a longer period of time is necessary before we can draw dependable conclusions as to which are the best rotations. From what has been given it will be seen that certain methods give the best results one year under certain climatic conditions, while other methods give the best results the following year under different climatic conditions. If definite conclusions are finally reached they will be the results of averages.

CLIMATIC CONDITIONS.

The climate of western Nebraska is classified as semiarid or subhumid. It may be better to describe it as changeable, varying from year to year from almost humid to almost arid extremes, with a mean annual precipitation much below that of eastern Nebraska, as shown by Figure 5. With this lower annual precipitation we have a higher rate of evaporation, due to a lower relative humidity and a higher wind velocity than in the more humid sections. The higher rate of evaporation makes the loss of water from our soils more rapid than where the climate is more humid, and consequently we must guard more carefully the water which falls. We are not attempting to give any discussion of the climatic conditions but we give several tables, a study of which will acquaint the reader with the conditions under which the work reported in this bulletin has been done.

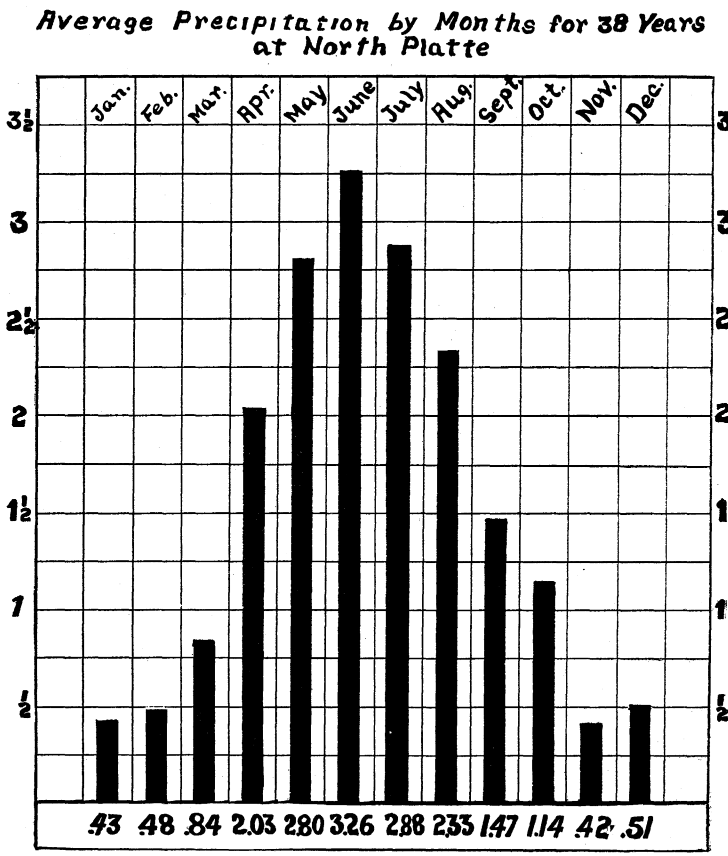

Fig. 4. Average precipitation by months.

