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EC14 The Climate of Nebraska

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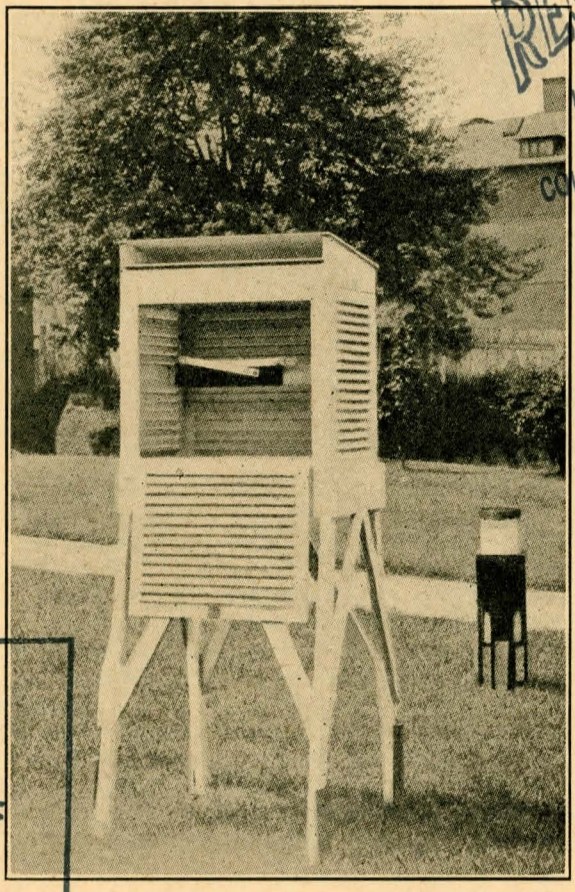

Thermometer Shelter and Rain Gage.

UNITED STATES
DEPARTMENT OF AGRICULTURE
COOPERATING

THE CLIMATE OF NEBRASKA

By George A. Loveland

The vegetation of any part of the earth is controlled by the soil and the climate. Plants can grow only when the sunshine, temperature, rainfall, and wind, that is, the weather conditions, are favorable. The climate of a place is its average weather. The average values of the elements that make up weather can be determined only by means of careful observations continued for many years.

The climate of Nebraska is known because a large number of records have been kept, most of them by intelligent, progressive citizens of the state. The earliest preserved records commence in the fifties. They were kept in part by the early settlers and in part by the soldiers at the frontier army posts. Many citizens co-operate with the United States Weather Bureau at the present time, freely giving their work to continue the daily record of Nebraska's weather.

GENERAL CLIMATIC CONDITIONS

The climate of Nebraska is determined by the geographical location of the state, near the center of a large continent with a high mountain range near its western border, conditions which cannot be modified by man. The important factors in determining its climate are: First, the distance from the equator, because the heat received from the sun is greater at the equator and decreases northward. Second, the altitude, or elevation above sea level, because the higher localities have lower temperature. Third, the distance and direction from the Gulf of Mexico and the Atlantic Ocean, because the supply of moisture for rain and snow comes mainly from these large bodies of water. Fourth, the Rocky Mountains, located near the western boundary, because they have an important effect upon both temperature and moisture.

Nebraska is in the general path of the low pressure or storm areas (technically called cyclones) that move across the United States from west to east. These are large eddies in the great river of air that is flowing constantly around the earth from west to east between latitudes 35 and 80 de-

grees. They move with the current of air and are similar to the eddies, or whirlpools, that float with the current in a river of water. However, these eddies or cyclones are drifting in an enormous river of air and are very large, frequently five hundred to two thousand miles in diameter; sometimes one cyclone covers more than half the United States.

