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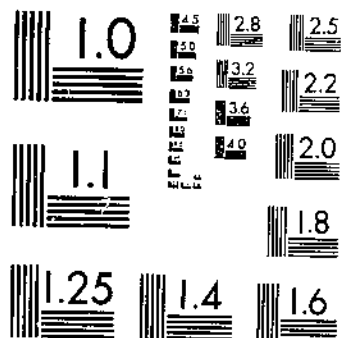
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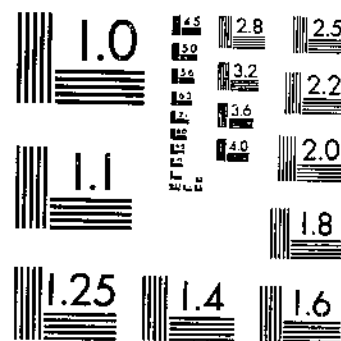
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TB 636 (1958) USDA TECHNICAL BULLETINS
CORRELATIONS BETWEEN ANNUAL PRECIPITATION AND THE YIELD OF SPRING WHEAT
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MICROCOPY RESOLUTION TEST CHART
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UNITED STATES DEPARTMENT OF AGRICULTURE
WASHINGTON, D. C.

CORRELATIONS BETWEEN ANNUAL PRECIPITATION AND THE YIELD OF SPRING WHEAT IN THE GREAT PLAINS¹

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United States Department of Agriculture, Bureau of Plant Industry, in cooperation with the Agricultural Experiment Stations of Montana, North Dakota, Wyoming, Nebraska, Colorado, and Kansas

CONTENTS

	Page		Page
Introduction.....	1	Relation of annual precipitation to the yield of spring wheat continuously cropped.....	24
Precipitation.....	1	Relation of annual precipitation to the yield of spring wheat on fallowed land.....	26
Yields.....	4	Summary and conclusions.....	28
Relation of annual precipitation to the average yield of spring wheat.....	5	Appendix.....	31
Results at individual stations.....	7		
Results at all stations.....	16		

INTRODUCTION

Continuous data obtained since 1906 by the Division of Dry Land Agriculture, Bureau of Plant Industry, in its investigations of crop rotation and cultivation methods in the Great Plains provide material to study some of the relations between climatic factors and crop yields in that region. The material is especially valuable for such a study, because the records are comparatively long and were made by technically trained men under uniformity of conditions, as to varieties and cultural methods on typical soils throughout the region, and climatic observations were made in close proximity to the fields on which the crops were grown.

The present bulletin is limited to a study of the relations between annual precipitation and the yields of spring wheat. The study is by no means exhaustive. A primary purpose of the publication is to make the data available to other workers who are interested in the subject. Detailed data of precipitation and yields are on file in the Division, at the field stations at which they were obtained, and for the several States at the cooperating agricultural experiment stations.

The locations of the field stations from which data used in this bulletin were obtained are shown in figure 1.

PRECIPITATION

Precipitation was measured with standard United States Weather Bureau equipment at each field station or substation. At North Platte, Nebr., the precipitation measured by the Weather Bureau in the city of North Platte, about 3 miles from the experimental plots, is used for the 6-month period October to March.

¹ Submitted for publication January 18, 1938.

Annual precipitation, as usually published, is computed for the calendar year ended December 31. For any given year this includes the precipitation for several months after wheat is harvested. Preliminary studies showed closer relations between precipitation and

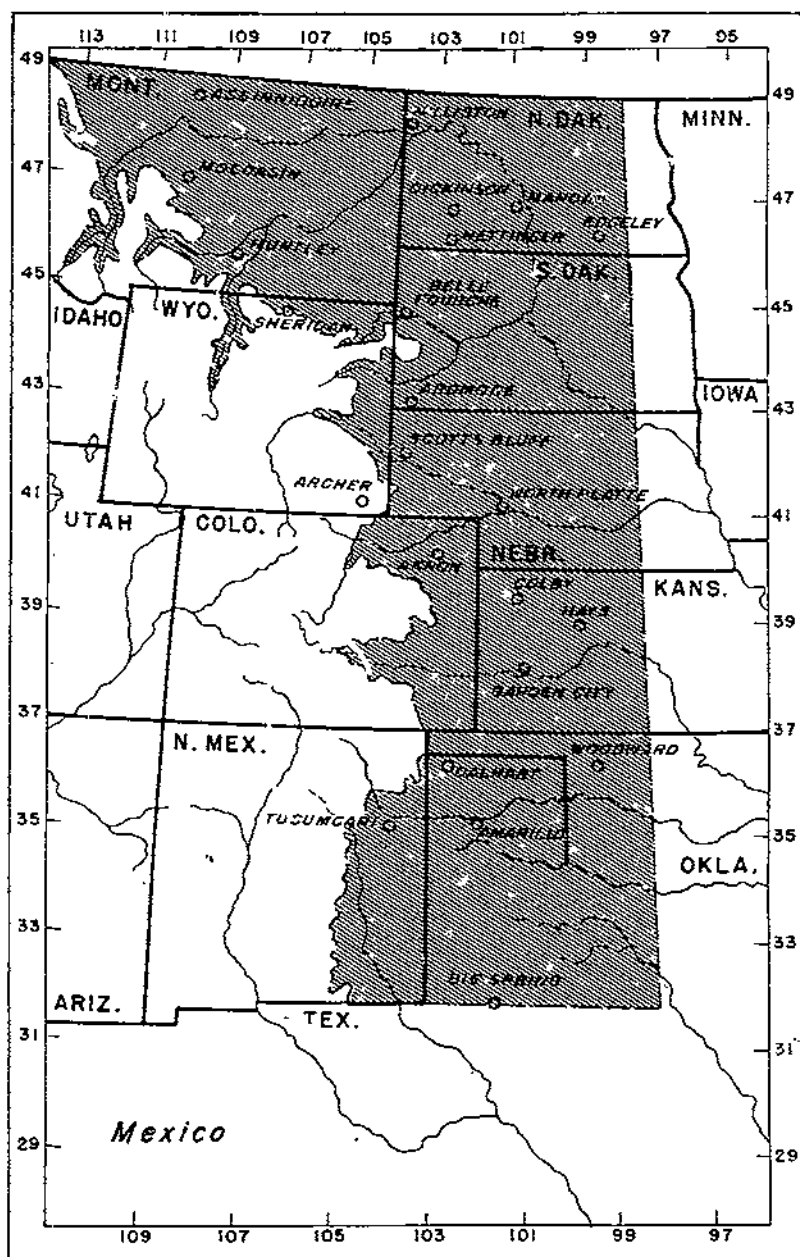


FIGURE 1.—Sketch map of the Great Plains showing the location of field stations at which the Division of Dry Land Agriculture has conducted experiments.

TABLE 1.—Precipitation for the year ended July 31 at field stations in the Great Plains during the period 1906-35

Station	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	Average
Assinniboine.....	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
Williston.....	---	---	---	14.7	10.0	10.0	20.3	13.8	21.0	13.1	18.4	12.5	11.5	16.3	14.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Moccasin.....	---	---	---	22.2	18.1	17.0	---	15.3	10.8	17.0	18.8	17.9	18.1	10.3	10.7	14.3	15.4	18.3	13.5	13.2	12.5	17.3	14.3	10.1	12.7	12.0	15.1	14.9	12.6	10.1	14.08
Hunter.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Dickinson.....	---	15.2	10.3	10.0	10.1	10.7	---	13.2	14.2	14.3	17.1	12.5	15.1	14.1	8.3	20.5	11.0	18.0	14.2	18.2	12.5	10.7	18.3	10.6	12.0	11.4	8.1	14.0	11.5	10.9	12.9
Mandan (main field).....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Mandan (south field).....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Edgeley.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Hettinger.....	18.6	12.8	16.1	16.8	11.2	14.8	24.0	15.0	---	13.9	---	13.7	11.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Sheridan.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Belle Fourche.....	---	---	---	13.5	17.0	12.5	6.0	13.0	14.5	13.1	21.1	13.1	13.7	14.4	15.0	28.1	13.3	20.0	17.0	20.8	15.5	16.8	23.4	10.3	19.3	15.5	10.6	17.4	19.4	12.8	14.1
Ardmore.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Scotts Bluff.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Aroher.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Average.....	18.0	14.0	15.3	18.7	14.2	11.8	17.4	14.0	17.8	19.5	16.3	13.4	13.6	12.5	16.2	13.3	16.0	16.2	16.2	14.9	12.8	19.3	16.0	13.5	13.1	13.3	16.1	13.7	10.7	13.0	14.91
North Platte.....	---	25.9	21.6	23.3	12.2	13.7	---	17.0	16.3	33.3	17.1	10.5	17.7	24.0	21.0	15.0	20.3	24.5	17.2	16.4	13.0	19.2	24.9	13.9	24.4	18.6	17.7	14.7	11.6	27.3	19.41
Akron.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Colby.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Hays.....	---	---	22.8	---	20.9	14.0	21.0	21.3	19.7	30.5	16.4	12.1	20.1	23.4	22.4	23.9	18.6	22.0	17.8	16.4	13.1	17.0	20.3	14.0	20.7	---	15.6	12.2	12.1	10.1	17.77
Amarillo.....	21.5	---	23.6	16.7	16.1	23.0	16.9	12.4	19.0	22.7	18.2	16.2	10.5	21.2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Average.....	21.5	25.9	22.7	20.5	16.6	16.8	20.1	16.6	18.5	27.0	17.1	14.9	18.5	23.5	21.4	20.2	19.3	21.1	17.5	16.9	15.0	20.2	24.0	15.7	22.1	20.2	19.2	15.1	13.0	18.7	19.01
Grand average.....	20.1	18.0	19.0	19.0	15.3	14.0	18.5	14.8	18.0	21.7	16.0	13.8	14.9	15.0	17.4	14.9	16.9	17.3	16.6	15.4	13.4	19.5	18.7	14.1	15.2	14.8	17.0	14.1	11.6	15.4	15.90

yield when the precipitation was calculated for a year ending nearer harvesttime. After assembling data on the dates of harvest of spring wheat, it was decided to calculate and use the precipitation for the year ended July 31. For some purposes it would have been more satisfactory to use the precipitation from the actual date of one harvest to the next, but this would introduce data not so generally available or readily determined. It seemed best in the present study to sacrifice, in the interest of uniformity, whatever may have been gained by a greater refinement.

Table 1 gives the annual precipitation for each station and year for which yields of spring wheat are given in subsequent tables. The reasons for a few blanks in otherwise continuous series will be given later.

YIELDS

Studies have been made with three indexes of yield: (1) The average yield of all plots; (2) the yield of continuously cropped plots; and (3) the yield on fallowed land. All yields are from $\frac{1}{2}$ -acre plots in the crop rotation and cultivation experimental fields at the several stations.

The index of average yield at each station is an average of about 30 plots. Some being on summer-fallowed land, some on green-manured land, some following a cultivated crop, some following small grains in rotations, and some continuously cropped to wheat, they represent high-, medium-, and low-producing methods. The representation of the different methods in the total may be illustrated by two typical cases. At the Moccasin station there are 4 plots on fallowed land, 2 on green-manured land, 14 following corn, 4 following oats, and 5 continuously cropped to wheat, total 29. At the Belle Fourche station there are 5 plots on fallowed land, 4 on green-manured land, 12 following corn, 1 following sorgho, 1 following potatoes, 3 following oats, and 4 continuously cropped to wheat, total 30.

The yields here used differ in some instances from averages from the same source that have been published before, because the material has been more closely selected to give greater uniformity between stations and during the entire period of years at each station. Examples of such changes are to be found in the main field at Mandan, where new averages for that field afford exact comparison between it and the south field so far as methods entering into them are concerned. The comparability between stations of the indexes of average yields is little affected by the distribution of methods entering into the averages.

The average yields are higher and have a greater range than statistical averages of the counties or sections in which they were produced. In some checks that it has been possible to make, the yields have been found to agree very closely with those of the best farmers in the section they represent. The yields at Assiniboine for the 6 years 1916-21 can be compared with published yields of farmers in the section. Under the heading, "The Story of Successful Farmers," Wilson² gave the yields of 12 farmers for these years. The annual averages of these yields of wheat and the averages on the Assiniboine station are shown in table 2. There is a general agreement in the class of yields—low, medium, or high—on the farms with those on the station. The farm average did not equal the exceedingly high

² WILSON, M. L. DRY FARMING IN THE NORTH CENTRAL MONTANA "TRIANGLE." Mont. Agr. Col. Ext. Bull. 66, 132 pp., illus. 1923.

yield of the station in 1916, but in the average of the other 5 years the farms exceeded the station.

TABLE 2.—Average annual yields of wheat on 12 farms in north central Montana and on the Assiniboine station, 1916-21

Location	1916	1917	1918	1919	1920	1921	Average
	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels	Bushels
Farm	35.1	11.8	9.6	1.6	9.6	12.5	13.4
Station	49.1	6.4	8.3	3.2	10.8	10.1	14.7

The spring wheat at all stations was durum, except that a change was made to Marquis, a bread wheat, at Dickinson in 1927 and Assiniboine and Moccasin in 1929 and to Ceres, a bread wheat, at North Platte in 1929. The variety of durum used at each station was one shown by varietal tests to be adapted to that area. Kubanka predominated, but there was some Arnautka, Peliss, Beloturka, Nodak, Monad, and Acme. Changes were made to some of the latter varieties to obtain greater rust resistance. So far as variety is concerned, practical uniformity in the yield indexes can be assumed.

In the tables of precipitation and yields there are a few blanks in data otherwise continuous over a series of years. These omissions indicate that the crop was destroyed or heavily damaged by hail or rust. Results for such years are properly included in calculating averages to be used for evaluating a section or determining the value of a crop for any section, but in a study of relations between a climatic factor and crop production it seems fair to exclude data for years in which there was no measure of the effect of the factor in question. This treatment, however, obscures an important point in the case of the Edgeley station where 3 years were excluded because of excessive damage by black stem rust. The greater frequency of such epidemics at this station is associated with higher precipitation and humidity, and the exclusion of such years masks the tendency to a lowered correlation between precipitation and yield with increased precipitation.

The second index of yield with which studies were made is the average of plots continuously cropped to spring wheat. These plots entered into the average yields previously described. The yields of continuously cropped plots are indexes of production by methods that provide, in comparison with other methods, a minimum of stored water in the soil at seeding time and produce minimum yields.

The third index of yield is the yield on fallowed land. This is the mean of five plots more or less that entered into the average yield index. It represents a method that generally provides, in comparison with other methods, a maximum of water in storage in the soil at seeding time and which usually produces higher yields than other cultural methods.

RELATION OF ANNUAL PRECIPITATION TO THE AVERAGE YIELD OF SPRING WHEAT

The average yield of spring wheat at each of 19 stations during the period 1906-35 is given in table 3. At other stations operated in the southern Plains by the Division of Dry Land Agriculture, spring wheat is so poorly adapted that it either has not been grown at all or records are not long enough or continuous enough to warrant their inclusion in this study.

In the tables and charts the arrangement of stations is from north to south and, in cases of little difference in that respect, from west to east, which is from higher to lower altitude.

RESULTS AT INDIVIDUAL STATIONS

Figures 2 to 6 are dot charts or scatter diagrams of the annual precipitations given in table 1 and the average yields of spring wheat given in table 3. The line showing the regression of yield on precipitation is superimposed on the chart for each station. If the correlation were perfect, 1.00, each dot would fall on the line. The vertical distance of each dot from the line measures the error in calculating the yield from the precipitation by means of the regression equation. Marked departures from the average relation invite investigation of their cause. The scatter diagram, correlation coefficient, and regression equation thus become powerful instruments in studying the relations of the two variables.

ASSINIBOINE

With a range of precipitation from 7.7 to 20.6 inches and a range of yields from 1.4 to 49.1 bushels in 19 years the correlation between precipitation and yield was 0.83. This is a highly significant correlation. The year 1934 was not included, because the yield was greatly reduced by severe hail. The year 1916 differs from the others in that all plots were on uniform preparation, the first crop after breaking prairie sod. It is included because of the range of both precipitation and yield that it introduces. The greatest departures from the standards set by the regression line are in the direction of yields higher than those indicated by the precipitation. In 1917 the yield was 6.4 bushels with a precipitation of 7.7 inches. Current notes attributed the production of even this small yield to the influence of water carried over in the soil from the heavy precipitation of the months (May, June, and July 1916) preceding the annual period.

A yield of 30.2 bushels in 1928 with a precipitation of 11.5 inches for the year ended July 31 was attributed to the unusually high June rainfall of 5.11 inches, which converted prospects of near or complete failure with continued drought into a truly remarkable crop.

In 1932 an average yield of 25 bushels was produced with a precipitation of 12.5 inches, a quantity sufficient, on the average, to produce only 14.5 bushels. The unusually good production was attributed largely to favorable quantities and distribution of rainfall in April and May, unusually heavy rainfall (4.50 inches) in June, and to freedom from diseases and insects.