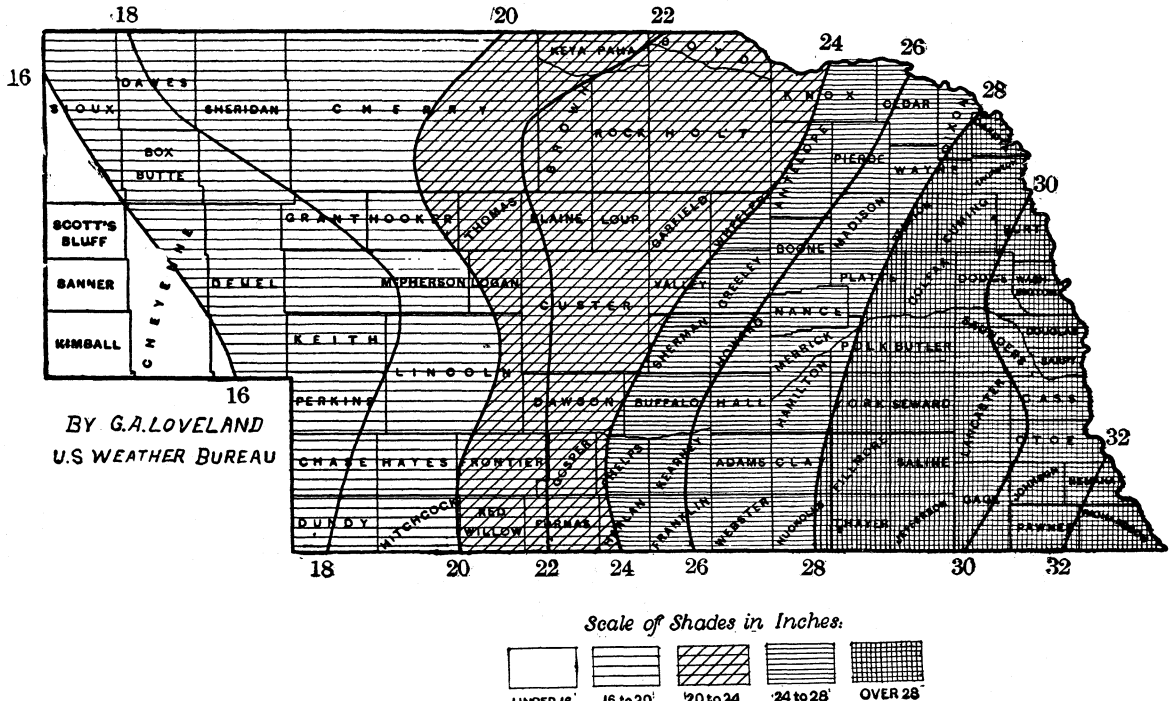

Fig. 5. Normal annual precipitation in Nebraska. Map showing rain belts. Figures on margin indicate average rainfall within the region, according to United States Weather Bureau. Region between "18" and "20" has received an average of from 18 to 20 inches of rainfall annually for period mentioned, according to the United States Weather Bureau record.

TABLE 27.—*Record of precipitation by months, for thirty-eight years, at North Platte, Nebraska, as reported by the United States Weather Bureau.*