Any violent and extensive commotion in the atmosphere is called a storm and these cyclones are one kind of storm. The thunder-storm and the tornado are also storms much smaller in area and much more violent. In fact, they occur in, and are a part of, a cyclone. All storms are characterized by a strong upward movement of the air, and the vapor of water, or moisture, is condensed by the cold of elevation. Storms are accompanied by clouds and usually by rain or snow, but often the storm (commotion of the air) extends beyond the area of rain or snow. These large storm areas move with an average speed of 600 miles in 24 hours, and are preceded by southerly winds and higher temperature and followed by northerly winds with lower temperature. Each storm causes an average of one or two rainy days as it passes eastward, when the center of the storm is near enough to Nebraska.

There is an average of two of these storm areas passing across the country each week with fair weather between and if the center of the storm passes over the state the change in weather conditions is rather rapid. However, if the center is some distance north or south of the state, as frequently occurs, the change in weather conditions is less rapid and less pronounced.

It is rarely the case that the storms follow each other in exactly the same path, and the regular change suggested by the average movement of storm areas does not occur at any one place. Besides, the storms vary in energy and rapidity of movement. Especially is this true at the different seasons of the year. They move more rapidly in winter than in summer and have greater energy. This is because the difference in temperature between the equator and the poles is greater in winter, which causes more rapid eastward movement of the river of air and more energetic eddies in it.

In the fair weather period between these storms, especially in winter, large volumes of pure, invigorating, and relatively cold air flow across the state. The most severe of these are called cold waves. A cold wave is a sudden fall of temperature of at least 20 or more degrees in 24 hours, with zero or

below as the lowest temperature in December, January and February, and with 16 degrees or below as the lowest in the other months of the year.

SUNSHINE

In Nebraska the all important sunshine—without which vegetation cannot develop—is practically always sufficient. Sometimes during the hot months when the continued sunshine, day after day, reaches a relatively dry soil it is injurious, because of the high temperature produced in both earth and air. Such injury occurs only when there is a lack of moisture in the soil, for when the soil is moist the sun evaporates a part of the moisture and heats the soil proportionately less, because the heat is used up in changing the water in the soil to vapor or steam. Thus, a part of the sun's heat has no effect upon the temperature of moist soil.

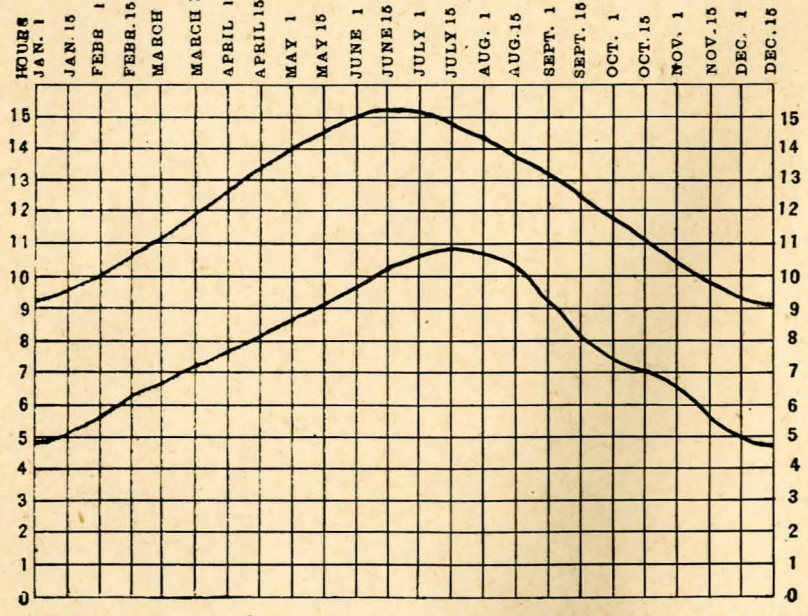

FIG. No. 1—Hours of Sunshine in Nebraska

In the chart the upper line indicates the number of hours the sun is above the horizon in the different parts of the year, and the lower line indicates the number of these hours it is

on the average free of clouds and so actually shining on the earth. The space between the lines indicates the average number of hours the sun is obscured by clouds in the various parts of the year. It will be noticed that in January the sun is obscured nearly one-half of the nine hours it is above the horizon, while in July and August it is obscured but a little more than one-quarter of the fifteen hours it is above the horizon. The number of hours the sun is shining on the earth, as well as the directness of the ray, is important in the control of temperature. Both tend to increase temperature in the summer and both are caused by the fact that the sun is farther north in the summer.