WILLISTON

There are only 12 years' records at Williston, but they cover a well distributed range of yields from 1.8 to 37 bushels and annual precipitation from 10 to 21 inches. In 1914 a June rainfall of 7.98 inches, which was more than double the normal, brought the total for the year ended July 31 to 21 inches. Drought in July reduced the yield to 25.7 bushels, a quantity that on the average should have been produced by a precipitation of 18.7 inches. A precipitation of 16.3 inches produced a yield of only 4 bushels in 1919, when a drought started in June and continued until harvest July 29. The yields in 1909 and 1915 were markedly above the averages indicated by the precipitation. All plots in 1909 were on land broken from prairie

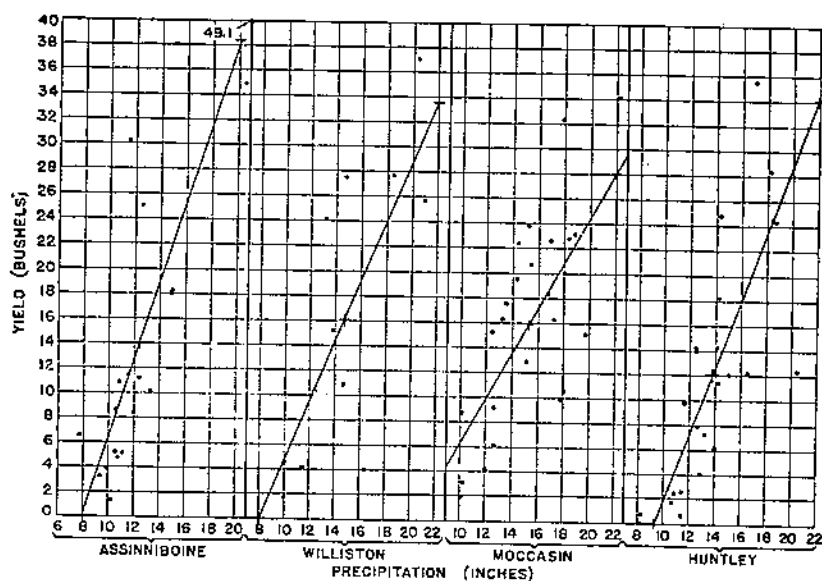


FIGURE 2.—Scatter diagram of precipitation for the year ended July 31, and the average yield of spring wheat at the Assiniboine, Williston, Moccasin, and Huntley field stations and the regression of yield on precipitation.

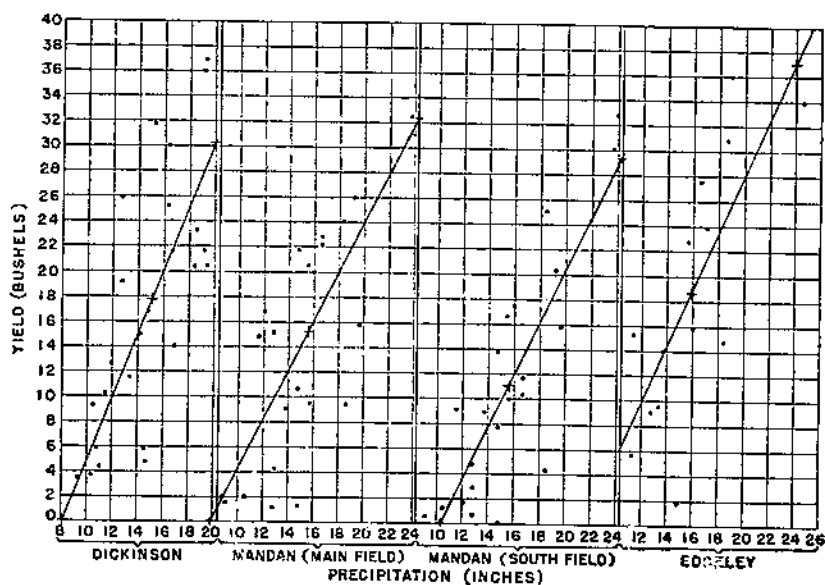


FIGURE 3.—Scatter diagram of precipitation for the year ended July 31 and the average yield of spring wheat at the Dickinson, Mandan (main field), Mandan (south field), and Edgeley stations and the regression of yield on precipitation.

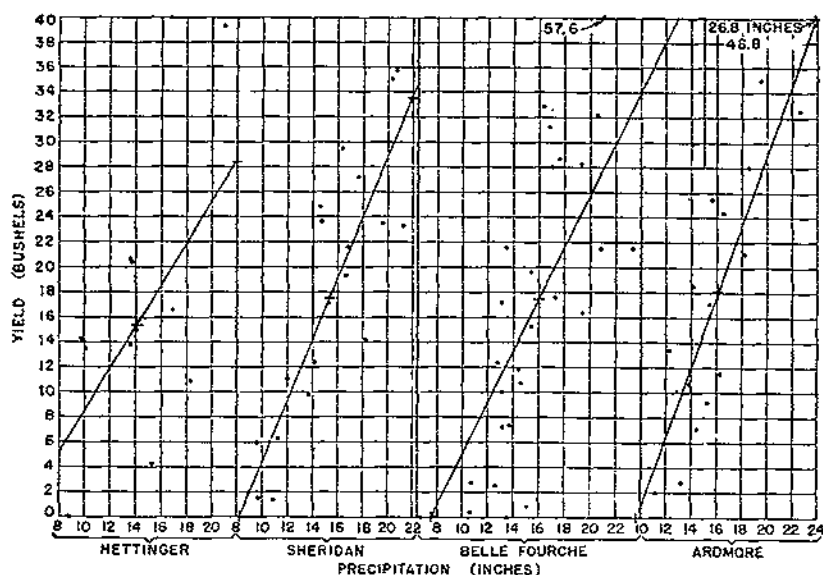


FIGURE 4.—Scatter diagram of precipitation for the year ended July 31 and the average yield of spring wheat at the Mettinger, Sheridan, Belle Fourche, and Ardmore field stations and the regression of yield on precipitation.

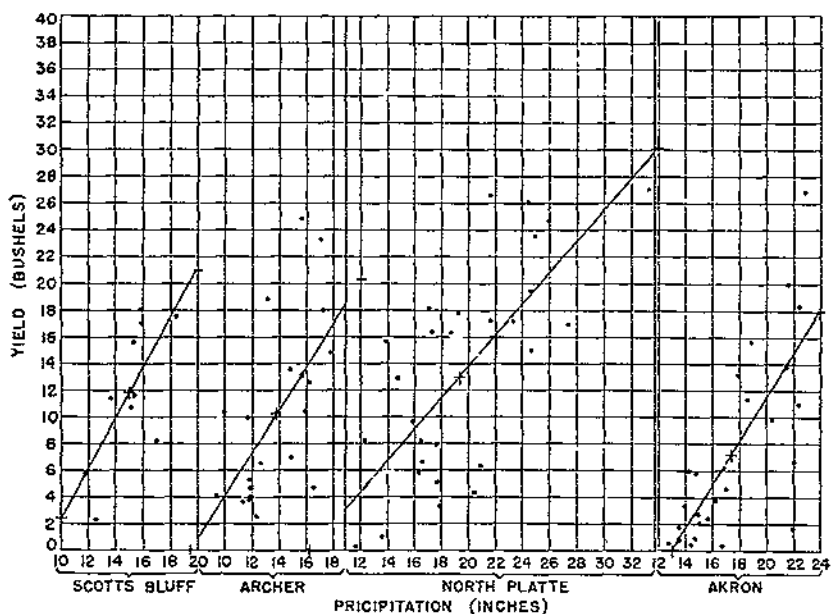


FIGURE 5.—Scatter diagram of precipitation for the year ended July 31 and the average yield of spring wheat at the Scotts Bluff, Archer, North Platte, and Akron field stations and the regression of yield on precipitation.

sod, June 12-17, 1908. This was, in effect, a fallow and operated to increase yields above the average of other years. The behavior in 1915 was general throughout the Plains and was associated with low temperatures and an absence of inhibiting factors.

MOCCASIN

The year 1912 is omitted from the Moccasin data because the crop was destroyed by hail. The coefficient of correlation between annual precipitation for the year ended July 31 and the yield is relatively low, 0.69, but is highly significant. Wheat harvest is later at Moccasin than at other stations, ranging from July 28 to September 13. The precipitation from harvest to harvest was determined, and the

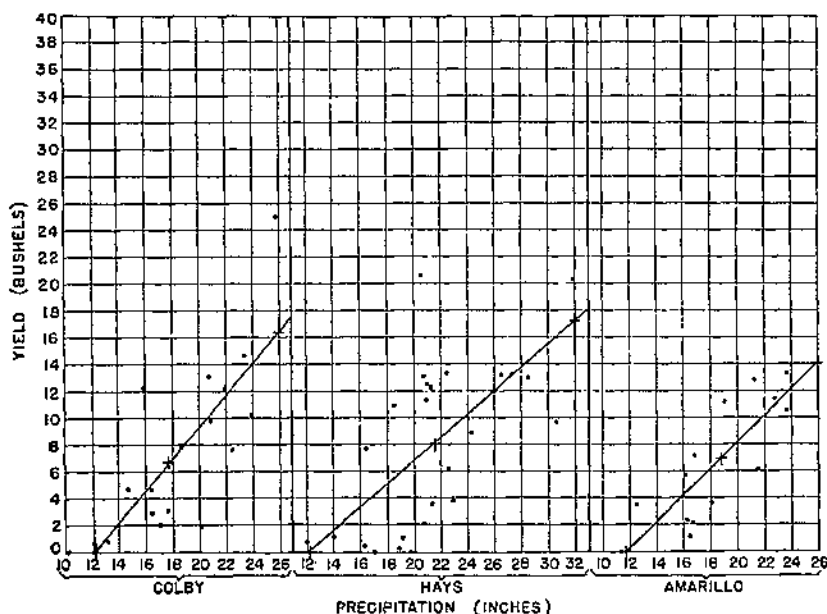


FIGURE 6.—Scatter diagram of precipitation for the year ended July 31 and the average yield of spring wheat at the Colby, Hays, and Amarillo field stations and the regression of yield on precipitation.

correlation of yield with it was calculated. This procedure, however, only raised the coefficient of correlation to 0.72.

The most conspicuous cases of yields below the indications of the precipitation were 1910, 1917, and 1920. In each of these years there was drought for a month or more preceding harvest. The greatest departure of a yield above the indications of the precipitation was in 1915, which has been considered in the discussion of results at Williston. In 1909, 1913, and 1928 yields were conspicuously higher than the precipitation indicated. In these years an unusual proportion of the precipitation came in June, May and June, or June and July. These plus and minus departures associated with high and low June rainfall suggest a high degree of control of the yield by that factor. It was found that the correlations between the precipitation for June; June and July; and May, June, and July and average yield were all higher than the correlation between the precipitation for the

year ended July 31 and the yield, the coefficients being 0.75, 0.80, and 0.80, respectively. These results are considered to be in part at least a manifestation of the effect of a shallow soil of limited water storage capacity in relation to the precipitation. This makes the crop highly dependent on the precipitation while it is growing. It is also significant that the precipitation in June averages approximately one-fifth of the total for the year, and that the correlation between June precipitation and of that for the year of which it is a part is 0.55.

HUNTLEY

The season of 1920 was very late at Huntley, and spring wheat was not harvested until August 16. The precipitation for the year ended July 31 was 20.5 inches, the highest during the 24 years under study. A month of hot, dry, windy weather preceding harvest reduced the yield to 12.4 bushels, a quantity that on the average should have been produced by 13.9 inches. The precipitations of 8.3 inches in 1919 and 8.1 inches in 1931 could have been somewhat greater without material increases in the yields. In 1919 the wheat in most plots did not head, and in 1931 the young plants on most plots died when they were only a few inches high.

DICKINSON

Two years, 1912 and 1914, are omitted from the Dickinson record because the crops were either destroyed or badly damaged by hail.

Yields markedly above the quantities indicated by the precipitation were recorded in 1907 and 1913. The crop in 1907 was the first on sod broken in 1906. The preparation which was uniform for all plots was in the nature of a fallow. Preparation for the crop of 1913 began soon after the destruction of the crops by hail on July 11, 1912. This was much earlier than usual and had much the effect of a fallow in storing or conserving water in the soil.

MANDAN

There are two fields at Mandan, one known as the main field and the other as the south field. In this bulletin, each field is given the status of a separate station. The soil of the main field is light and that of the south field is heavy. The main field is nearly level, but the south field is on a sharp slope and there is considerable run-off. This field also receives run-off from sod that lies above it.

The years of highest precipitation and highest yield in both fields were 1914 and 1915. The crop of 1914 was the first following the breaking of prairie sod in June 1913. All plots were uniform and of the nature of fallow, but the preparation had less effect in determining the yield than did a record-breaking precipitation of 14.25 inches in May and June 1914. Of the total precipitation of 24.0 inches in the crop year 1915, 17.78 inches came in May, June, and July 1915. The crop on both fields each year was fairly well in line with the average expectation from the total precipitation. The two lowest precipitations, 10.4 inches in 1926 and 9.0 inches in 1934, were below the quantities necessary to production with most methods except fallow. The greatest departures of yield below the averages indicated by the precipitation were in 1921 and 1931. In 1921 a drought in

June continued until after harvest, which was on July 20. In 1931 the precipitation in July was more than 4 inches, but the normal development of the crop had been prevented by a dry spring without a reserve of water in the soil.

EDGELEY

The years 1914, 1916, and 1919 were rejected from the Edgeley record because of heavy damage by rust. The heaviest precipitation, 24.6 inches in 1912, produced next to the highest yield, 33.9 bushels, but the evidence indicates that the precipitation could have been lower without reducing the yield. Current notes stated:

At no time during the season did the plants suffer on account of a lack of moisture, and several times during the summer more rainfall occurred than was necessary to keep them in good thrifty condition. Several heavy rains occurred, and in two instances more than 3.5 inches fell during a week.

The yield in 1915 was 10.6 bushels higher than the precipitation indicated. The characteristics of that year have been mentioned in preceding pages. Current notes attributed the low yield in 1911 to drought and hot winds in June.

HETTINGER

The year 1916 at Hettinger was rejected because a very promising crop of wheat was nearly destroyed by rust. This left only a 10 years' record, and with this small sample the correlation was comparatively low and by Fisher's z test not significant.³ The highest precipitation, 21.0 inches in 1915, was more than accounted for by a yield of 39.4 bushels. The lowest precipitation, 8.6 inches in the crop year 1921, resulted in total failure. In each of 3 years, 1912, 1914, and 1919, when the yield was not so high as the precipitation indicated, there was drought in the late growing or fruiting periods.

SHERIDAN

In each of the four years 1917, 1924, 1932, and 1933 when the yield was markedly lower than the average indicated by the precipitation there was extended drought before and continuing to harvest.

BELLE FOURCHE

Belle Fourche presents an unbroken record of 28 years. The precipitation of 6.6 inches in the crop year 1911 was too low to be within the range of crop production. Seed planted at the usual time had not germinated at harvesttime. The year 1915 was one of those unusual years when all conditions were so favorable and inhibitive factors so inoperative that a yield far beyond the usual range was harvested. By the regression equation established by the 28 years the precipitation would have accounted for a yield of 28.0 bushels, but a yield of 57.6 bushels was obtained.

The precipitation for the crop year 1920 was 28.1 inches. The precipitation in May was 8.35 inches and in June it was 5.90 inches. Current notes stated that loss of water by run-off was very great, and

³ FISHER, R. A. STATISTICAL METHODS FOR RESEARCH WORKERS. Ed. 6, rev. and enl., 336 pp., illus. Edinburgh and London, 1932.

When z is more than twice σ , (the standard deviation of z) the correlation is considered significant.

that some of the heaviest rains in May came when the soil was already nearly saturated and most of the water was lost. The precipitation on 4 successive days in May was 0.37, 4.00, 1.14, and 0.17 inches. A very heavy crop of straw used water at a high rate, and the crop suffered from drought before harvest, August 7.

The next highest precipitation was 23.4 inches in 1927. The precipitation in April and May was 10.88 inches. Much of it was received in such excessive amounts at a time that a great deal of run-off occurred.

From the record to date it appears that precipitation in excess of 21 inches at this station comes in such form that it is lost by run-off and is not reflected in the yield.

If the year 1911, when the precipitation was far too low to be used as an index of yield, is rejected, and precipitations in excess of 21 inches are scaled down to that quantity, the coefficient of correlation between precipitation and yield is increased from 0.67 to 0.75.

ARDMORE

The wheat crop at Ardmore was destroyed by hail in 1914 and 1922, and those years are eliminated from this study. With a range of precipitation from 11.2 to 26.8 inches and a range of yield from 2.0 to 46.8 bushels in 18 years' records, the yield followed the precipitation very closely, as shown by the highly significant correlation coefficient of 0.90. Both the precipitation and the yield were much higher in 1915 than in any other year. The relation between the two was normal, although there was heavy run-off and floods from torrential rains in April and June.

While the present records indicate that 21 inches is the maximum of effective precipitation at Belle Fourche, they indicate a higher limit, possibly 24 or more inches at Ardmore. This could easily be explained by the greater penetrability, depth, and water-holding capacity of the soil at Ardmore. The years of excessive precipitation are so infrequent, however, that the evidence on the point in question is very meager.

SCOTTS BLUFF

Only 10 years' records are available from Scotts Bluff. The crop in 1916 was little more than half that indicated by the precipitation of 17.0 inches. There were three hailstorms in June that damaged the crop. The wheat was young enough to stage considerable recovery, and the reduction in yield from this source is unknown. There is also a record that 1.50 inches of rain with hail fell in 15 minutes and was largely lost by run-off. The year is retained in this study because there was also damage by drought and soil blowing.