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	Departure from normal
1875	.24	.26	.40	6.21	1.69	1.62	2.12	.66	1.40	.14	.52	.09	15.35	—3.28
1876	.09	.13	.49	.51	2.97	.49	1.16	2.46	1.47	1.07	.49	.51	11.84	—6.79
1877	1.38	.37	.19	.37	3.22	2.99	2.04	5.03	4.49	1.23	.30	3.86	25.47	+6.12
1878	.00	.18	1.40	1.15	3.24	5.85	3.58	1.52	.91	.13	.46	.20	18.62	— .01
1879	2.33	.43	.11	1.92	2.25	3.31	8.47	.16	.40	.21	.10	.37	20.06	+1.42
1880	.03	.03	.18	.16	2.28	3.12	2.87	3.96	1.53	2.72	.23	.37	17.48	—1.15
1881	.16	.76	1.26	.87	4.84	6.12	3.09	.75	2.36	2.22	.37	.13	22.93	+4.30
1882	.46	.13	.04	1.94	3.98	4.84	2.65	1.68	.28	1.23	.01	.71	17.95	— .68
1883	1.20	1.38	.47	3.02	4.07	7.49	1.34	4.51	1.08	3.47	.42	1.43	29.88	+11.25
1884	.10	.23	1.86	2.14	2.40	1.39	2.19	2.13	.08	.74	.04	.27	13.57	—5.06
1885	.12	.16	.37	1.59	3.31	3.79	3.12	4.87	.86	1.18	1.71	.95	22.03	+3.40
1886	.09	.17	.63	2.09	3.67	1.14	.68	1.99	1.22	.59	.43	.40	13.10	—5.53
1887	.15	.49	.22	3.41	.81	3.20	3.05	4.61	5.10	.15	.19	.30	21.68	+3.05
1888	.09	.42	1.44	2.36	4.93	2.76	2.61	.65	.58	1.12	.08	.42	17.46	—1.17
1889	.97	.07	.62	2.65	2.71	1.95	6.01	2.06	2.57	.31	.20	.54	20.66	+1.97
1890	.35	.38	.27	4.46	.90	2.06	.39	2.42	.19	.84	.42	.03	12.71	—5.92
1891	.65	.49	2.19	2.58	1.69	7.19	3.91	2.45	.87	.57	.08	.69	23.36	+4.73
1892	1.04	.97	.61	4.30	3.70	.60	3.59	3.01	.56	1.49	.08	.42	20.37	+1.74
1893	.03	.62	1.29	.15	1.35	4.11	1.13	3.62	.32	.05	.11	.40	13.16	—5.47
1894	.33	.29	1.72	1.64	.39	3.54	2.39	.17	.14	.59	.01	T.*	11.21	—7.42
1895	.14	.84	.09	1.93	2.38	4.35	1.08	2.13	.48	.09	.96	.11	14.58	—4.05
1896	.27	.06	.87	3.44	1.47	2.76	1.86	2.07	1.84	1.51	.16	.21	16.52	—2.11
1897	.47	.46	.66	2.59	.11	1.72	1.85	3.05	.59	4.11	.85	.63	17.09	—1.54
1898	.77	.19	.64	1.42	4.12	2.54	1.29	1.40	2.56	.07	.51	.03	15.54	—3.09
1899	.11	.36	.83	.82	3.58	1.95	2.04	1.83	.28	.28	1.59	.32	13.99	—4.64
1900	.06	.78	.26	3.34	.90	1.42	3.37	1.37	.25	.39	.09	.06	12.29	—6.34
1901	.04	.44	1.53	2.53	1.83	3 69	.34	2.00	3.14	.41	.30	.19	16.44	—2.19
1902	.40	.35	1.42	.92	7.98	3.46	4.56	1.74	3.34	1.32	T.	.78	26.27	+7.64
1903	.27	1.29	.12	.95	3.74	3.99	2.93	3.58	.76	44	.28	.01	18.36	— .27
1904	.32	.06	.52	1.52	3.63	4.43	4.90	3.25	2.40	1.92	.03	.19	23.17	+4.54
1905	.90	.69	2.15	3.78	4.56	7.63	2.58	1.57	1.23	1.05	.67	T.	26.81	+8.18
1906	.61	.80	2.22	2.89	2.82	.68	3.14	5.56	4.25	3.05	1.01	.96	27.99	+9.36
1907	.39	.51	.10	.43	2.40	2.69	6.79	2.14	2.91	.14	.31	.80	19.61	+ .98
1908	.16	.78	.20	.64	3.95	5.07	3.17	1.57	.24	3.39	.59	.20	19.96	+1.33
1909	.29	1.61	.98	.72	2.32	5.46	5.21	1.24	.77	.20	2.24	1.37	22.41	+3.78
1910	.34	.02	.19	.48	2.59	2.75	.50	2.02	.97	.01	.11	.72	10.70	—7.93
1911	.28	.39	.20	2.48	1.73	1.13	3.31	2.11	1.37	3.66	.04	.65	17.43	— .20
1912	.74	.81	3.08	2.93	1.93	.57	4.01	1.27	2.04	1.12	.01	.18	18.69	+ .09
Average	.43	.48	.84	2.03	2.80	3.26	2.88	2.33	1.47	1.14	.42	.51	18.60	

*T. indicates "trace;" less than one one-hundredth of an inch.