TEMPERATURE

The temperature in most of Nebraska is not a limiting factor in the growth of crops common to the temperate zone but in parts of the northern and northwestern sections the low temperature, combined with other unfavorable climatic conditions, limit productiveness.

An accurate thermometer is needed to determine temperature. It is a waste of time and effort to keep a careful record from an inaccurate thermometer. A set of one maximum and one minimum thermometer gives the best temperature data, for from these instruments the highest and lowest temperature can be obtained from one daily reading and from these a good mean temperature can be obtained. The daily mean temperature is really the average of the hourly temperatures, but the average of the highest and lowest will vary but little from the true mean and is frequently used. Very good results can be obtained from readings taken from an accurate common thermometer at 7 a. m., 2 p. m., and 7 p. m. (or better 9 p. m.). The mean is then made by adding the 7 a. m., 2 p. m. and twice the evening reading together, and dividing the sum by 4. The daily minimum temperature usually occurs just before sunrise and the maximum from 3 to 5 p. m. The highest and lowest temperatures can be approximated by noticing the thermometer at the times mentioned.

The thermometer should be located in the shade, for if it is placed in the sun it gives the effect of the sun on the mercury in the thermometer and not the temperature of the air. Mercury, iron, and metals generally become very hot when in direct sunshine, much hotter than air, soil, vegetation, or animals. The standard test of the result of the sunshine is the temperature of the air. Therefore the thermometer should

be protected from the direct rays of the sun and from radiated heat from the earth or buildings. This can best be done by placing it in a shelter or box made with louvre or lattice work for sides, which allows the air to pass freely through but with boards for top and bottom to protect from radiated heat.

The following chart shows the mean annual temperature, which is obtained by averaging the mean monthly temperatures and that in turn is obtained by averaging the mean daily temperatures for the month.

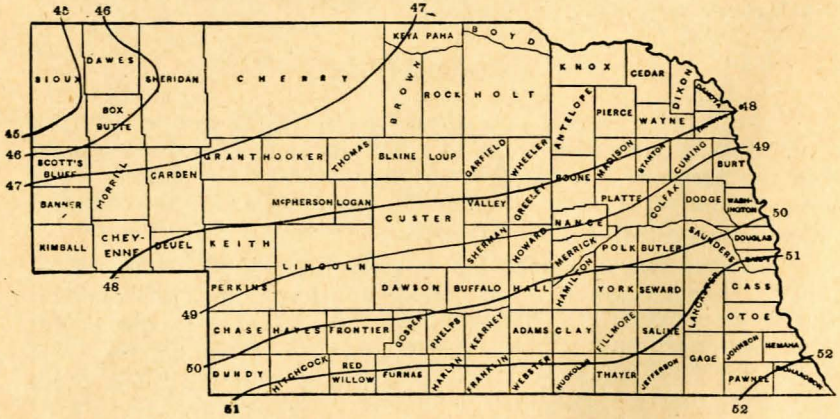

FIG. No. 2—Mean Annual Temperature.

The lines are drawn for each degree. The average temperature for the state for the year is 48.7 degrees. The highest mean temperature, 52 degrees, occurs in the southeastern portion of the state at an elevation of 900 feet. The temperature decreases westward along the southern border to 50 degrees in Dundy county at an elevation of 3,000 feet; however, the mean annual temperature is about 51 degrees in most of the southern tier of counties. It decreases northward about 1 degree for each 38 miles in most of the State, but is more rapid in the northwestern section and less rapid near the Missouri River in the northeastern section. Besides being farther north, the northern border is more elevated, ranging from 1,300 feet in the east to 3,700 feet in the west. The temperature ranges from nearly 48 degrees in the northeast to less than 45 degrees in the northwest.