ARCHER

The yields of wheat were reduced to such an extent at Archer in 1920 by delay in seeding resulting from an administrative situation that the year is rejected in these studies. The highest precipitation for a crop year in the 21 years under study was 17.7 inches. In four of the years of heavier rainfall when the crop was markedly below the average indicated by the precipitation, there was hail damage in 1914, June drought in 1924, drought in June in 1931, and run-off and floods in May followed by drought before harvest in 1935. The close

grouping of one-third (seven) of the years within a range of precipitation from 11.3 to 12.6 inches and of yields from 2.6 to 6.6 bushels may be of interest.

NORTH PLATTE

The record at North Platte is complete for 29 years. The original plot field was destroyed in 1935 by the construction of an irrigation reservoir. The yields for that year were interpolated from the yields of other plots and fields. The estimated figure is a fair index of what the yields from the original plots would have been. There were five crop years with annual precipitation between 24 and 26 inches. Precipitations up to 24 to 26 inches seem to be effective at this station. In 1919, however, a precipitation of 24.6 inches did not produce a yield in line with the expectation from that quantity. The reason is not fully evident at the present time. The rainfall in June and July was 6.5 inches above the normal. It was currently noted that the production of other crops was relatively better than that of spring wheat.

The two precipitations above 26 inches appear to be above the limits of effective quantities. In 1935 the precipitation was 27.3 inches and the yield was only 17.0 bushels. Nearly half the precipitation, 13.25 inches, came in April and May, and hot, dry weather preceded harvest. The precipitation for the crop year 1915 was 33.3 inches. This produced slightly the highest yield in the records of the station. The precipitation in April, May, June, and July was 23.5 inches, more than double the normal quantity. There was much run-off. Harvest was unusually late, August 10. At that time cropped land was filled with water to its field-carrying capacity, which is a very unusual condition in the Great Plains. Normally the available water of the soil is exhausted at harvesttime.⁴

In 1912 and 1922 the yields were markedly below expectations from the precipitation. In both years there was heavy early precipitation followed by June drought.

The high yield in 1916 was the result of an unusual carry-over of water from 1915.

AKRON

Akron presents a record of 27 years for study. In this period there were 8 years with precipitation above 20 inches, but the maximum was only 23.0 inches. Perhaps the greatest interest attaches to the fact that there were 15 years when both the precipitation and the yield were below their respective averages, 17.5 inches and 7.2 bushels. In the one other year with precipitation below the average the yield was 9.2 bushels.

There were 3 years when the yield did not fully respond to high precipitation. In the crop year 1919 the total precipitation was 22.0 inches. A sizable portion of this quantity, 9.79 inches or almost twice the normal, came in August and September 1918. Precipitation in April, May, and June 1919 was below normal, and by the middle of June small grain was suffering from drought to the extent that some of it did not even head. This was a clear case where distribution of the precipitation overshadowed its quantity. The precipitation for the

⁴ COLE, JOHN S., MATHEWS, O. R., and CHILCOTT, E. C. USE OF WATER BY SPRING WHEAT ON THE GREAT PLAINS. U. S. Dept. Agr. Bull. 1004, 34 pp., illus. 1923.
MATHEWS, O. R., and CHILCOTT, E. C. STORAGE OF WATER IN SOIL AND ITS UTILIZATION BY SPRING WHEAT. U. S. Dept. Agr. Bull. 1189, 28 pp., illus. 1923.

crop year 1927 was 22.3 inches. This quantity should have produced a crop of 15 bushels, but the yield was only 11 bushels. The precipitation in August 1926 was 5.07 inches, which was 2.79 inches more than normal. Current notes attributed the low yield to the effects of drought in May. If the excess rain of the preceding August be deducted from the total, the sum remaining is in line with the production. It is a matter of observation in the field and of determination by soil-moisture studies that a heavy August rainfall on small-grain stubble at Akron is likely to be largely dissipated by weeds and by direct evaporation from the soil.⁵ In the crop year 1930 a precipitation of 21.9 inches produced a wheat crop of only 1.7 bushels. The precipitation in August, September, and October 1929 was 3.4 inches above normal. Precipitation double the normal in May was followed by drought in June which the spring-sown wheat was unable to withstand.

COLBY

The year 1931 at Colby is rejected for spring wheat, because that crop was destroyed by heavy freezes in April and frosts in May. The yields for 20 years are on a low average plane but cover a range from 0 to 25 bushels and show response to precipitations ranging from about 12 to 26 inches. A precipitation of 10.1 inches in the crop year 1935 was too low to approach possibilities of production. A yield heavier than indicated by the precipitation in 1932 may be attributed to adequate rainfall and other favorable conditions in June that resulted in good filling and normal ripening of a rather unpromising crop. Particular interest attaches to the five near or complete failures when the precipitation was less than 14 inches.

HAYS

The spring wheat crop at Hays was destroyed by green bugs (aphids) in 1907 and by hail in 1909 and 1923. These years are rejected, leaving a total of 26 years for study. The precipitation is of a higher order than at any of the other stations having continuous records for spring wheat.

Quantities up to 26 or 27 inches appear to be effective in influencing the yield of spring wheat. In four years with precipitation from 26.0 to 28.5 inches the yields were confined to a range from 12.1 to 13.3 bushels. In 1915 the precipitation was 30.5 inches, but the yield was only 9.7 bushels. The April-July rainfall totaled 21.0 inches. There was some loss from run-off, but the effective precipitation was too heavy for the best results. Early promise of a heavy crop was reduced by the damaging effects of too much rain, and the quality of the crop was damaged by wet weather which interfered with harvesting and threshing.

The highest precipitation, 31.9 inches in the crop year 1928, produced a yield of 20.3 bushels. The only other yield as high as this, 20.6 bushels in 1922, was produced with a precipitation of 21.5 inches. In line with average behavior a precipitation of about 36 inches would be required to produce these yields. In 1928 nearly half the total came in June and July. The distribution of the precipitation and other conditions, such as low temperatures, freedom from disease, and lack of

⁵ GRACE, O. J. THE EFFECT OF DIFFERENT TIMES OF PLOWING SMALL-GRAIN STUBBLE IN EASTERN COLORADO. U. S. Dept. Agr. Bull. 253, 15 pp., illus. 1915.

weed growth, were very favorable to production. In five years with precipitation less than 18 inches there were four complete or near failures and one crop of 7.7 bushels.

Spring wheat is not adapted to conditions at Hays, and the yields of that crop should not be used as an index of the agricultural value of the section it represents.

AMARILLO

The year 1907 was rejected at Amarillo, because the crop was nearly destroyed by hail. In the 13 other years for which records are available there was only 1 with precipitation below 16 inches. With a precipitation of 12.4 inches in 1913, the yield of spring wheat was 3.5 bushels. In the other 12 years the precipitation ranged from about 16 to 24 inches. The coefficient of correlation for 13 years was 0.77.

RESULTS AT ALL STATIONS

The years when distribution of the precipitation exercises a major control of yield as compared with the control exercised by the quantity of precipitation are relatively few. Illustrative cases of wide departure from control by quantity of precipitation have been considered by individual stations, and some generalizations of such departures may be made. Yields markedly below the quantity indicated by the annual precipitation sometimes result from abnormally heavy precipitation in the late summer or early autumn—August and September—of the year preceding harvest. A more frequent cause is prolonged drought preceding harvest and following an excess of rain during earlier months and a consequent heavy vegetative growth. Run-off during the period of heavy rains sometimes is a factor in reducing the effectiveness of the total precipitation. It may be inferred from the discussion of results at individual stations that excessively heavy precipitation in a single month or succession of months may be subject to discount in considering its effect. Yields markedly above the statistical indications of the total quantity of precipitation may be associated either with a carry-over of water from the previous year, generally indicated by an excess precipitation during that year, or by an adequate precipitation during the fruiting and filling period preceding harvest, following a deficiency before that time.

The monthly precipitation at each station is given in the appendix to this bulletin.

Table 4 gives for each station the number of years studied; the average precipitation and its standard deviation (σ) for those years; the average yield and its standard deviation (σ); the coefficient of correlation of precipitation with yield and Fisher's z test of its significance;⁶ and the regression of yield, the dependent variable, on precipitation, the independent variable. As shown in table 4, the number of years studied at each station ranges from 10 to 29, the total at 19 stations being 387. The coefficient of correlation was from 0.60 to 0.69 at five stations, from 0.70 to 0.79 at eight, from 0.80 to 0.89 at five, and at one it was 0.90.

⁶ Fisher, R. A. See footnote 3.

TABLE 4.—Mean precipitation, mean average yield of spring wheat, correlation of the two variables, and the regression of yield on precipitation at 19 stations in the Great Plains for the number of years specified at each during the period 1906-35

Station	Years	Precipitation		Yield		Coefficient of correlation			Regression of yield on precipitation	
		Mean	σ	Mean	σ				Origin	Slope
Northern:	Number	Inches		Bush- els		r	z	σ_z		
Assiniboine.....	19	12.35	3.30	13.99	12.02	0.83	1.19	0.250	7.94	3.17
Williston.....	12	14.68	3.70	16.08	11.84	.75	.97	.333	7.98	2.40
Moccasin.....	26	15.32	3.17	16.00	8.32	.69	.85	.209	6.48	1.81
Suntley.....	24	13.80	3.17	12.08	10.31	.83	1.19	.218	9.33	2.70
Dickinson.....	27	15.06	3.04	17.74	10.07	.77	1.02	.264	8.11	2.55
Mandan (main field).....	22	15.60	3.86	15.32	9.96	.77	1.04	.229	7.90	1.99
Mandan (south field).....	22	15.60	3.86	11.23	9.53	.85	1.26	.229	10.25	2.10
Edgeley.....	14	15.94	3.57	18.67	10.68	.76	1.00	.301	7.72	2.27
Hettinger.....	10	14.08	3.92	15.39	10.03	.61	.71	.378	4.78	1.65
Sheridan.....	19	15.35	3.69	17.48	10.84	.83	1.19	.250	8.18	2.44
Belle Fourche.....	28	16.06	4.25	17.54	13.18	.67	.81	.200	7.62	2.08
Ardmore.....	18	16.12	3.87	18.24	11.97	.90	1.47	.258	9.57	2.78
Scotts Bluff.....	10	15.03	1.99	11.83	5.33	.70	.87	.378	8.70	1.88
Archer.....	21	13.77	2.53	10.31	6.66	.61	.71	.235	7.35	1.61
Total or average.....	272	14.91	3.42	15.14	10.14	.76			7.99	2.23
Central and southern:										
North Platte.....	29	19.41	5.06	13.09	8.25	.73	.93	.196	8.34	1.19
Akron.....	27	17.45	3.33	7.23	7.06	.76	1.00	.204	12.98	1.61
Colby.....	20	17.77	4.53	6.70	6.53	.81	1.13	.242	12.04	1.17
Hays.....	26	21.59	4.90	8.13	6.32	.66	.79	.209	12.23	.87
Amarillo.....	13	18.82	3.47	6.99	4.39	.77	1.04	.316	11.64	.97
Total or average.....	115	19.01	4.24	8.43	6.51	.75			11.44	1.10

When the regression lines are drawn on a single chart (fig. 7), a grouping is noted, or perhaps of greater importance, there is noted a marked similarity of a certain group. In origin and slope of the regression line, the stations from the northernmost south to Archer are in a group distinct from the others. In this group the quantity of precipitation required on the average to initiate production is lower with one exception and the average quantity required per unit increment of yield is lower with one exception than they are at the other stations.

This group was designated as the northern group of stations, or the stations within it as northern stations. In their average yields of spring wheat and in the efficiency of use of precipitation in its production they exhibit an adaptation of that crop that is not shared by the stations outside the group.

North Platte is in some respects a border-line station. Its average yield of spring wheat (table 4) clearly would place it in the northern group, but these yields are produced with so much greater precipitation and consequent lower efficiency of water use as to place it equally clearly outside that group. The lack of agreement in the latter item and the relative unimportance of spring-sown wheat in the agricultural economy of the section represented by the station have been the determining considerations in excluding it from the northern group.

There is less question about the position of Archer. The average yield is low, but the economy of water use is in line with the northern stations. It is singled out for mention here to point out that while

it is the southernmost of the stations grouped as northern, it is at a much higher elevation above sea level—about 6,000 feet—than any of the other stations.

Among the stations designated as northern, Assiniboine is distinct from the others in its equal production at a lower precipitation level. Geographically its distance north of Williston is insignificant, 30

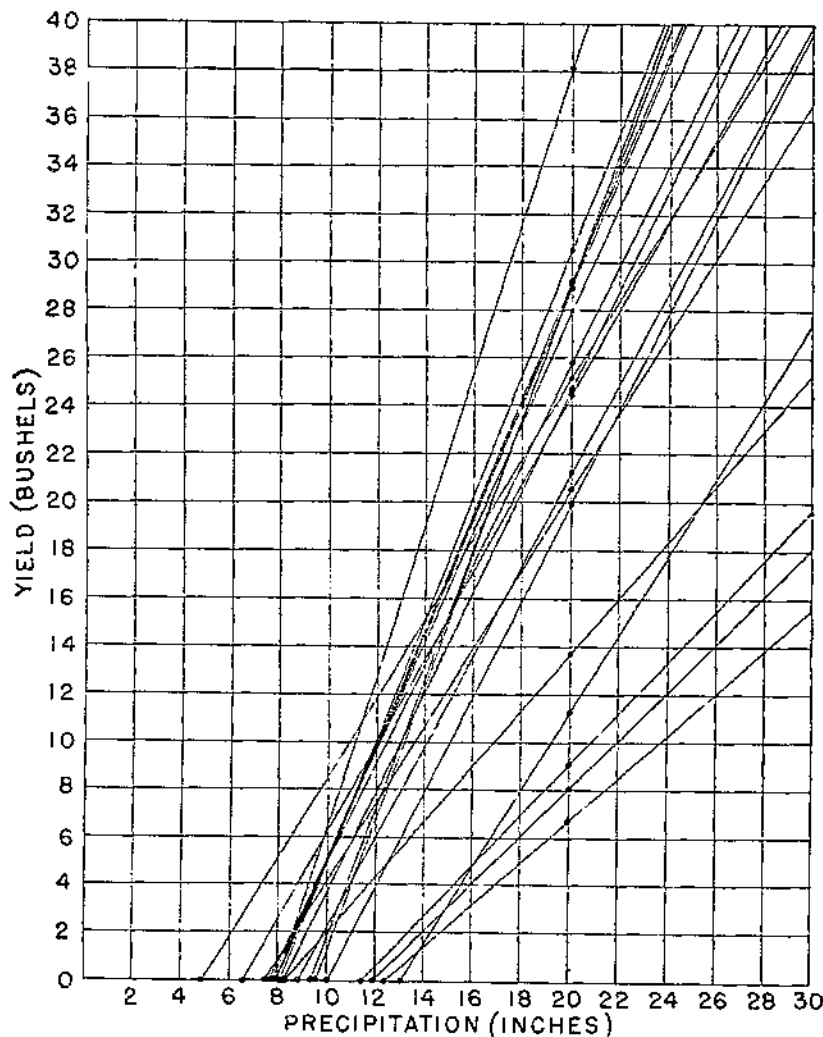


FIGURE 7.—Lines showing the regression of the average yield of spring wheat on precipitation for the year ended July 31 at each of 19 field stations in the Great Plains.

miles, but its elevation above sea level is about 600 feet greater. According to the formula of Hopkins⁷ that 400 feet of altitude is equal to 1° of latitude, this would be equivalent to approximately a further 100 miles. The greater efficiency of water in producing spring

⁷ HOPKINS, ANDREW DELMAR. PERIODICAL EVENTS AND NATURAL LAW AS GUIDES TO AGRICULTURAL RESEARCH AND PRACTICE. U. S. Monthly Weather Rev., Sup. 9, 42 pp., illus. 1918.

wheat at Assinniboine was noted in another study.⁸ In that study the use of water was limited to the decrease in the water content of the soil between the time the crop came up and the time it was harvested plus the precipitation during that period.

It is worthy of note that with the same precipitation the south field at Mandan produces lower yields than the main field. This is owing to a combination of steep slope and heavy soil in the south field. These should, and it is a matter of observation that they do, contribute to run-off. The heavy soil also holds more water near the surface, from which it is lost by evaporation. Both factors tend to lower the efficiency of the precipitation.

Of the stations outside the northern group, there is a similarity between North Platte and Akron, which are intermediate between the northern group and the other stations outside that group. Akron requires more precipitation than North Platte to initiate yield but requires a smaller quantity for each unit increment of yield. Equality is reached at 26.2 inches precipitation and 21.3 bushels yield. The average precipitation is 2 inches more at North Platte than at Akron and average yields are higher.

Colby, Hays, and Amarillo are more or less similar and form a group distinct from the others. The low yields indicated within the probable range of precipitation clearly show the lack of adaptation of spring wheat at these stations. Spring wheat, however, is of little importance in the sections represented by these stations, and its performance is not an index of agricultural possibilities in them.