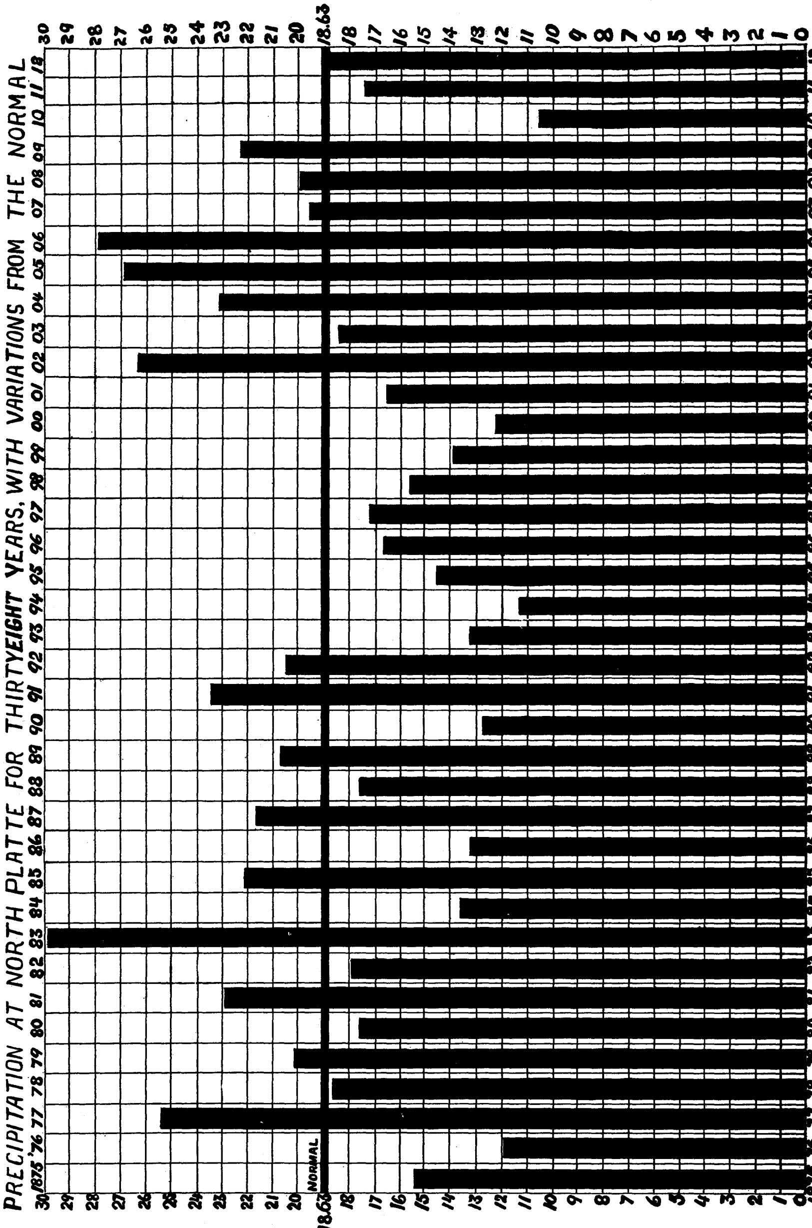

Fig. 6. Precipitation at North Platte, Nebr., by years, 1875-1912

TABLE 28.—*Daily precipitation from March 1 to June 30, 1908-1912.*

Day	March					April					May					June				
	1908	1909	1910	1911	1912	1908	1909	1910	1911	1912	1908	1909	1910	1911	1912	1908	1909	1910	1911	1912
1					.18				T.				.48			.09	.46	T.	.01	
2					.53								.17	.11		T.	.13	.07		
3							T.		.10		.12			.10	.17	T.		.42		
4	T.*							T.	.18		1.16		.02	.01	.55			T.		
5	.10	T.					.11				.19		.35		.08		.16	.03		
6	.04			.01			.23		.01				.01	.05		.25	T.			.07
7	T.	.13		T.		T.										.03	.44	.04		
8					.01											.02	T.	.18	.02	.13
9			.18								.09					.48	2.12		.01	.10
10		T.			.05						T.		.05	.08	83		.91	.02		
11		.15			.18				T.			.02	.01			1.24	.23			.15
12	T.	T.					T.				.18					.01				.09
13					.40			.10	T.		.58	.01					T.		.01	.01
14					18		.02	.07		.01	.86	.01	.01			.13	.04			
15		T.				.08	T.	.27				.13	T.			.41				
16							.22	.02				T.	T.			.08		.16	.63	
17		T.	T.			T.										.44		T.		
18						.43						.03								
19	.06	.T			.35	T.						.09	T.		.11					
20		.02			1.14		.12			1.00		.45		.02			T.			
21		T								.11			.05	.62			.21			
22											T.			.15		1.80				
23		.29			.03	.02	T.				.02	1.11				.07	T.	T.	.08	
24		.38				.11			.05		.59	.02			.02		T.	1.13		
25				01		T.			.98		.03	T.				T.	.12		.32	
26		T.	T.	.18		T.	.02					.13	1.44	.07			.12			
27		T.			.01					1.61	.07					T.	T.			
28		T.				T.	.02			.05	.03		T.	.47		.02			.05	
29		.01	T.				T.		.86			T.		.05			.52			
30			.01				T.	.02	.30	.15		.04						.70		.02
31		T.			.02						.03	.28			.11					
Total	.20	98	.19	.20	3.08	.64	.72	.48	2.48	2.93	3.95	2.32	2.59	1.73	1.93	5.07	5.46	2.75	1.13	.57

*T. indicates "trace;" less than one one-hundredth of an inch.