January is the coldest month, with a mean temperature of 25 degrees in the southeast and 20 degrees or a little below in

the north. February is almost as cold, averaging about 3 degrees warmer, while December is next, with an average of but 1 degree higher than February. While the coldest weather of the year may occur in any of these three winter months it is most likely to occur in January, and it most frequently occurs in the last half of that month. In the coldest days of winter the temperature usually falls to between 10 and 20 degrees below zero, while on rare occasions, 30 degrees below zero occurs. In the elevated portion of the northwestern part of the State as low as 47 degrees below zero has been recorded, while in a large portion of the northern and central counties the lowest recorded temperature is about 40 degrees below zero.

The temperature rises rapidly after February, approximately one-third of a degree a day until the latter part of June. This is followed by two and one-half months of hot weather, with a normal daily mean temperature from 70 to 78 degrees. The maximum temperature frequently exceeds 95 degrees and usually a few times each summer it exceeds 100 degrees. The hottest days in summer mostly occur in the last half of July, but the hottest spell of the year sometimes comes in August or September. The highest temperature recorded is 114 degrees, and in several years, at a few places, temperatures ranging from 108 to 112 degrees have been recorded. These high temperatures seldom last more than a few hours in the middle of the day. Usually there is a fresh wind blowing and the air is quite dry, making the high temperature less oppressive than the figures would seem to indicate. From the middle of September the temperature decreases rapidly, approximately one-third of a degree a day, to December.

DEW AND FROST

In the clear, relatively cold air of the fair weather periods between the storms, objects of the earth lose their heat rapidly by radiating it into space. Vegetation, for instance, becomes cooled below the dew point of the air near it and small drops of water are deposited. This is called dew.

In the spring and fall when the temperature of the vegetation falls below 32 degrees, the deposit instead of being water is crystals of ice. This is called frost. The temperature of the vegetation may be 10 or more degrees lower than is indicated by the thermometer in the shelter located about five feet above sod. Frost usually injures vegetation.

Light frosts, sufficiently severe to kill tender vegetation or only a few of the less vigorous fruit blossoms, are likely to occur throughout May and sometimes early in June, especially in the northwestern counties. The average date when the last freezing temperature or frost sufficiently severe to kill staple crops occurs, is shown by the following map:

The latest that a killing frost has occurred in most of the State is May 27th. This was in 1907, when the freezing temperature covered most of the southern and eastern counties. In the northwestern part of the State such severe frosts have occurred in June, and in 1902, one occurred on June 21st. The last killing frost, it will be observed, happens as a rule in the southeastern section in the last ten days of April,

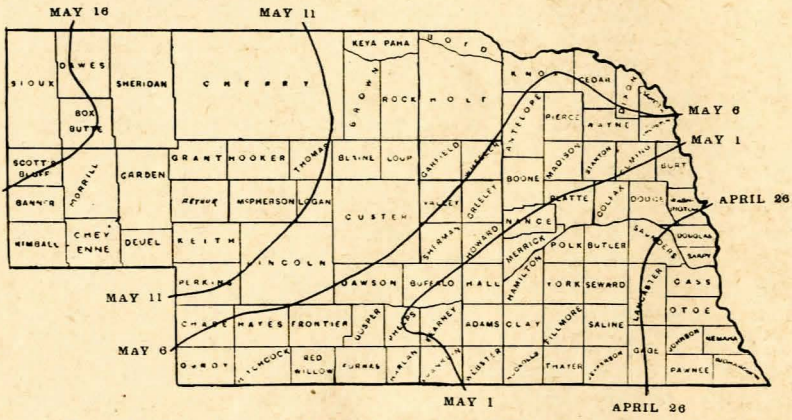

FIG. No. 3.—Average dates of the last killing frost in spring

but comes gradually later northward and westward, occurring near May 1st in the greater portion of the southern and eastern sections, and from May 10th to 15th in the more elevated portions in the north and west.