A marked similarity has been shown among the northern stations, Assinniboine, Williston, Moccasin, Dickinson, Mandan (both fields), Huntley, Hettinger, Edgeley, Sheridan, Belle Fourche, Ardmore, Scotts Bluff, and Archer, in the relations of precipitation for the crop year and the yield of spring wheat. As compared with the other stations they form a group representing the area to which spring wheat is adapted on that section of the Great Plains within the United States. This group is represented by 272 pairs of observations of precipitation and yield. The coefficient of correlation between these 272 pairs is 0.74 when the group is considered as a unit. This correlation is highly significant. A scatter diagram of these data is shown in figure 8. The diagonal line is drawn from the regression equation of yield on precipitation: $\text{Yield} = (\text{precipitation} - 8.02) 2.19$. In round numbers, 8 inches of precipitation results in a 0 yield, and the increment of yield is 2.19 bushels for each inch above that quantity.

In considering results at individual stations, it was pointed out that there appeared to be limits to the quantity of precipitation that could be effectively utilized in the production of a current crop, and that the upper limit of effective precipitation varied to some extent with the station. Figure 8 shows the first point rather clearly for the area as a whole, but also emphasizes the meagerness of the data on excess precipitation. There are only 10 instances in this group where the precipitation was above 22 inches, and in all but one of these, Ardmore, 1915, at least the quantity above that amount was not reflected in the yield. There were only three yields above 40 bushels—Assinniboine, 1916; Belle Fourche, 1915; and Ardmore, 1915.

⁸ COLE, JOHN S., MATHEWS, O. R., and CHILCOTT, E. C. See footnote 4.

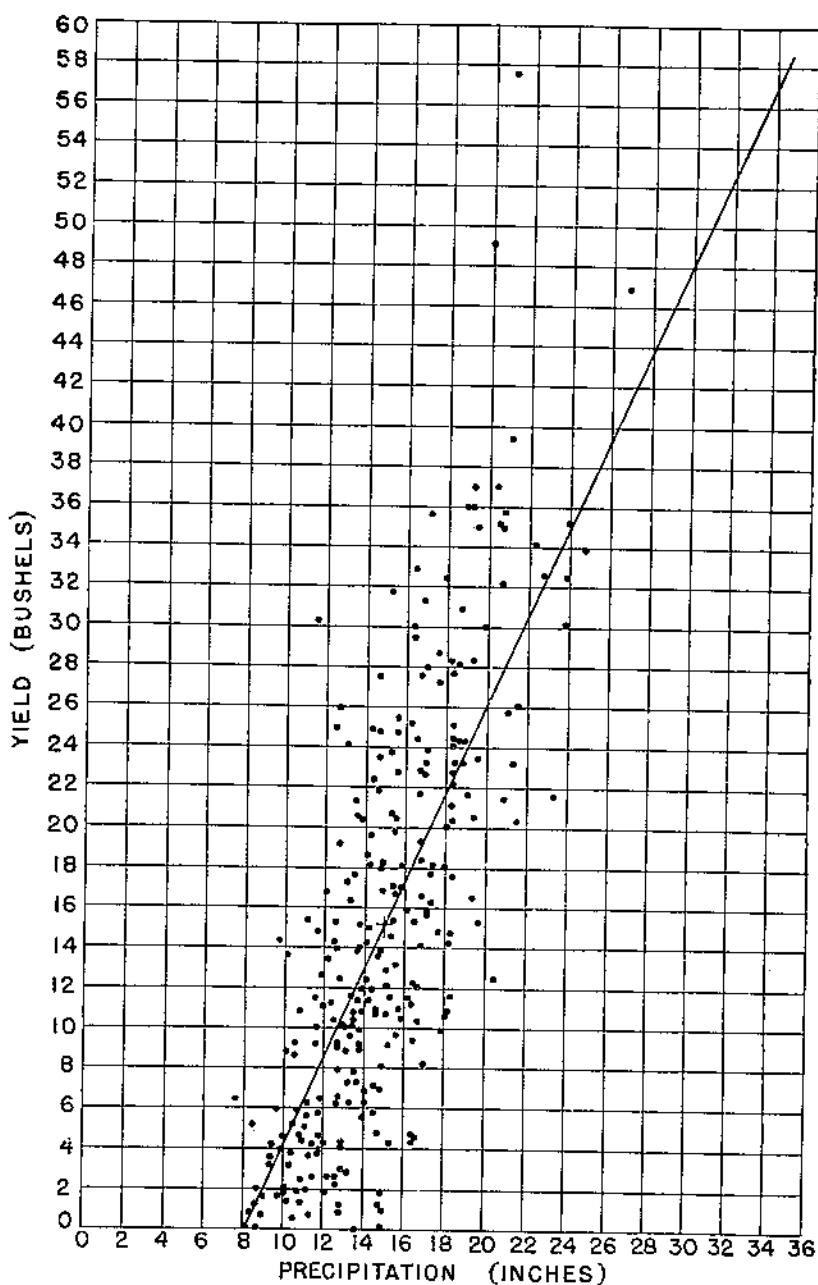


FIGURE 8.—Scatter diagram of 272 paired items of precipitation for the year ended July 31 and the average yield of spring wheat at 14 northern stations in the Great Plains, 1901-35. The diagonal line is drawn from the regression of yield on precipitation: $\text{Yield} = (\text{precipitation} - 8.02) 2.19$.

There were only 2 station years with precipitation below 8 inches and 14 with precipitation below 10 inches. Only one of these had a yield above 6.4 bushels per acre.

The large group of items (42) with 12 inches or less precipitation and 7 bushels or lower yield is of particular interest in its practical importance. There were 16 other instances with 12 inches or less precipitation in which the yield was more than 7 bushels, but in only 1 case more than 16 bushels.

The average precipitation of the 272 station years was 15.0 inches and the average yield 15.2 bushels. Segregation into four groups representing the quadrants limited by these means (line cases assigned to the lower group) gives the results in table 5.

TABLE 5.—*Number of station years, average precipitation, and average yield of spring wheat in each quadrant of the scatter diagram of 272 years at northern stations*

Quadrant	Station Years	Average precipitation	Average yield
	<i>Number</i>	<i>Inches</i>	<i>Bushels</i>
Precipitation and yield below mean.....	122	12.13	6.79
Precipitation below mean, yield above mean.....	28	13.54	20.51
Precipitation and yield above mean.....	93	18.53	26.06
Precipitation above mean, yield below mean.....	29	16.76	10.47

When the precipitation was below mean, the chances were 4.36 to 1 that the yield would be below mean. When the precipitation was above mean the chances were 3.21 to 1 that the yield would be above mean. When the two groups were combined, the chances were 3.77 to 1 that precipitation above or below the mean would be accompanied by a yield in the same bracket.

If the 272 cases are segregated into four quadrant groups on the basis of individual station means, the results are almost the same, 119, 29, 98, and 26 cases in the four quadrants, respectively.

When the quadrant grouping on the basis of station means is extended to include the whole 387 cases at 19 stations, the chances were 4.03 to 1 that a precipitation above or below the station mean would be paired with a yield in the same bracket.

Up to this point the study of the relations of precipitation and yield has been based on performance at individual stations in individual years. The question naturally arises: What will the relations be if the base is expanded so that the indexes of precipitation and yield represent an area rather than single stations? The wider the base, the more general is the application of results, and consequently the greater is their value.

The average precipitation at the northern stations (table 1) and the averages of the paired yields (table 3) were determined for each year as indexes of annual precipitation and yield. This reduced the 272 pairs to 30 pairs, 1 for each year 1906-35, representative of the area on the northern Great Plains which has a prominent place in the production of spring wheat. The number of stations entering into the averages each year, the average precipitation, the average yield, and two other items yet to be described are given in table 6. The scatter diagram (fig. 9) shows the relation between precipitation

and yield to be linear. The coefficient of correlation between precipitation and yield is 0.88. The line in figure 9 is drawn from the regression equation: $\text{Yield} = (\text{precipitation} - 10.07) 3.19$. The last two columns in table 6 give the annual yield estimated from the annual precipitation by this equation, and the errors of estimate

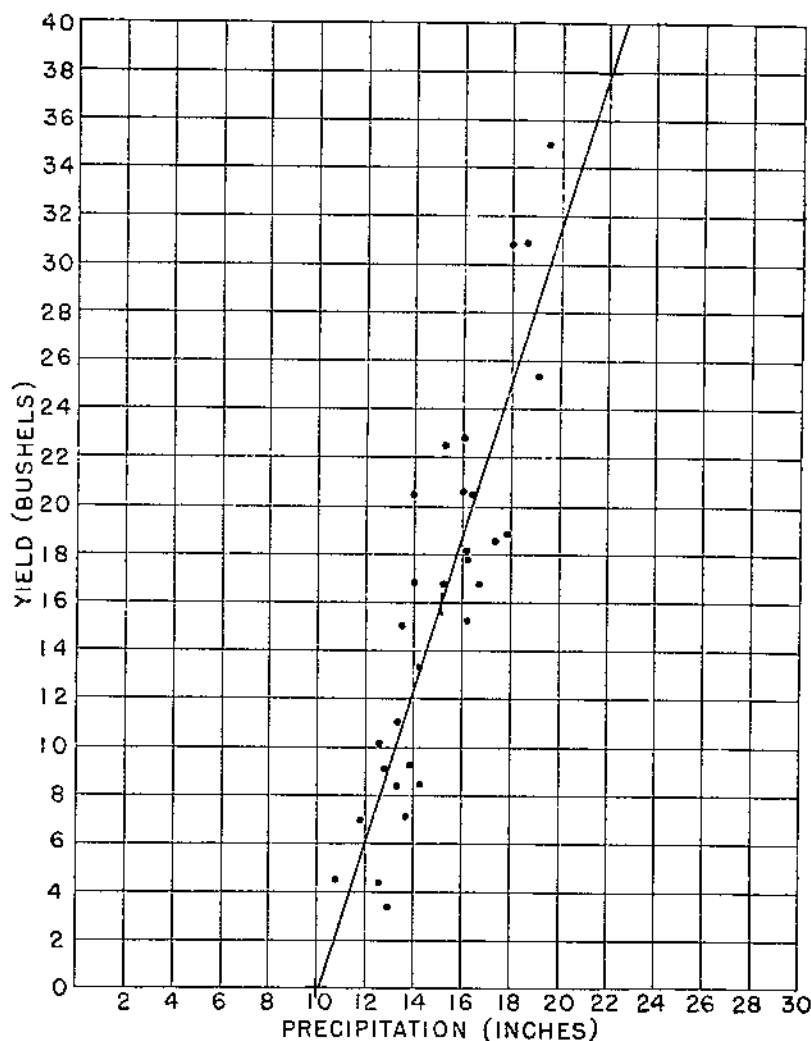


FIGURE 9.—Scatter diagram of the annual averages of precipitation for the year ended July 31 and the average yields of spring wheat at 14 northern stations in the Great Plains for the 30 years 1906-35. The diagonal line is drawn from the regression equation: $\text{Yield} = (\text{precipitation} - 10.07) 3.19$.

which average 3.31 bushels, or 20.7 percent of the average yield, 16.0 bushels. In 15 of the years the error of estimate was less than 3 bushels.

The correlation between these indices of precipitation and yield representative of an area is higher than the correlation between the individual pairs of annual precipitation and yield at each station. It is also higher than the correlation at any station except Ardmore.

TABLE 6.—*Number of stations, average precipitation for the year ended July 31, average yield of spring wheat, estimated yield, and error of estimate at northern stations, 1906-35*

Year	Sta- tions	Preci- pitation	Yield, actual	Yield, esti- mated	Depart- ure of actual yield from esti- mate	Year	Sta- tions	Preci- pitation	Yield, actual	Yield, esti- mated	Depart- ure of actual yield from esti- mate
	Num- ber	In.	Bu.	Bu.	Inc.		Num- ber	In.	Bu.	Bu.	Bu.
1906	1	18.6	30.9	27.2	3.7	1922	11	16.0	20.6	18.9	1.7
1907	2	14.0	20.5	12.5	8.0	1923	10	16.2	17.8	19.6	-1.8
1908	3	15.3	22.5	16.7	5.8	1921	10	16.2	18.2	19.6	-1.4
1909	5	18.1	30.8	25.6	5.2	1926	10	14.9	16.8	15.1	1.4
1910	5	14.2	8.5	13.2	-4.7	1926	10	12.8	10.2	8.7	1.5
1911	5	11.8	7.0	5.5	1.5	1927	10	19.3	25.4	29.4	-4.0
1912	6	17.4	18.6	23.4	-4.8	1928	10	16.4	22.8	20.8	2.0
1913	9	14.0	16.8	12.5	4.3	1929	10	13.5	13.4	10.9	2.5
1914	8	17.8	18.9	21.7	-2.8	1930	10	13.1	9.1	9.7	-.6
1915	12	19.5	35.0	30.1	4.9	1931	10	13.3	3.4	10.3	-6.9
1916	11	16.3	26.5	19.9	6.6	1932	10	16.1	16.8	19.2	-2.4
1917	14	13.4	11.1	10.6	.5	1933	9	13.7	7.1	11.6	-4.5
1918	14	14.6	15.1	11.3	3.8	1934	8	10.7	4.5	2.0	2.5
1919	13	12.5	4.4	7.8	-3.4	1935	9	13.9	9.3	12.2	-2.9
1920	13	16.2	15.3	19.6	-4.3						
1921	13	13.3	8.4	10.3	-1.9						
						Average		15.1	16.0	16.0	3.31

The objection may be legitimately raised that the samples in 1906, 1907, and 1908 are too small, those years being represented by only 1, 2, and 3 stations, respectively. This point has been given consideration. With 1906 excluded, the correlation coefficient is 0.86. With 1906 and 1907 and also with 1906, 1907, and 1908 excluded, it is 0.89. Changes in the regression equation resulting from the omission of one or all of these years are so small that the extension of the record by their inclusion seems justified.

When it is considered that the individual years in a span of 30 are represented by indexes with spread from 10.7 to 19.5 inches of precipitation and from 3.4 to 35.0 bushels yield, the high correlation between precipitation and yield of spring wheat on the northern Great Plains appears as a whole to be one of the most important findings of this study. Over the area as a whole there is a range of annual precipitation that results in a wide range of yield, and there are good years and bad years as measured either by precipitation or by production. The need of stabilization by carrying reserves or resources accumulated in good years is emphasized. If the excess of nonperishable products, such as wheat, in the good years could be stored to reduce the deficit of the poor years there would be enough for all.

To show the conditions more clearly, the actual yields and the yields estimated by the regression of yield on precipitation— $\text{yield} = (\text{precipitation} - 10.07) 3.19$ —are shown in chronological order in figure 10. Can there be any question that years and combinations of years like 1906-09, 1912-16, 1922-25, and 1927-28 are surplus years as truly as 1910-11, 1919, 1930-31, and 1933-35 are deficit years; or that land values fixed by the one find no support in the other?

RELATION OF ANNUAL PRECIPITATION TO THE YIELD OF SPRING WHEAT CONTINUOUSLY CROPPED

In the preceding pages the index of yield was the average of a composite of methods contributing low, medium, and high yields. Under the above heading the index of yield is the average of a few plots representative of methods that produce yields of a comparatively low order. To provide this index, the plots continuously cropped to spring wheat in a test of cultural methods at each station were selected. At Williston, Dickinson, Edgeley, Hettinger, North Platte, and Colby only two plots were used; plot A was spring-plowed and plot B was fall-plowed. At Assiniboine, Huntley, Mandan (both fields), Sheridan, Belle Fourche, Ardmore, Scotts Bluff, Archer, and Hays the number was extended to four by the addition of plot E, fall-plowed and subsoiled, and plot F, which was fall-listed. At Moccasin, Akron, and Amarillo there were five plots, G, which was

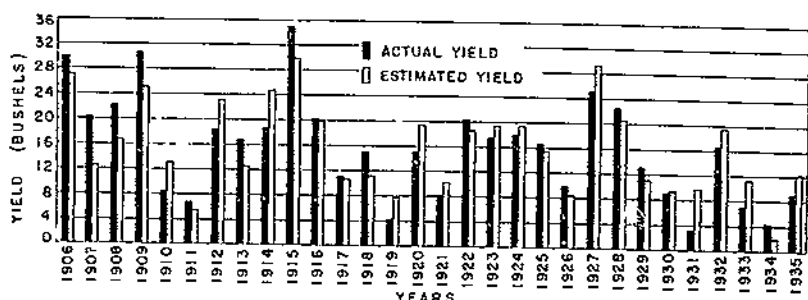


FIGURE 10.—Average and estimated average annual yields of spring wheat at 14 northern stations in the Great Plains, 1906-35.

variously late fall-plowed and deeply spring-plowed, being added to the other four. The yields of the continuously cropped plots are all of the same order as compared with the yields from other methods, such as fallow, and it is believed the greater reliability of the index afforded by averaging as large a number as were available offsets the advantage of strict comparability that could have been obtained by using only the A and B plots for all stations.

The annual yields of the continuously cropped plots for each year at each station are given in table 7. The precipitations paired with these yields were given in table 1. The number of years, the average yield of continuously cropped spring wheat and its standard deviation, the coefficient of correlation between the precipitation for the year ended July 31 and the yield, and the regression of yield on precipitation for each station are given in table 8. The mean of yields at the northern stations was 3.18 bushels less than the mean of the average yields (table 4). The coefficients of correlation with precipitation were generally higher for the yields under continuous cropping than for the average yields but not at all stations. The highest correlation was 0.96 at Ardmore, and the lowest was 0.49 at Hays. The correlation coefficients were all significant by Fisher's *z* test. The regression lines exhibit the same groupings as in the cases of average yields.