TABLE 29.—*Daily precipitation from July 1 to October 31, 1908-1912.*

Day	July					August					September					October				
	1908	1909	1910	1911	1912	1908	1909	1910	1911	1912	1908	1909	1910	1911	1912	1908	1909	1910	1911	1912
1	.41			.16	.13		.39	T.	.02	.01		.30	T.						.22	
2	.01			.08	.02		.08	T.	.11	.66			T.					T.	.02	
3				.02	.36								.08	.38					.02	
4			T.		.21			.28	.68			.40	.07						.01	
5	.22	.11	.41	.18		.01		.41				.02							2.61	
6	.66					.34		.04	.84											
7		T.*		.10			T.	.19		.14		.01		.09		.05	T.			
8		T.		.50			.02	T.									.19			.32
9		2.35				.21								.61	.27					
10		.77				T.	.08		.01						.18					.11
11	.01	.14	.04			.01	.58		.34						.57		.01			.28
12	.68			.42		02		.57					.08		.23					
13	T.					.22		.01	.01			.01			.52					
14	.02			.03		.02	.06				T.	.03	.07	.01	.14					
15	T.	.28		.16		T.				.45				.04	.01				.61	
16	T.	.19				T.		.25	.13	.01									.13	
17				.22			T.	.16	.05									T.		
18	.06				1.07	.34							T.	.04		.10		.01		
19	.14		.03	T.			.03								.03	3.24	T.			
20					.39							T.		.07	.04		T			
21		T.	T.									T.	.04							
22	.79			.80		.03					T.		T.							
23	T.		T.			.09							.42							
24	.03	.07				T.	T.	.06						.06						
25		.01			.07	.01					.24		.21			T.				.01
26	T.			T.	1.10	.05					T.								.04	.08
27	.14	T.	T.			T.									.05					
28			T.																	
29		1.18	.02	.64				.05						.02						
30		.10	T.		.62	.22								.05						
31		.01			.04			T.												.32
Total	3.17	5.21	.50	3.33	4.01	1.57	1.24	.24	2.19	1.27	.24	.77	.97	1.37	2.04	3.39	.20	.01	3.66	1.12

*T. indicates "trace;" less than one one-hundredth of an inch.

TABLE 30.—*Rate of evaporation from a free water surface for the months of April to September.**

Month	Rate of evaporation						
	1908	1909	1910	1911	1912	Average monthly evaporation	Average daily evaporation
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
April	6.087	4.620	7.689	5.699	2.738†	6.024‡	.196
May	6.951	7.352	5.976	7.213	8.218	7.142	.230
June	6.803	6.123	9.901	12.485	7.554	8.573	.286
July	7.471	7.853	9.747	9.858	8.863	8.758	.282
August	7.703	8.339	7.603	8.093	7.557	7.859	.262
September	8.308	6.128	5.848	6.354	5.261	6.380	.212
Total evaporation for the 6 months by years	43.323	40.415	46.764	49.702	40.191		

* In cooperation with Office of Physical Investigation, Bureau of Plant Industry, Washington, D. C.

† Records not made until April 14.

‡ Average of only 4 years.

SUMMARY.

Under this head we are bringing together several rather tentative conclusions, which our work in crop growing indicates. We do not offer all these as definite and will look to subsequent work to confirm or contradict them.

1. Summer tilled land has produced on an average 10 bushels more than twice that produced on land not summer tilled when sown to winter wheat.

2. Turkey Red and Kharkov have given the highest yields and for this locality we consider them practically the same.

3. Whenever there is a shortage of moisture thin seeding of winter wheat on summer tilled land has given the best results.

4. Seeding winter wheat by September 15 except in dry years has given best average results in this locality.

5. Early seeding of spring small grains has given the best average yields.

6. Spring grains have given a heavier yield on summer tilled land than on land not summer tilled, but only in the case of barley has it been at all profitable to summer till for spring grains.

7. Seeding oats, barley and emmer at six pecks per acre has given the best average results.

8. In all spring small grains the earlier varieties have given the best average results.

9. Common six-row barley has proven the best of all varieties so far tested.

10. Winter emmer has not proven hardy in this locality.

11. Drilling small grain has in practically all cases given an increased yield over broadcasting.

12. Durum wheat and barley have produced more feed per acre than other spring small grains.

13. Listing corn has proven much more profitable than surface planting.

14. Ordinary cane (sorghum) has proven the best annual forage crop.

15. Brome grass has not proven profitable either as a pasture grass or as a hay crop.

16. Alfalfa is the most valuable forage crop that can be grown in the valleys. On the table-land it is of questionable value when sown broadcast except during years of abundant rainfall or when sown on some place which receives run-off water from adjacent land.