Light frosts, not sufficiently severe to cause any practical damage to vegetation, have occurred in a few years in the very last days of August, and in several years in the first half of September. Such frosts, and in some years, more severe ones, are to be expected during the last half of September. The map shows the average date in the fall when the first freezing temperature, or frost sufficiently severe to kill staple crops, occurs.

It will be noticed that severe frost happens usually after October 1st in a large area in the southeastern part of the State. It occurs earlier in the northwest, where for a large area the date averages between the 21st and the 25th of September. The earliest date in the records of the past fifty years for the southern and eastern sections was September 12th. This was in 1902. The average number of days without a killing frost ranges from 160 days in the southeast to 130 in the northwest. This is usually called the growing season, although grass and some small grain extend the period of growth several weeks at each end.

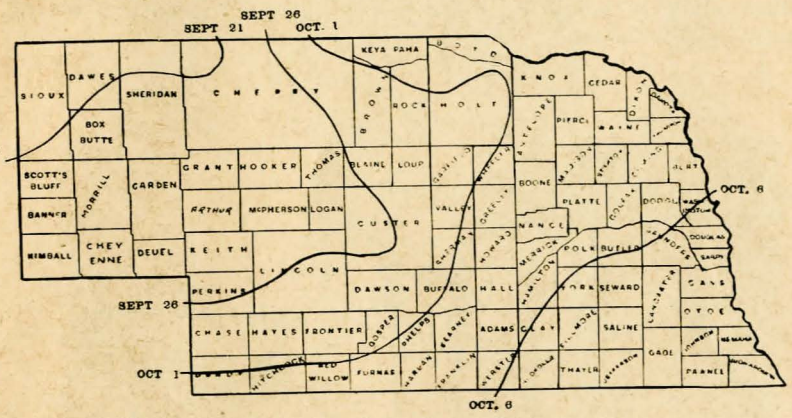

FIG. No. 4.—Average date of the first killing frost in autumn.

CLOUDS

The invisible vapor of water, which is always in the air, is converted into visible drops of water by cooling the air below the dewpoint. This is the temperature at which the air is saturated or holds all the vapor it can hold. With a further cooling some is condensed, that is, changes form and appears as drops of water.

The cooling of the air sufficiently to cause extensive condensation is caused by an upward movement such as takes place in storm areas. The condensation takes place usually from one to five miles above the earth, and the collection of drops or ice crystals is called clouds. The clouds are named from their appearance. The white, high, fibrous feather-like clouds are formed of ice crystals and are called cirrus. The heavy, thick, woolly-appearing clouds are called cumulus.

These frequently develop into the cumulo-nimbus, or thunderheads, so often noticed in connection with thunderstorms in Nebraska. The lowest clouds, a simple veil frequently covering the whole sky, are called stratus. Clouds combining the characteristics of the primary kinds are given a name indicating the fact, like cirro-cumulus, etc.

When the upward current of air is rapid large volumes of air are cooled below the temperature of the dew point, condensation is rapid, numerous small drops of water will be formed, and from these will develop the larger drops which fall as rain. When the temperature where the condensation takes place is below 32 degrees crystals of ice and flakes of snow will develop.