TABLE 7.—Annual yields of spring wheat continuously cropped at field stations in the Great Plains during the period 1906–35

Station	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	Average
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.
Assiniboine																															
Williston																															
Moccasin																															
Huntley																															
Dickinson																															
Mandan (main field)																															
Mandan (south field)																															
Edgeley																															
Hettinger																															
Sheridan																															
Belle Fourche																															
Ardmore																															
Cotts Bluff																															
Archer																															
Average																															
North Platte																															
Akron																															
Colby																															
Hays																															
Amarillo																															
Average																															
Grand average																															

TABLE 8.—Mean yield of spring wheat continuously cropped, correlation of precipitation for the year ended July 31 and the yield, and the regression of yield on precipitation at 19 stations in the Great Plains during the period 1906-35¹

Station	Years	Yield		Coefficient of correlation			Regression of yield on precipitation		
							Origin	Slope	
Northern:		Number	Bushels	σ	r	z	σ_z		
Assiniboine.....	19	10.56	12.40	0.87	1.33	0.25	6.12	3.27	
Williston.....	12	12.56	16.00	.90	1.10	.333	8.87	2.10	
Moccasin.....	20	11.92	8.81	.77	1.02	.209	9.75	2.14	
Rantley.....	24	8.36	8.46	.76	1.00	.218	9.68	2.03	
Dickinson.....	27	11.81	9.22	.70	.87	.204	9.80	2.12	
Mandan (main field).....	22	12.53	9.31	.78	1.05	.229	8.94	1.88	
Mandan (south field).....	22	9.30	9.49	.81	1.13	.229	10.92	1.99	
Edgemoor.....	14	14.08	11.17	.77	1.02	.301	10.99	2.41	
Hettinger.....	10	10.72	10.07	.70	.87	.378	8.12	1.80	
Sheridan.....	19	11.89	8.58	.82	1.16	.250	9.11	1.91	
Belle Fourche.....	28	14.19	13.04	.87	.81	.230	9.16	2.06	
Ardmore.....	18	12.29	12.46	.90	1.05	.268	12.15	3.09	
Scotts Bluff.....	10	8.19	5.25	.81	1.13	.376	11.20	2.14	
Archer.....	21	7.88	8.27	.65	.78	.236	8.88	1.61	
Total or average.....	272	11.16	9.61	.78			9.68	2.19	
Central and southern:									
North Platte.....	20	12.33	8.33	.70	.87	.196	8.67	1.15	
Akron.....	27	6.09	6.48	.75	.97	.204	13.27	1.46	
Colby.....	20	5.93	6.30	.80	1.10	.242	12.45	1.11	
Hays.....	26	7.70	5.99	.49	.64	.209	8.99	.81	
Amarillo.....	13	6.52	5.12	.83	1.19	.316	13.50	1.22	
Total or average.....	115	7.71	6.44	.71			11.38	1.11	

¹ The mean precipitation for each station is given in table 4.

Considering the northern stations as a group, the correlation between the 272 pairs of variables was 0.76, which is not significantly different from the similar correlation of precipitation and average yields. The regression equation of yield on precipitation is: Yield = (precipitation - 9.64) 2.11. The crop return for each unit of precipitation is smaller than with the average yield index, as is to be expected, because the same precipitation produced a lower yield.

When the 272 pairs of variables are reduced to 30 pairs by determining the annual averages of precipitation and yield at all northern stations, the coefficient of correlation between the two variables is 0.85. The regression equation is: Yield = (precipitation - 11.02) 3.07.

RELATION OF ANNUAL PRECIPITATION TO THE YIELD OF SPRING WHEAT ON FALLOWED LAND

The third index of yield is the yield on land that had been summer-fallowed instead of cropped during the preceding year. The tendency of this method is to provide the crop more water than other methods by storing it in the soil in advance of the annual crop and precipitation cycle. The increased water supply results in a greater crop yield. The contrast in both items is particularly sharp between continuous cropping and fallowing.

At most stations the index of yield on fallowed land is the average of three to five plots. Comparability of the data from year to year and from station to station is very high.

The index figure of yields on fallowed land at each station for each year is given in table 9. These yields pair with the precipitations for the year ended July 31 given in table 1.

TABLE 9.—Annual yields of spring wheat on fallowed land at field stations in the Great Plains during the period 1906–35

Station	1906	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935	Average	
	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	
Assiniboine				25.7	4.9	8.2	39.9	17.8	30.3	33.2	27.1	13.0	8.4	4.3	12.8	17.5	12.2	22.9	17.2	19.2	14.1	39.6	42.8	17.3	11.2	2.6	27.4	11.8		9.6	12.45	
Williston																																
Moccasin				34.1	7.2	20.1		22.9	19.5	35.3	24.2	10.4	22.5	5.8	15.6	23.0	21.9	28.8	21.6	22.3	20.3	17.2	28.7	9.5	12.0	8.0	15.8	8.6	7.7	5.0	18.00	
Huntley							8.0	25.5	26.3	37.5	16.9	16.6	27.6	2.4	11.6	18.5	24.7	17.9	28.3	25.3	7.3	27.5	20.6	10.1	2.9	6	6.5	5.7	6.6	6.8	15.89	
Dickinson		31.1	33.6	36.9	26.0	22.1		27.3		40.7	21.8	15.5	14.3	6.2	23.3	8.9	30.2	19.2	24.4	20.4	10.7	23.1	27.9	18.8	20.3	8.7	27.6	16.0	6.9	11.5	21.24	
Mandan (main field)									32.3	43.7	23.9	17.3	23.5	13.3	9.2	3.6	25.1	15.8	30.4	31.8	7.6	26.0	24.3	21.4	20.3	18.2	33.8	2.7	4.0	24.1	20.55	
Mandan (south field)									28.9	42.7	15.5	13.7	6.2	14.3	8.4	3	17.6	14.7	18.4	18.7	4.1	30.0	32.8	10.3	14.4	9.2	23.9	2.7	2.5	12.3	15.53	
Edgeley	30.6	10.9	15.8	27.5	8.0	3.2	35.4	26.1		37.1		12.1	17.4		6.7	14.5	24.8															
Hettinger							19.9	29.6	9.8	39.2																						
Sheridan																																
Belle Fourche				21.7	32.7	4.3	0	0	15.6	16.1	56.8	20.0	11.5	31.5	4.5	30.7	25.6	32.5	30.9	21.3	24.3	46.5	24.3	42.6	28.4	19.0	1.8	19.6	19.6	19.4	0.5	21.81
Ardmore								7.2		50.6	18.5	9.7	37.1	14.7	26.3	22.8		25.7	18.3	18.7	10.3	33.4	36.8	23.6	11.9	4.2	12.2				21.22	
Scotts Bluff							27.8	18.1	13.8	30.0	11.3	19.3	23.4	4.1	19.8	10.2																17.78
Archer									8.8	24.5	4.3	14.7	23.0	4.8		11.6	6.4	16.1	10.6	10.5	18.1	19.4	14.9	13.0	6.6	5.0	7.0	6.1	4.1	11.9	11.60	
Average	30.6	21.0	23.7	31.4	10.1	10.7	21.8	21.1	20.6	39.3	21.1	13.1	20.5	7.1	16.8	13.4	22.8	21.9	21.5	22.3	16.1	27.9	31.6	17.5	13.4	6.4	20.0	10.0	7.8	11.2	18.54	
North Platte		28.9	41.4	22.6	16.3	0	9.9	8.7	12.8	28.8	18.4	16.0	17.5	16.9	21.0	16.6	11.1	21.4	22.2	20.6	10.8	20.3	34.4	24.7	27.2	20.6	25.4	16.5	3.4	25.0	19.29	
Akron				18.4	12.2	8.2	19.1	9.1	21.4	30.8	13.4	13.9	3.9	6.5	20.9	2.1	10.3	8.0	1.3	9.6	7	13.4	21.5	3.5	2.2	2.3	8.7	2.6	1.6	12.1	10.29	
Colby										24.2	4.8	0	5.2	16.1	16.4	9.9	11.5	14.2	6.0	11.6	4.0	8.5	7.5	8.5	15.2		24.2		4	2.8	0	9.30
Hays			4.2		11.3	3.2	10.5	6.9	0	7.4	1.7	4.5	13.4	12.4	14.7	13.2	27.3		16.8	7.0	15.3	18.0	33.8	18.1	21.1	15.0	18.1	1.3	2.4	0	11.45	
Amarillo	4.9		16.0							8.6	12.5	10.5	6.4	2.9	2.8	14.5																8.88
Average	4.9	28.9	20.5	17.2	11.9	5.0	12.2	8.3	11.7	20.3	8.9	7.5	8.6	13.3	18.3	10.5	15.1	14.5	11.6	12.2	7.7	13.8	24.0	13.7	16.4	12.6	19.1	5.2	2.6	0.3	11.84	
Grand average	17.8	23.6	22.1	26.1	10.9	8.2	18.0	17.2	17.9	33.7	17.3	11.6	17.4	8.8	17.1	12.7	20.7	20.2	18.7	19.4	13.7	23.9	29.5	16.4	14.3	7.8	19.7	8.6	6.0	10.6	16.78	

The number of years, the average yield of spring wheat on fallowed land and its standard deviation, the correlation between the precipitation for the year ended July 31 and the yield of spring wheat on fallowed land, and the regression of yield on precipitation for each station are given in table 10.

TABLE 10.—Mean yield of spring wheat on fallowed land, correlation of precipitation for the year ended July 31 and the yield, and the regression of yield on precipitation at 19 stations in the Great Plains during the period 1906-35¹

Station	Years	Yield		Coefficient of correlation			Regression of yield on precipitation	
		Mean	σ				Origin	Slope
Northern:	Number	Bushels		r	z	σ_p		
Assiniboine.....	19	18.45	12.77	0.77	1.02	0.250	6.10	2.98
Williston.....	12	18.68	12.14	.69	.35	.333	6.43	2.26
Moccasin.....	26	18.00	8.63	.56	.63	.209	3.51	1.53
Huntley.....	24	16.88	10.25	.65	.78	.218	0.25	2.10
Dickinson.....	27	21.24	9.16	.71	.80	.204	6.13	2.14
Mandan (main field).....	22	20.56	10.78	.75	.97	.229	5.76	2.69
Mandan (south field).....	22	15.53	10.78	.84	1.22	.229	8.96	2.34
Edgeley.....	14	19.29	10.93	.74	.95	.301	7.43	2.27
Hettinger.....	10	18.30	11.13	.52	.58	.378	1.00	1.48
Sheridan.....	19	21.28	11.16	.77	1.02	.250	6.24	2.34
Belle Fourche.....	28	21.81	13.79	.58	.66	.200	4.47	1.88
Ardmore.....	18	21.22	12.21	.80	1.10	.258	7.71	2.52
Scotts Bluff.....	10	17.78	8.10	.44	.47	.378	5.19	1.79
Archer.....	21	11.50	6.15	.53	.56	.236	4.84	1.29
Total or average.....	272	18.54	10.57	.67	-----	-----	5.70	2.07
Central and southern:								
North Platte.....	29	19.29	8.75	.60	.69	.196	.74	1.03
Akron.....	27	10.29	7.80	.65	.78	.204	10.59	1.50
Colby.....	26	9.30	7.32	.69	.85	.242	9.43	1.12
Hays.....	26	11.45	8.53	.53	.59	.209	9.44	.94
Amarillo.....	13	8.88	4.05	.44	.47	.310	1.54	.51
Total or average.....	115	11.84	7.29	.58	-----	-----	6.35	1.02

¹ The mean precipitation for each station is given in table 4.

As compared with the yields on continuously cropped land and the average yields, the yields on fallowed land are higher (at northern stations about 7 bushels more than on continuously cropped land and about 3 bushels more than the averages of all methods), the coefficient of variation is lower, the coefficient of correlation with precipitation is lower, and the yield for each unit of precipitation is higher. The average of the coefficients of correlation at 14 northern stations was 0.78 for continuous cropping and 0.76 for the average yield index, whereas it was only 0.67 for fallowed land.

The correlation of the 272 pairs of variables at northern stations was 0.67 for fallowed land, the same as the average of the coefficients for the 14 stations. The regression equation for the yields on fallowed land was: Yield = (precipitation - 5.87) 2.05.

When the 272 pairs of variables are reduced to 30 pairs, each representative of annual averages, the coefficient of correlation is 0.84, and the regression equation is: Yield = (precipitation - 8.70) 2.99.

The effect of a cultivation method or cropping system, such as fallow, that tends to store water in the soil in advance of the crop year is to reduce the control of yield by the precipitation during the crop year.

SUMMARY AND CONCLUSIONS

Data covering a total of 387 crop years at 19 field stations in the Great Plains are given of precipitation for the year ended July 31 and three indexes of yield of spring wheat. The primary study is made with an index of the average yields of about 30 plots representing low-, medium-, and high-yielding methods. Less detailed studies are made with the average yields of continuously cropped plots, a low-yielding method, and an average of yields on fallowed land, a high-yielding method.

The vehicles of study are correlations of precipitation, the independent variable, with yield, the dependent variable; scatter diagrams or dot charts; and the regression of yield on precipitation.

The coefficients of correlation of precipitation and average yield at the several stations ranged from 0.61 to 0.90 and averaged 0.76.

Yields markedly below the quantity indicated by the annual precipitation sometimes result from abnormally heavy precipitation in the late summer or early autumn—August and September—of the year preceding harvest. A more frequent cause is prolonged drought preceding harvest and following an excess of rain during earlier months and a consequent heavy vegetative growth. Run-off during a period of heavy rains sometimes is a factor in reducing the effectiveness of the total precipitation.

Yields markedly above the statistical indications of the total quantity of precipitation may be associated either with a carry-over of water from the previous year, generally indicated by an excess precipitation during that year, or by an adequate precipitation during the fruiting and filling period preceding harvest, following a deficiency before that time.

A similarity in the regression lines showing the number of bushels of wheat produced by any given quantity of precipitation places all stations north of and including Archer, Wyo., in a group designated "northern" that is distinct from all stations to the south of and including North Platte, Nebr. The placing of Archer in the northern group is attributed to the climatic factors associated with its elevation of 6,000 feet above sea level. Yields alone would place North Platte in the northern group, but efficiency in the use of water in the production of spring wheat associates it with the central and southern group.

For 272 station-years at northern stations during the period 1906-35, the average (weighted) precipitation was 14.96 inches, the average (weighted) yield was 15.18 bushels, the coefficient of correlation was 0.74, and the regression equation was: $\text{Yield} = (\text{precipitation} - 8.02) 2.19$. A precipitation above or below the mean was accompanied by a yield in the same bracket in the ratio of 3.77 times to 1 when it was not.

When the 272 pairs of variables are reduced to 30 pairs representing annual averages for each of the years 1906-35, the coefficient of correlation is increased to 0.88. The regression equation is: $\text{Yield} = (\text{precipitation} - 10.07) 3.19$. The error of estimate of yields calculated by this equation averages 3.28 bushels or 20.5 percent of the mean yield, 16.0 bushels.

The use of methods, such as continuous cropping to small grains, that leave the soil exhausted of available water at the beginning of

the crop year, increases the dependence of the crop on the precipitation during the crop year, which is evidenced by higher coefficients of correlation.

The use of methods, such as summer fallow, that store water in the soil before the beginning of the crop year reduces the dependence of the crop on the precipitation during the crop year and is evidenced by lower coefficients of correlation.

APPENDIX

TABLE 11.—Monthly and annual precipitation at the field station, Assiniboine, Mont., for the 21 years 1915-35¹

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1915.....	0.87	0.44	0.10	0.24	1.95	3.35	3.17	0.94	2.05	0.42	0.12	0.77	14.22
1916.....	1.75	.47	.59	.69	2.69	4.32	5.20	.20	1.90	.82	.15	.58	19.36
1917.....	.51	.20	.04	.88	.42	1.59	.43	.70	5.33	.38	.08	1.32	11.86
1918.....	.75	.25	.40	.44	.08	1.51	.74	2.10	.64	1.17	.42	.05	8.55
1919.....	.38	.56	.50	.31	1.09	1.96	.19	.60	.67	.48	.56	.23	7.56
1920.....	.88	.30	.40	1.71	1.39	2.89	1.36	1.25	.35	1.04	.01	.30	11.20
1921.....	.05	.06	1.81	.80	2.83	2.09	2.18	.53	1.45	.19	.70	.11	13.37
1922.....	.19	.76	.27	1.43	2.37	.90	1.90	.92	.54	.11	.31	.56	10.26
1923.....	1.00	.15	.05	.76	1.93	4.88	3.65	1.49	.64	.73	.15	.60	16.03
1924.....	.27	.49	.55	.82	.89	5.14	.61	1.78	.69	.34	.39	.55	12.52
1925.....	.15	.26	.42	2.71	.77	.85	1.33	.34	1.24	2.31	0	.47	8.90
1926.....	.34	.36	.14	.02	.85	2.07	2.87	.35	.37	.98	1.18	.57	19.04
1927.....	.28	.49	.70	1.69	7.29	5.11	1.50	2.01	.50	.06	.03	1.14	11.74
1928.....	.19	.08	.04	.75	2.50	2.78	.28	.96	1.68	.49	.35	.93	12.25
1929.....	.57	.32	.90	.61	2.50	1.64	.61	.40	1.69	.55	.50	.22	8.88
1930.....	.15	.22	.56	1.08	1.29	1.59	3.13	.38	.61	.01	.39	.13	8.29
1931.....	.48	T	.47	.73	.39	4.50	1.32	2.76	.49	.58	.32	.15	15.29
1932.....	.05	.68	.74	1.75	1.94	2.55	3.4	5.46	.57	.77	.64	.85	15.16
1933.....	.22	.19	.39	1.17	2.00	2.91	.36	1.08	1.75	.62	.12	.48	9.31
1934.....	.16	.05	.61	.54	.63	2.91	.36	1.08	1.75	.62	.12	.48	9.31
1935.....	.51	.13	.69	1.20	1.69	.68	1.53	.29	.15	.45	.30	.10	7.72
Average.....	.46	.31	.49	.97	1.68	2.84	1.57	1.30	1.34	.51	.37	.50	12.34

¹ Record previous to May 1916 from U. S. Weather Bureau station at Havre.

TABLE 12.—Monthly and annual precipitation at the field station, Williston, N. Dak., for the 18 years 1908-20¹

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1908.....	0.04	0.39	0.79	1.96	1.80	2.64	0.60	1.11	2.18	1.81	0.16	0.01	13.49
1909.....	.31	.10	.12	.64	2.84	3.72	1.72	.38	1.27	.17	.20	.46	11.93
1910.....	.27	.34	1.81	1.40	1.30	1.65	1.27	1.69	.14	.05	.60	.28	10.36
1911.....	.56	.34	.20	.32	3.00	1.37	1.40	2.56	2.49	.53	1.25	.59	14.61
1912.....	.44	.17	.35	2.18	4.59	1.59	3.60	3.47	1.21	1.12	.14	.18	19.04
1913.....	.52	.14	.94	.27	1.05	2.15	2.60	5.50	1.13	.89	.15	T	15.34
1914.....	.55	.28	.50	.48	1.21	7.98	2.32	3.55	.64	.38	.24	.33	18.46
1915.....	.38	.18	.13	.71	2.08	2.02	2.42	.41	1.74	1.76	2.08	.88	14.70
1916.....	1.17	.39	.60	1.34	1.68	4.81	1.18	2.45	1.72	.63	.35	1.50	18.22
1917.....	.47	.67	.47	1.26	.08	2.53	.34	.34	.90	1.00	.01	1.00	8.97
1918.....	.75	.13	.48	2.39	1.39	.72	2.48	4.20	.30	.38	1.04	1.00	15.26
1919.....	.07	1.02	1.08	1.12	2.15	2.64	1.33	.65	.99	1.65	.46	.25	13.42
1920.....	.92	.13	2.18	.86	2.03	3.50	.98	.81	.60	.92	.09	.13	13.13
Average.....	.50	.33	.72	1.15	1.95	2.87	1.71	2.08	1.18	.87	.52	.51	14.39

¹ Record for 1908 and January, February, and March 1909 from the U. S. Weather Bureau Station at Williston, N. Dak.

TABLE 13.—Monthly and annual precipitation at the field station, Moccasin, Mont., for the 28 years 1908–35¹

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1908	0.55	0.49	0.98	0.81	7.31	2.45	0.20	1.18	1.41	6.27	T	0.22	21.67
1909	.90	.98	1.22	1.03	1.34	5.99	2.54	4.21	4.47	.49	0.30	1.21	23.78
1910	.99	.74	.10	1.31	2.40	1.69	1.10	2.02	2.54	1.36	1.28	.46	15.06
1911	.58	.85	.54	1.86	2.68	2.55	.50	6.34	1.37	1.94	1.76	.68	21.45
1912	.88	.60	.81	1.43	3.94	.64	1.92	1.27	1.63	1.68	.14	.09	15.00
1913	.89	.09	.20	.79	2.64	4.77	1.12	.51	1.01	1.63	.93	.38	14.96
1914	.47	1.35	1.12	1.19	2.91	4.84	.64	.65	1.11	.74	.64	.21	15.67
1915	.76	.08	2.69	1.43	2.12	3.97	3.54	.92	2.65	.85	1.01	.66	20.68
1916	.74	1.22	1.33	1.20	2.25	3.97	2.03	1.29	1.81	1.00	.64	2.39	19.87
1917	1.67	1.30	.85	1.18	2.79	1.81	.96	.75	2.91	.62	.09	2.56	17.69
1918	2.34	.02	.57	.44	2.69	1.55	2.95	1.48	1.25	1.09	1.14	.26	16.38
1919	.13	.71	1.20	.17	.73	1.08	1.02	.29	1.48	1.43	.93	.73	9.90
1920	.70	.63	.39	5.37	2.91	3.97	.89	1.83	.66	.65	.15	.21	18.26
1921	.66	T	.60	5.10	3.31	2.46	3.87	1.03	1.69	.03	1.47	.47	15.48
1922	.67	.69	.29	2.12	1.42	4.43	1.10	.88	.51	.77	1.19	1.51	15.38
1923	.17	1.08	.69	.48	2.75	5.30	3.20	2.68	1.03	.48	.15	.57	18.58
1924	.64	.27	.86	.87	1.25	3.37	1.39	1.31	1.28	.51	.08	.41	12.14
1925	.50	.61	1.08	1.72	1.15	4.07	.52	.88	1.36	1.26	.04	.31	13.50
1926	.29	.42	.31	.41	1.91	1.95	3.37	1.69	2.96	.33	.81	.34	14.79
1927	.42	.37	.56	1.17	5.08	2.47	1.06	1.74	.46	.74	1.64	.31	16.02
1928	.68	.88	.42	.60	.53	3.86	2.90	.85	.41	1.03	.05	.50	12.21
1929	.99	.64	.71	.27	2.12	1.86	.62	.34	2.41	.53	.85	1.94	13.28
1930	.78	.32	.93	.85	1.49	.91	1.37	2.02	.94	1.99	.45	.13	12.18
1931	.23	.04	.44	.80	1.04	1.30	2.48	1.13	1.88	.24	.77	.27	10.71
1932	.58	.29	1.61	1.03	1.50	3.63	2.12	1.75	.58	1.22	.51	.77	15.59
1933	.41	.74	.10	3.01	3.11	2.45	.29	3.38	.57	.60	.39	.75	15.78
1934	.28	.43	.96	.24	.96	2.70	1.38	.13	1.37	.41	.17	.54	9.57
1935	.20	.15	1.33	.48	2.25	1.89	1.15	.54	.18	1.46	.11	.15	9.89
Average	.63	.53	.82	1.16	2.39	2.92	1.65	1.53	1.50	1.12	.63	.68	15.56

¹ Record for 1908 and January, February, and March 1909 from Utica, Mont., about 6 miles distant.

TABLE 14.—Monthly and annual precipitation at the field station, Huntley, Mont., for the 25 years 1911–35

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1911	0.82	0.14	0.15	0.85	3.29	2.13	0.81	1.05	0.57	0.88	0.82	0.13	11.64
1912	.27	.21	.41	2.00	2.44	1.64	2.75	1.39	2.97	3.25	.75	.00	18.08
1913	.29	.10	.40	.43	1.27	2.20	1.10	1.19	1.43	2.59	.45	.17	11.92
1914	.11	.19	.62	1.16	2.83	3.31	.05	.78	1.90	1.07	.97	.24	12.21
1915	.41	.02	.78	.23	2.50	5.99	3.11	.50	1.64	.31	1.34	.71	17.54
1916	.40	.24	1.02	.89	1.81	2.11	1.50	.39	1.16	1.34	1.07	1.50	13.49
1917	.76	.49	1.41	1.01	2.88	2.75	.37	.24	.83	.75	.07	3.58	15.14
1918	2.42	.33	.69	.67	2.09	1.20	1.29	1.18	1.87	.53	1.20	.09	13.46
1919	.23	.35	.67	.54	.83	.21	.63	.63	2.47	2.61	1.96	1.10	12.22
1920	.75	1.28	1.17	2.03	2.47	2.45	1.58	1.01	.32	.20	.05	.48	13.80
1921	.25	.30	1.38	.72	3.85	2.19	.83	.19	.66	.21	1.72	.30	12.60
1922	.75	.80	.30	3.55	2.65	4.98	1.75	.84	.34	.49	1.27	1.53	19.95
1923	.18	.19	.43	1.48	1.65	2.60	3.17	2.16	4.29	1.15	.10	.86	18.06
1924	.53	.56	2.26	.87	1.55	2.48	1.59	.11	.27	.97	.53	1.14	12.86
1925	.65	1.10	.98	1.24	2.27	2.69	.53	.42	.54	1.24	.40	1.61	13.67
1926	.40	.40	.34	.33	1.55	1.28	2.22	.98	2.26	.10	1.87	.36	11.83
1927	1.06	.15	.12	3.38	5.09	2.21	.94	2.85	1.14	.31	1.94	2.20	21.39
1928	2.75	.06	.24	1.07	.84	1.45	1.66	1.01	.36	1.77	.58	1.14	12.93
1929	1.21	.97	1.68	.76	.50	2.17	.49	.17	1.41	.84	.58	1.02	11.80
1930	.87	.39	1.34	1.86	.61	1.25	1.05	1.15	1.23	2.19	.34	T	12.28
1931	.25	.65	.61	.61	.17	.45	.47	.75	.84	.98	.68	.35	6.77
1932	.80	.35	2.43	1.78	1.81	2.89	.31	.87	.49	2.01	.31	.04	14.15
1933	1.15	.96	.31	1.12	2.90	1.07	.24	3.40	.19	.68	.89	.98	13.89
1934	.33	.33	1.60	.27	.35	1.24	.63	.34	1.01	.52	.16	.74	7.52
1935	.45	.38	2.80	1.22	2.91	1.33	1.08	.28	.43	.57	.80	.49	12.73
Average	.77	.44	.96	1.20	2.05	2.16	1.21	.65	1.22	1.11	.79	.82	13.68

TABLE 15.—*Monthly and annual precipitation at the field station, Dickinson, N. Dak., for the 30 years 1906-35*¹

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1906	0.65	0.40	0.98	1.10	7.11	5.40	0.16	2.64	0.25	0.14	0.87	0.76	20.46
1907	.80	.14	.39	.30	1.38	2.68	4.82	1.93	1.22	.04	.02	.22	13.94
1908	.28	.73	1.42	1.27	3.79	4.06	1.34	1.73	1.55	2.49	.78	.24	19.31
1909	.57	.52	.25	.60	6.04	3.02	1.87	5.54	.72	1.08	.29	1.02	21.22
1910	.34	.97	.83	1.71	1.26	3.03	2.35	1.45	.49	.54	.15	.15	13.39
1911	.90	.55	.43	.48	1.63	2.61	1.29	1.69	2.53	2.09	.56	.22	14.98
1912	.41	.12	.30	2.51	3.99	2.06	3.90	2.71	1.81	1.15	.18	T	19.34
1913	.13	.04	1.37	.59	1.63	1.83	1.26	2.79	.97	1.04	.43	T	11.93
1914	.04	.43	1.27	.80	2.60	7.60	5.27	2.20	1.21	.42	.25	.29	22.38
1915	.07	.15	.21	.73	3.95	5.89	3.81	.26	2.17	1.79	1.15	.22	20.53
1916	.50	.32	.47	2.57	2.52	3.80	2.37	1.93	.70	1.10	.38	.98	17.94
1917	.60	.23	.48	1.18	.36	2.54	1.40	1.43	.20	.22	T	.61	9.25
1918	.38	.25	.31	2.11	1.67	1.61	1.73	2.99	.48	.42	.10	.30	12.36
1919	T	.67	.19	1.14	2.41	.52	.53	.51	.71	.67	.34	.16	8.35
1920	.79	.05	.18	.79	1.64	4.16	2.81	2.33	1.74	1.11	.10	.18	15.88
1921	.22	.28	1.01	1.02	1.78	3.09	1.61	2.73	2.15	.13	1.05	.61	15.68
1922	.32	.99	.29	1.11	1.97	6.57	1.92	1.74	1.23	.58	1.72	.58	18.02
1923	.30	.30	.37	1.77	1.24	4.55	4.67	.82	4.55	.77	.31	.18	19.73
1924	.03	.34	1.11	1.03	1.12	3.26	3.03	.42	.66	3.37	.12	.65	15.34
1925	.42	.17	.55	1.26	1.88	3.36	1.29	1.30	.46	.98	.13	.55	12.15
1926	.45	.38	.28	.46	2.90	1.94	1.14	1.56	2.14	.32	.76	.75	13.08
1927	.49	.19	.74	1.70	5.67	2.12	2.93	1.29	1.54	.53	1.09	1.33	19.62
1928	.45	.29	.35	1.15	1.22	3.95	2.96	3.38	.50	.58	.08	.39	15.30
1929	1.82	.41	2.10	.60	3.48	2.89	.57	.06	1.67	1.44	.64	1.53	17.21
1930	.65	1.31	.92	1.95	1.19	4.26	.08	.55	1.54	1.42	.46	.38	13.79
1931	.22	.52	1.08	.11	1.21	3.46	3.71	1.14	3.02	.88	.38	.37	16.08
1932	.90	.34	.53	1.92	2.12	4.67	2.04	1.66	.21	2.12	.45	.28	17.24
1933	.63	.35	.24	.86	2.56	2.05	1.82	.72	.49	.55	.69	.41	11.57
1934	.20	.15	.67	.62	.28	3.80	.75	.45	.49	.11	.14	.22	7.87
1935	.39	.23	1.12	2.48	3.09	1.63	3.10	1.66	.07	.01	.77	.45	15.00
Average	.47	.39	.67	1.29	2.46	3.41	2.22	1.68	1.25	.93	.48	.47	15.63

¹ Record previous to April 1908 from U. S. Weather Bureau station at Dickinson.TABLE 16.—*Monthly and annual precipitation at the field station, Mandan, N. Dak., for the 23 years 1913-35*¹

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1913	0.37	0.03	0.49	0.55	1.99	2.06	2.72	0.77	2.29	1.13	0.16	0.28	12.84
1914	.07	.05	1.89	1.53	3.57	10.88	1.35	1.89	1.24	.90	.31	.37	23.87
1915	.01	T	.30	1.11	4.98	6.32	6.48	.63	1.84	1.85	.34	.14	24.06
1916	.28	.09	1.88	.93	1.69	2.25	3.55	2.04	.92	.27	.07	1.10	15.07
1917	.28	.19	.35	1.87	.35	2.56	1.68	.89	1.97	.05	.03	.19	10.31
1918	.20	.11	.45	2.81	2.45	.08	2.47	2.03	.63	.27	.45	1.02	13.37
1919	.08	.80	.83	1.72	3.95	1.12	.85	1.72	1.49	.98	1.19	.25	13.48
1920	.52	.20	1.21	.58	1.72	1.85	2.68	1.81	1.29	.25	.37	.21	12.69
1921	.18	.09	.79	2.59	3.05	.82	3.38	.35	1.58	.58	1.39	.87	15.23
1922	.28	1.55	.52	.66	2.05	3.43	3.17	.32	2.31	.64	1.60	.82	17.35
1923	.36	.38	.16	1.85	1.15	1.94	4.12	1.15	2.31	.54	.28	.14	14.41
1924	.03	.25	.28	1.68	.41	5.50	2.07	2.35	1.34	1.91	.06	.15	14.06
1925	.28	.63	.44	.94	1.18	7.34	.33	1.31	1.99	.69	.70	.44	11.51
1926	.71	.22	.04	.13	2.41	1.20	2.19	1.31	2.38	.16	.15	.77	20.30
1927	.18	.14	1.17	1.37	6.65	2.00	2.37	3.16	.49	.44	1.56	.77	16.62
1928	.26	.07	.23	.99	2.55	6.32	4.94	2.24	1.53	.19	.08	.17	16.22
1929	.80	.31	1.47	1.75	2.68	.99	1.20	.81	1.56	1.81	.14	.70	14.85
1930	.19	1.68	T	1.71	2.23	1.50	2.40	2.00	2.56	1.85	1.13	.13	17.38
1931	.05	.44	1.82	.43	2.14	1.65	4.32	1.01	3.11	1.46	.47	.74	17.44
1932	.44	.19	1.00	.99	3.48	2.53	1.90	.70	.24	.27	.15	.18	15.76
1933	1.23	.34	1.02	.86	1.83	2.18	1.60	.41	.27	.55	.90	.52	11.91
1934	.06	.05	.58	.03	.17	3.78	1.10	.25	.47	.73	.17	.14	8.13
1935	.13	.36	1.13	3.09	2.63	2.85	4.71	1.34	.22	.00	.96	.88	18.30
Average	.30	.33	.78	1.37	2.32	3.15	2.68	1.30	1.37	.88	.51	.44	15.43

¹ Record for 1913 from U. S. Weather Bureau station at Bismarck.

TABLE 17.—*Monthly and annual precipitation at the field station, Edgeley, N. Dak., for the 18 years 1905-22*

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1905.....	0.15	0.17	0.79	1.41	4.33	3.48	2.60	1.71	0.85	0.24	1.40	0.00	17.19
1906.....	.13	T	.16	1.58	5.59	3.69	3.17	1.56	1.45	.93	1.05	.05	19.56
1907.....	.42	.06	.21	.35	2.23	1.78	2.10	1.20	2.79	.82	T	T	11.94
1908.....	.04	.65	1.45	1.26	3.47	3.26	1.19	1.97	1.81	1.34	.53	.20	17.27
1909.....	.12	.25	T	.73	4.56	1.97	3.24	1.87	1.00	.39	.34	.84	15.31
1910.....	.14	.30	1.20	2.15	3.30	1.91	.72	2.21	4.43	.15	.16	.10	13.77
1911.....	.27	.35	.03	1.55	2.71	1.22	1.61	4.12	2.52	.67	.20	.41	16.06
1912.....	.48	.01	.08	2.71	3.23	3.52	5.97	2.71	2.47	.94	T	.28	21.81
1913.....	.31	.04	.24	1.46	1.44	3.98	2.65	2.74	2.90	3.37	.28	.25	20.66
1914.....	.13	.20	.57	4.88	1.80	4.00	2.55	1.97	.80	.92	.10	.13	18.05
1915.....	.21	.80	.20	1.30	4.47	4.57	3.11	1.61	2.23	2.78	.26	.30	22.20
1916.....	.01	.16	1.59	1.23	4.16	2.91	4.18	2.95	1.02	.36	.79	.20	20.29
1917.....	.28	.45	.50	2.02	2.22	3.08	2.22	2.89	.89	.24	.10	.16	16.85
1918.....	.17	.11	.10	2.95	1.21	1.21	3.21	2.47	.16	.38	1.03	.38	13.36
1919.....	.10	.42	.73	1.27	4.07	4.94	3.47	.43	3.5	1.18	.43	.29	17.39
1920.....	.35	.02	.11	1.31	3.07	3.44	2.40	.58	2.93	.10	.05	.05	14.41
1921.....	.10	.16	.99	1.09	3.31	5.79	2.61	1.27	4.01	.62	.30	.31	21.13
1922.....	.45	1.05	.55	.76	4.02	2.44	1.34	.43	1.05	.65	2.73	.15	15.62
Average.....	.27	.29	.52	1.70	3.01	3.10	2.69	1.87	1.89	.84	.51	.29	17.07

TABLE 18.—*Monthly and annual precipitation at the field station, Hettinger, N. Dak., for the 12 years 1911-22*

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1911.....	0.20	0.01	0.16	0.57	0.44	1.19	0.28	2.33	1.97	0.55	0.40	0.40	8.50
1912.....	.40	.20	.20	1.32	2.90	1.25	4.90	1.10	2.45	.95	T	.01	15.08
1913.....	T	.00	.24	.26	2.37	3.03	2.26	1.14	1.59	1.61	.20	.02	13.02
1914.....	T	.26	.48	.71	1.15	0.69	4.34	.88	.66	.94	T	.68	16.09
1915.....	.20	.35	.10	1.56	3.17	5.57	6.85	1.56	2.02	.84	.29	.39	22.99
1916.....	.60	.28	3.04	1.82	1.79	2.99	1.79	2.20	.35	.15	.29	.60	15.91
1917.....	.69	.07	.40	1.18	1.12	1.78	1.28	.94	.09	.13	T	.17	7.85
1918.....	.02	.02	.51	1.41	1.91	1.38	3.17	2.74	.30	.10	.55	.30	12.50
1919.....	T	.10	3.08	3.76	1.59	.80	1.80	.32	.78	.34	.50	.00	13.13
1920.....	.00	.05	.25	2.35	2.39	3.29	3.35	1.11	.69	.86	.11	.06	14.31
1921.....	.90	.46	.68	.21	2.63	1.47	.63	.57	1.94	.62	.68	.42	9.93
1922.....	.22	1.50	.90	.66	3.56	3.90	.00	.75	.47	.55	3.17	.69	16.37
Average.....	.19	.27	.84	1.32	2.09	2.88	2.55	1.30	1.10	.58	.47	.31	13.88

TABLE 19.—Monthly and annual precipitation at the field station, Sheridan, Wyo., for the 20 years 1916-35¹

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1916.....	0.92	1.17	0.92	2.71	3.04	2.23	0.83	0.13	0.56	2.85	0.90	1.07	17.33
1917.....	.84	.37	1.31	.83	3.84	1.35	.09	.43	.08	1.02	.08	.78	10.83
1918.....	1.56	.08	1.65	2.92	3.18	1.54	1.16	1.02	2.80	.80	.60	.15	17.26
1919.....	.28	.23	.21	.94	1.01	1.12	.77	.30	1.16	1.80	.82	.14	8.56
1920.....	.46	.38	.49	2.35	2.68	3.11	1.11	.58	.45	1.13	.60	.32	13.64
1921.....	.44	.02	.65	.94	2.08	2.63	1.41	.30	.35	.21	1.38	.20	10.61
1922.....	1.27	.19	.35	2.63	2.82	3.48	3.12	1.27	.15	1.26	.82	.59	17.95
1923.....	.41	.23	1.34	2.37	1.95	2.94	3.45	.85	0.35	1.54	.43	.33	25.18
1924.....	.30	1.10	1.00	1.63	1.56	2.12	.98	.36	1.09	2.22	.63	.93	13.98
1925.....	.10	.79	.92	5.83	1.93	2.11	.08	.11	.59	3.01	.38	1.50	17.95
1926.....	.73	.48	.78	.47	3.22	1.09	1.73	.70	3.14	.90	1.27	.33	14.90
1927.....	.57	.19	1.17	3.49	4.79	3.28	.83	3.11	1.44	.17	2.66	.40	22.16
1928.....	1.31	.64	.82	1.54	1.75	3.68	2.78	.46	.15	2.60	1.36	.18	17.27
1929.....	.05	.52	2.08	3.02	2.20	1.81	.68	.42	1.14	1.06	1.71	1.07	17.05
1930.....	.49	.51	.64	1.22	2.30	.58	.76	.28	.03	1.64	.17	"	8.08
1931.....	.54	.57	1.70	1.21	2.19	1.11	1.47	.00	2.70	2.24	.68	.16	14.83
1932.....	1.19	.11	1.76	3.76	3.15	2.60	.85	.59	1.20	2.00	.50	.60	19.27
1933.....	.63	.51	1.98	3.16	4.39	1.23	.78	1.04	.57	1.21	.41	.34	16.25
1934.....	.15	.24	1.04	2.23	.68	1.36	.32	1.16	1.53	2.14	.25	.32	10.40
1935.....	.08	.28	1.49	1.84	3.05	1.27	.75	1.34	.86	.49	.46	.52	13.03
Average.....	.64	.43	1.15	2.24	2.03	2.05	1.23	.68	1.46	1.55	.79	.50	15.35

¹ Record previous to April 1917 from U. S. Weather Bureau Station at Sheridan.

 TABLE 20.—Monthly and annual precipitation at the field station, Belle Fourche, S. Dak., for the 29 years 1907-35¹

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1907.....	0.91	0.48	0.41	1.45	7.00	3.02	4.69	1.07	2.13	"	T	0.44	21.60
1908.....	.20	.19	1.65	1.16	3.95	1.47	1.26	.62	.52	2.03	0.20	.91	14.16
1909.....	.17	.23	.19	.84	3.87	5.59	2.45	.55	1.07	.76	.73	1.28	17.73
1910.....	.73	.70	.93	1.57	1.20	1.51	1.42	1.03	2.92	.27	.11	.10	12.55
1911.....	.13	.05	.09	.17	.45	.50	.80	1.86	.92	.39	.98	.30	6.64
1912.....	.24	.10	.71	2.32	2.26	.29	3.20	2.80	3.49	.51	.04	.13	16.09
1913.....	.57	.24	.99	.25	1.98	3.10	.35	.26	2.38	1.88	.10	.45	12.53
1914.....	"	1.00	.28	1.09	2.22	2.09	1.34	1.12	.35	1.77	.00	.43	11.70
1915.....	.92	1.01	.10	2.58	2.32	4.74	5.74	.44	1.20	1.25	.43	.17	21.02
1916.....	.30	.23	.98	.64	3.17	2.19	2.01	2.02	.20	.99	.33	.28	13.40
1917.....	.92	.74	.27	2.51	3.71	.97	.80	1.67	.35	.46	"	.92	13.32
1918.....	.99	.64	.81	2.40	1.00	1.17	3.41	2.99	3.08	.22	.15	.85	18.31
1919.....	.04	.57	.87	2.14	1.14	.35	2.59	1.02	1.20	2.49	1.22	.62	14.25
1920.....	.65	.16	1.35	2.59	8.35	5.90	2.53	.58	.63	1.67	.55	.95	25.89
1921.....	.29	"	.34	.72	1.44	3.30	2.30	.52	.72	.10	.30	.50	11.09
1922.....	1.31	.38	.20	2.84	3.42	3.74	6.52	.90	"	.79	2.82	.24	23.16
1923.....	.22	.23	.32	.82	2.31	3.81	4.54	5.35	5.95	3.14	.27	.41	27.37
1924.....	.08	.88	.70	.81	.68	1.27	1.22	2.60	.72	3.86	.93	.65	13.80
1925.....	.33	.21	.18	1.53	1.55	3.10	.39	.78	.65	.96	.19	.91	10.76
1926.....	1.07	.19	.24	.10	4.69	4.56	1.98	1.48	.72	.63	.96	.05	17.16
1927.....	.36	.13	1.14	3.92	6.90	2.81	4.26	2.13	1.17	.39	.53	.58	24.46
1928.....	.16	.07	.79	.35	1.81	3.38	4.89	1.44	1.05	.80	.57	.04	15.95
1929.....	.19	.47	2.00	1.36	4.45	3.05	3.23	.82	4.01	2.25	.41	.11	22.35
1930.....	.28	.10	.52	1.52	2.09	2.19	1.23	1.53	.31	1.46	.02	.27	12.11
1931.....	.11	.20	1.08	.47	1.68	1.42	1.31	.36	.45	.96	.31	.45	8.80
1932.....	.33	.07	.57	3.16	5.77	3.76	1.17	2.28	.57	1.42	.07	.07	19.24
1933.....	.08	.10	.96	3.41	7.61	1.22	1.56	2.61	.93	.38	.17	.18	19.21
1934.....	.29	.03	1.03	1.38	.30	3.65	1.82	.31	1.09	1.80	.47	.47	12.64
1935.....	.11	.59	1.40	.81	4.72	1.75	.48	.93	.14	.36	.35	.46	12.10
Average.....	.44	.34	.75	1.55	3.20	2.62	2.40	1.43	1.36	1.17	.46	.45	16.19

¹ Record from January 1907 to February 1908 from Orman, S. Dak. Record for March 1908 from Vale, S. Dak.

TABLE 21.—Monthly and annual precipitation at the field station, Ardmore, S. Dak., for the 21 years 1912-32

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1912	1.12	0.30	1.35	2.15	0.80	1.87	1.97	0.83	1.68	0.55	0.27	0.90	12.89
1913	.03	.40	.50	1.52	2.04	1.59	1.78	1.23	1.50	1.59	.15	0.90	13.23
1914	.02	.45	.28	3.27	1.24	3.24	.49	1.79	.75	1.51	.11	.43	13.47
1915	.50	.64	.80	4.26	3.40	6.67	6.01	1.37	4.70	.81	.11	1.08	30.41
1916	.25	.35	.64	1.04	3.01	2.58	1.80	1.09	.02	.85	.39	.29	13.53
1917	.47	.09	1.02	2.74	5.34	1.71	.47	1.09	.43	.67	.18	.70	15.81
1918	.48	.29	.60	2.85	5.80	1.75	3.49	.44	3.01	.45	.25	.66	20.26
1919	.15	.55	.02	3.78	2.85	1.50	3.05	.47	.38	2.10	.78	.14	15.28
1920	.15	.18	.07	.72	5.20	3.10	.77	1.59	.29	1.48	.29	.31	18.43
1921	1.15	.14	.07	3.23	2.55	4.54	1.26	.55	.46	.06	.08	.30	12.78
1922	.55	.30	.40	.98	3.80	2.59	4.07	.78	.15	.83	2.19	.41	17.50
1923	.02	.75	.70	.60	.75	5.03	.67	3.09	1.52	1.48	.13	.25	18.60
1924	.02	.45	.42	1.34	2.02	4.02	2.55	.72	1.24	1.70	.57	.44	11.74
1925	.20	.12	.40	.40	2.53	1.80	3.55	.72	.70	2.45	.32	.65	15.93
1926	.08	.12	.40	4.00	3.26	3.28	8.55	2.94	1.09	1.20	1.70	.09	16.66
1927	.22	.34	1.14	4.00	3.26	3.28	8.55	2.94	1.09	1.20	1.70	.09	16.66
1928	.28	.28	.49	27	1.59	3.67	3.33	2.25	1.01	1.16	.75	.27	21.07
1929	.09	.17	1.31	1.41	2.19	2.21	2.00	.70	.30	.55	.14	.10	12.05
1930	.36	.18	.37	1.93	2.69	1.24	.70	3.01	1.10	3.58	.34	.01	15.71
1931	.02	.36	.73	.19	1.13	1.80	.79	1.34	.44	1.71	.31	.33	9.24
1932	.39	.07	.71	4.17	2.73	.69	1.01	2.63	.19	.95	.09	.14	13.77
Average	.34	.34	.65	2.07	2.77	2.75	2.23	1.50	1.13	1.29	.47	.36	15.90

TABLE 22.—Monthly and annual precipitation at the field station, Scotts Bluff, Nebr., for the 11 years 1911-21

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1911	0.45	0.10	.00	2.31	0.81	2.13	1.28	0.65	2.14	1.10	0.08	0.34	11.39
1912	.20	.09	1.27	3.72	1.65	1.01	2.45	2.77	2.70	1.16	.37	.02	18.53
1913	.08	.46	.85	.13	3.72	1.71	1.30	4.33	1.18	.47	.11	.82	15.10
1914	.00	.04	.19	3.18	2.29	1.84	.39	.54	.24	.88	.00	.30	9.95
1915	.15	.71	2.12	4.27	2.37	1.94	2.20	4.62	3.65	.90	.05	.60	23.58
1916	.19	.16	.00	.53	2.21	2.14	1.87	2.24	.48	1.00	.10	.27	11.37
1917	.14	.06	.98	2.03	5.20	2.09	.62	3.37	1.65	.37	.09	.14	13.74
1918	.34	.27	.28	3.61	4.26	1.23	1.02	1.27	3.47	.60	.32	1.42	18.18
1919	.05	.45	.43	.54	1.45	1.04	1.37	.09	3.29	1.30	.70	.15	10.80
1920	.29	.41	.67	2.05	4.13	2.09	3.27	1.90	.57	1.16	.09	.33	16.86
1921	.76	.10	.14	.57	3.31	1.37	1.51	1.21	1.14	.93	.53	.77	12.38
Average	.24	.31	.64	2.09	2.86	1.74	1.57	1.81	1.80	.91	.23	.47	14.73

TABLE 23.—Monthly and annual precipitation at the field station, Archer, Wyo., for the 23 years 1913-35

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1913.	0.55	0.74	0.33	1.35	2.25	1.51	2.05	2.09	2.23	0.65	0.46	1.65	15.88
1914.	.7	.60	.56	2.54	1.46	1.12	1.45	2.03	.32	1.29	.26	.16	11.77
1915.	.08	.49	.71	4.90	1.78	1.83	1.55	2.53	1.95	1.81	.03	.56	15.32
1916.	.10	.06	.19	.74	1.61	.48	1.81	4.05	1.37	.73	.88	.34	12.39
1917.	.06	.80	.85	1.87	4.56	.46	1.79	1.20	.91	.57	.40	.61	14.26
1918.	.47	.89	.19	4.13	1.86	2.78	2.74	1.66	2.41	1.33	.54	.58	19.59
1919.	.17	.14	.87	.53	.31	.59	2.70	1.19	3.10	1.48	1.28	1.10	13.38
1920.	.20	.60	.34	3.88	2.08	4.33	1.21	1.25	.88	.57	.15	.27	15.85
1921.	.05	.07	.14	.86	2.19	2.37	1.70	.70	.05	.21	.08	.73	10.33
1922.	.32	.28	.20	2.43	2.15	2.40	1.51	2.36	.14	.06	2.23	.44	14.62
1923.	.06	.42	1.06	.56	2.98	2.69	1.35	4.59	1.14	3.32	.16	.69	18.75
1924.	.06	.30	.87	.58	3.38	.86	.50	.27	2.54	1.66	.12	.13	11.27
1925.	.01	T	.32	1.28	1.27	1.11	3.88	1.38	.78	2.37	.65	.67	13.22
1926.	.29	.16	.36	1.10	2.48	4.44	3.13	1.50	.46	.83	.12	.33	15.19
1927.	.02	.30	1.22	1.28	1.60	2.70	2.79	3.10	1.53	1.04	.16	.12	16.13
1928.	.10	.47	.56	.36	3.78	2.67	1.45	.72	.06	.73	.54	.92	11.46
1929.	.02	.31	.30	3.11	1.49	.45	2.23	2.28	1.65	.53	.75	.13	13.10
1930.	.24	.19	.28	1.10	3.69	.18	1.05	6.21	1.35	2.32	.40	.01	17.02
1931.	.02	.27	.25	.92	1.24	1.92	1.53	1.57	.58	1.33	.15	.12	9.90
1932.	.03	.20	.60	.48	1.67	3.47	1.60	1.16	.76	.19	.77	.12	9.90
1933.	.06	.07	.44	1.83	2.92	.54	1.66	3.13	2.12	.00	.04	.26	13.12
1934.	.03	.84	.35	.97	1.48	1.57	1.32	1.51	.47	.00	.03	.07	8.58
1935.	.03	.13	.61	2.60	7.63	1.56	1.71	.52	1.74	.19	.13	.07	17.22
Average.	.16	.37	.50	1.72	2.43	1.84	1.88	2.05	1.21	1.02	.41	.38	13.97

TABLE 24.—Monthly and annual precipitation at the field station, North Platte, Nebr., for the 30 years 1906-35

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1906.	0.61	0.80	2.22	2.89	2.82	0.98	3.14	5.56	4.25	3.05	1.01	0.96	27.99
1907.	.39	.51	.10	.23	2.61	2.53	4.74	1.80	2.44	.64	.31	.80	17.10
1908.	.16	.78	.20	.45	4.50	6.01	3.44	1.88	.20	3.41	.59	.20	21.91
1909.	.29	1.61	.98	.55	3.09	4.99	5.48	1.73	.46	.22	2.24	1.37	23.01
1910.	.34	.02	.19	.62	1.76	3.11	.12	3.21	.97	.01	.11	.72	11.18
1911.	.25	.39	.20	2.34	1.34	.50	3.01	2.64	1.28	3.45	.04	.65	16.70
1912.	.71	.81	3.08	3.02	1.72	.70	2.78	1.23	2.04	1.44	.01	.18	17.85
1913.	.16	.94	1.08	2.09	2.44	2.81	2.76	1.28	.99	.14	.14	3.09	18.52
1914.	.18	.96	.41	1.46	1.66	4.59	1.37	3.54	.16	1.39	T	.87	16.59
1915.	.51	1.11	2.23	6.77	5.80	4.76	6.19	3.19	2.09	1.16	.22	.82	34.85
1916.	.85	.81	.20	.70	2.23	4.40	.40	2.88	1.40	.50	.47	.42	15.26
1917.	.74	.35	1.48	1.45	4.02	2.00	.78	3.46	2.45	.32	.71	.27	18.03
1918.	.54	.28	.32	2.32	3.25	1.82	1.93	1.98	.46	1.43	.29	1.31	15.93
1919.	.03	1.50	.44	1.77	2.72	7.33	5.33	1.12	1.81	1.36	2.83	.32	26.56
1920.	.07	.72	.38	4.24	3.40	1.93	3.31	4.52	.15	1.29	.04	.60	20.74
1921.	.68	.36	.42	1.17	2.43	1.14	3.12	3.50	1.56	.92	.04	.14	15.48
1922.	.66	.05	.47	2.88	4.19	1.17	4.69	2.35	.66	.14	2.35	.01	19.62
1923.	.11	.14	.38	2.02	6.17	4.63	5.52	3.80	1.40	1.77	.45	.30	26.78
1924.	.08	.36	1.93	.36	2.48	2.35	1.81	1.85	2.04	.95	.08	1.81	16.10
1925.	.07	.51	.22	2.07	2.30	3.09	1.36	2.46	1.20	.76	.37	.64	15.05
1926.	.22	.12	.54	.37	1.29	3.51	2.11	3.20	1.20	.63	.33	.28	14.00
1927.	.48	1.26	3.74	2.33	4.39	.51	3.53	3.42	.26	.26	.26	.28	21.16
1928.	.13	.17	1.40	T	4.21	4.72	6.40	T	.75	2.61	.99	.08	21.46
1929.	.23	.44	.28	4.33	2.36	.73	1.12	3.42	2.54	1.62	.48	.01	17.56
1930.	.51	.24	.29	3.61	6.28	4.62	.78	2.22	1.11	4.15	1.03	.17	25.91
1931.	.03	.76	1.81	1.27	.21	4.10	.79	.80	.41	.34	.59	.15	11.26
1932.	.41	.39	.64	2.21	1.78	4.84	5.24	1.67	2.33	1.03	T	.27	18.71
1933.	.16	.15	.62	5.73	2.85	.61	1.24	2.83	2.23	T	.17	1.06	17.76
1934.	.05	.52	.36	.41	.67	2.12	1.03	3.99	3.77	.30	.17	.42	13.81
1935.	.18	.31	.57	5.06	8.19	3.64	.72	3.05	.39	.22	.78	.27	23.38
Average.	.31	.54	.81	2.13	2.06	3.04	2.64	2.55	1.42	1.15	.58	.60	18.72

TABLE 25.—*Monthly and annual precipitation at the field station, Akron, Colo., for the 28 years 1903-35*

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1903	0.60	0.34	2.06	1.70	3.30	2.37	2.42	1.47	0.05	3.20	2.00	T	16.85
1904	T	1.38	3.06	1.40	1.87	3.32	4.61	3.77	2.16	.86	.48	0.55	22.46
1910	.05	.16	.28	3.96	2.06	1.38	1.47	3.72	3.81	.05	.12	.32	17.36
1911	.60	.44	.06	2.63	1.15	1.48	1.34	1.30	2.40	1.47	.28	1.38	14.51
1912	.28	1.43	.78	2.49	2.88	3.39	3.58	1.58	1.88	1.99	.18	.29	20.73
1913	.22	.46	1.57	2.19	1.44	1.35	1.85	1.14	2.08	.34	.70	3.27	16.55
1914	.03	.32	1.20	4.01	1.46	3.54	1.96	1.05	.23	2.68	.10	.90	15.88
1915	1.10	1.98	1.50	5.19	4.13	3.75	1.10	3.51	1.76	.48	.15	.65	25.00
1916	.50	.09	.09	1.59	2.24	2.00	1.77	2.82	.20	1.02	.75	.61	13.74
1917	.28	.88	.72	.90	7.79	.56	1.52	1.78	2.19	.57	T	.50	17.50
1918	.07	.80	.65	1.20	1.76	.98	3.10	7.36	2.43	1.07	.75	1.55	22.28
1919	.35	.17	.05	1.96	1.59	2.27	1.79	.44	2.62	1.64	1.29	.70	15.52
1920	.22	.17	.05	3.28	2.90	3.97	4.72	1.45	1.80	.44	.47	.90	21.35
1921	1.22	T	1.25	2.77	.47	1.32	2.88	.92	.79	.87	.20	.65	13.44
1922	.65	.25	.15	3.96	3.53	1.43	3.24	1.24	.06	.05	1.90	.10	16.66
1923	.50	.18	.25	1.65	4.94	2.17	3.62	.75	.82	1.91	.47	.70	18.16
1924	T	.59	1.25	.31	3.26	.35	1.71	.77	4.04	.40	.13	.77	14.08
1925	.05	.01	.39	3.24	1.19	2.90	1.03	1.01	.50	1.46	.47	.53	11.82
1926	.45	.05	.60	.18	3.77	1.42	6.46	5.07	.72	1.03	.41	.28	20.16
1927	.17	.29	2.41	2.27	1.46	5.16	3.00	3.74	.90	.14	.64	.22	20.40
1928	.13	.17	.32	.17	3.52	5.39	3.14	.25	.04	1.75	.49	T	15.37
1929	.07	.34	.32	3.43	1.19	1.15	4.44	2.66	2.67	2.76	.49	.09	18.61
1930	.07	T	.32	2.28	5.52	1.61	3.54	3.48	.39	.83	1.05	.09	19.03
1931	.01	.71	.95	1.35	1.35	2.20	1.49	1.04	.50	.61	.11	.00	10.74
1932	.27	.25	.60	1.93	2.91	2.80	4.17	1.27	.05	.49	.19	.21	15.14
1933	T	.04	.74	4.58	4.15	.92	2.01	4.54	1.13	T	.04	.78	18.90
1934	.02	.91	.22	1.42	4.14	.14	.51	3.56	.75	.04	.37	.09	12.61
1935	.01	.23	1.22	3.25	7.35	3.08	.37	.83	2.24	.21	.28	.04	19.09
Average.....	.28	.44	.78	2.22	2.88	2.37	2.59	2.23	1.40	.96	.52	.61	17.31

TABLE 26.—*Monthly and annual precipitation at the field station, Colby, Kans., for the 22 years 1914-35*

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1914	0.05	0.45	0.21	1.21	3.07	2.32	5.01	1.85	0.52	0.57	T	0.51	14.07
1915	.38	1.49	1.43	3.61	4.55	4.03	6.60	4.17	.67	1.10	0.48	.48	28.99
1916	.65	.05	.33	2.03	1.33	3.15	2.07	1.48	.40	.62	.21	.37	12.59
1917	.12	.20	.56	1.66	2.01	1.42	3.07	5.78	4.25	.28	.42	.20	19.97
1918	.77	1.79	1.34	1.05	2.16	.19	1.89	1.88	2.16	2.87	.21	2.63	18.91
1919	T	1.57	.36	2.82	2.23	2.47	3.95	.65	2.07	.82	1.63	.19	18.97
1920	.23	.31	.46	3.74	2.42	5.63	4.19	3.75	2.56	2.71	.27	1.31	27.63
1921	1.15	.03	.68	1.88	1.95	3.52	4.24	2.23	2.80	.45	.18	.46	19.37
1922	.18	.33	1.26	4.06	2.55	1.34	2.74	1.38	.43	.08	3.13	.02	17.54
1923	.05	.18	.88	2.80	6.28	3.27	3.46	3.55	1.87	3.43	.12	.75	26.64
1924	.22	1.82	1.78	.48	1.30	.80	1.77	3.09	1.78	.95	1.4	1.97	18.10
1925	.23	.25	.47	1.44	3.52	1.07	1.50	3.50	2.00	.82	.16	.39	15.35
1926	.52	.12	.50	.87	2.08	1.57	2.04	.92	.22	.83	.34	.10	10.58
1927	.11	1.26	1.60	3.51	.49	3.75	2.00	1.87	2.68	.25	.10	.45	18.00
1928	T	.48	1.53	.89	4.58	5.40	2.66	1.19	2.23	2.66	.65	.06	19.74
1929	.06	.76	.13	3.15	3.25	1.96	1.07	1.13	3.02	1.70	1.81	.02	18.06
1930	.20	.32	.08	2.41	5.11	3.29	1.57	4.15	.73	5.54	1.23	.15	24.78
1931	.00	1.51	.24	.82	1.22	2.00	2.77	1.49	.35	.93	1.06	.04	14.53
1932	.38	.57	.34	2.05	1.45	3.08	3.26	1.03	.83	.34	.27	.35	14.86
1933	T	.08	.70	.36	.92	1.59	.41	1.40	.76	.09	.18	.23	16.69
1934	.06	.87	.51	.36	.92	1.59	.41	1.40	.76	.09	.18	.23	7.37
1935	.01	.30	.33	.29	2.92	3.14	.50	.89	1.69	.11	1.17	.14	11.49
Average.....	.24	.67	.81	1.98	2.63	2.55	2.68	2.43	1.52	1.20	.69	.52	17.92

TABLE 27.—*Monthly and annual precipitation at the field station, Hays, Kans., for the 29 years 1907-35*

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1907	0.64	0.22	0.85	0.11	0.80	4.72	9.09	2.85	2.06	1.06	0.11	1.78	24.27
1908	T	.62	T	2.18	2.98	6.05	2.82	5.29	.74	1.76	1.79	.03	24.56
1909	.39	.28	1.16	.39	1.28	10.04	3.66	1.37	2.90	1.78	3.55	1.60	27.80
1910	.58	.26	.03	.97	3.88	2.58	2.02	4.01	.60	.32	T	.14	15.59
1911	.12	2.12	.14	.78	2.10	.85	2.66	3.44	2.56	.30	1.14	1.82	17.03
1912	.02	1.95	1.80	1.55	3.40	3.49	.55	3.96	1.59	.56	1.13	.03	19.96
1913	.36	.68	.41	2.97	5.72	3.34	.55	.11	4.64	.25	.72	3.14	22.69
1914	.04	.42	.16	2.24	3.36	3.13	1.51	3.01	.53	1.17	T	.63	16.19
1915	.68	1.80	1.74	3.84	5.96	5.04	6.13	3.91	2.88	.58	.30	.04	32.90
1916	.53	.15	.31	2.60	1.49	5.87	.40	2.03	1.15	1.04	.02	.61	16.20
1917	.09	T	.07	2.07	1.65	2.15	1.07	5.56	1.54	.09	1.64	.15	16.08
1918	.80	1.15	1.71	2.81	4.86	.60	3.24	1.81	1.35	2.31	1.10	2.38	24.12
1919	T	2.18	.33	5.01	5.89	2.83	1.34	.85	3.28	1.85	1.54	.15	25.25
1920	.05	.37	.30	2.25	3.68	1.93	2.27	5.63	1.37	3.58	.73	.46	22.62
1921	.40	.10	.49	3.59	2.64	3.76	3.28	3.46	.63	.05	.00	.50	18.90
1922	T	.93	1.71	4.96	3.24	3.56	2.48	.59	.28	.27	1.28	T	19.30
1923	T	.10	1.04	1.61	4.29	4.44	.54	4.02	4.33	4.37	.26	.41	25.44
1924	.31	.26	1.81	.92	3.26	.47	1.97	1.99	.76	.49	.25	1.11	13.60
1925	.05	.24	.38	3.90	.88	4.22	6.34	3.29	.96	.75	1.12	.02	22.15
1926	.36	1.13	1.86	.68	1.90	2.57	1.90	.79	2.59	.60	1.12	.37	15.87
1927	.04	.98	1.85	2.50	1.87	8.09	1.55	6.95	2.34	T	.03	.10	26.39
1928	.03	1.57	1.42	1.25	3.17	8.15	6.92	1.72	.56	2.01	1.88	.02	28.70
1929	.20	.61	.01	2.12	3.99	1.04	6.66	2.75	3.40	2.96	1.51	.03	25.18
1930	.10	.63	.02	1.71	3.10	3.86	1.10	3.34	2.14	5.25	2.63	.14	24.02
1931	.02	.21	3.96	3.18	1.42	4.89	1.36	2.65	.23	1.57	3.76	.56	23.61
1932	1.82	.50	.82	2.04	2.78	8.46	2.05	4.80	4.52	1.69	.12	.18	29.78
1933	.07	.21	.33	2.05	2.18	.67	2.00	2.33	1.99	.03	.54	2.17	14.57
1934	.29	1.16	.45	.33	1.20	4.85	.64	3.03	1.28	.52	.75	.02	14.72
1935	T	.28	.15	.16	6.82	3.96	.07	1.56	4.29	.73	2.17	.20	20.40
Average.....	.27	.74	.86	2.11	3.10	3.99	2.63	3.00	1.99	1.31	1.04	.63	21.67

TABLE 28.—*Monthly and annual precipitation at the field station, Amarillo, Tex., for the 15 years 1905-1919*

Year	January	February	March	April	May	June	July	August	September	October	November	December	Annual
	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>	<i>In.</i>
1905	1.00	1.52	2.62	4.32	6.16	2.19	3.76	0.63	3.08	0.30	5.09	1.45	32.32
1906	.41	.51	.64	3.33	1.15	2.07	2.90	6.76	1.98	2.49	2.58	.19	24.92
1907	1.11	.34	.02	1.30	1.13	2.23	1.47	6.15	.97	1.64	.69	1.46	18.41
1908	.26	.72	T	1.86	3.44	1.73	4.64	3.39	1.50	.37	.51	.00	18.42
1909	.07	.28	.18	.27	1.13	5.90	2.19	1.39	1.90	1.18	3.25	.54	19.18
1910	.05	.17	.41	.53	2.61	1.48	2.61	2.46	.05	.13	.19	T	10.69
1911	.07	3.26	.50	3.90	6.74	.35	5.92	2.54	1.30	1.53	.55	1.14	27.80
1912	T	1.85	.78	3.82	1.62	2.31	2.50	1.51	2.28	.33	T	.33	14.33
1913	.01	.41	.44	1.69	1.71	2.20	1.40	.47	5.00	.83	2.26	2.17	19.28
1914	T	.01	.02	1.27	3.83	.65	1.90	2.52	1.10	3.98	.00	.87	16.15
1915	.29	1.49	.58	4.89	2.03	1.16	3.74	4.64	4.03	1.02	.25	.05	25.07
1916	.17	.00	.56	1.82	.86	2.70	1.17	3.41	2.16	3.07	.08	.68	16.58
1917	.12	.06	.03	.61	2.83	.66	2.61	5.50	2.05	.31	.55	.01	15.34
1918	.13	.29	.86	4.48	2.39	1.19	2.69	2.20	.74	2.24	.83	1.73	17.17
1919	.05	.66	.84	2.52	2.03	3.52	2.39	3.43	4.72	.57	1.26	.95	22.95
Average.....	.25	.76	.63	1.98	2.65	2.03	2.79	3.13	2.29	1.33	1.21	.86	19.91

¹ Record previous to April 1907 from U. S. Weather Bureau, station at Amarillo.

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