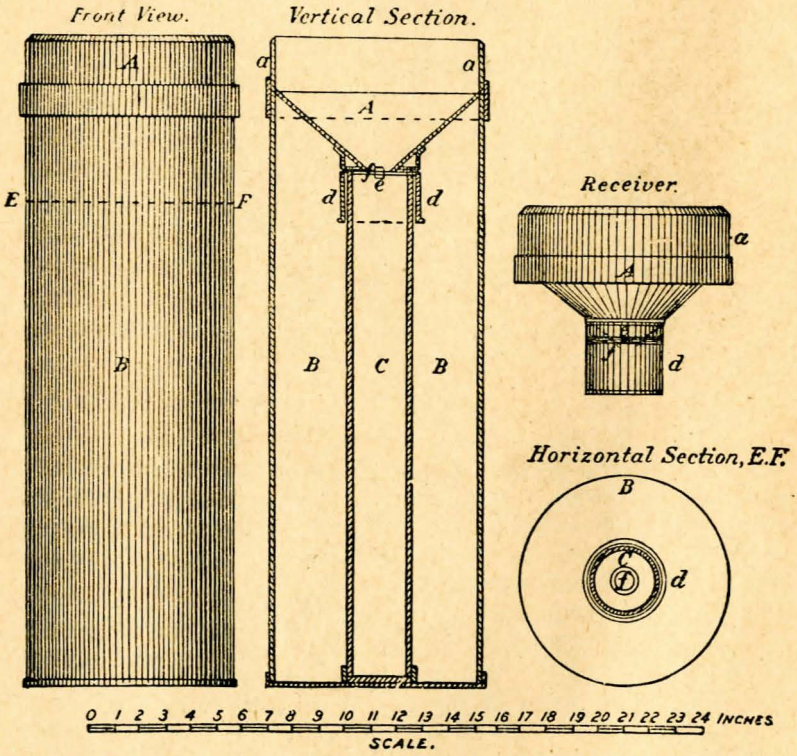

FIG. No. 5—Rain Gage.

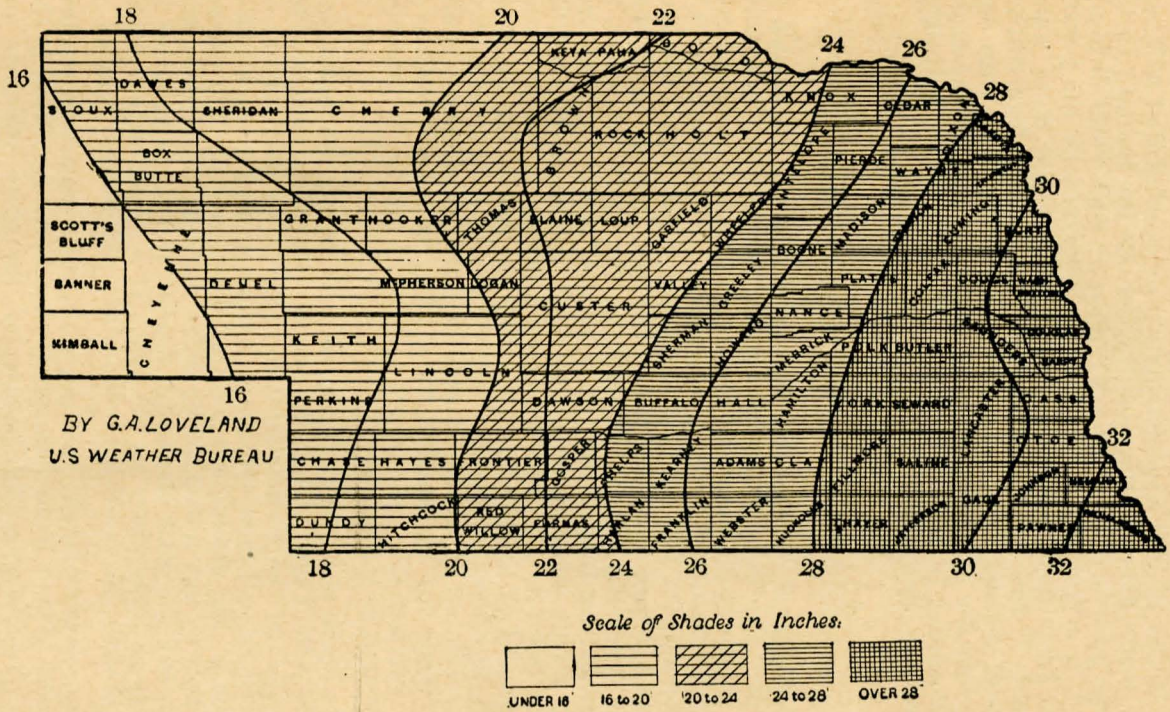

FIG. No. 6—Average annual precipitation for the different sections of Nebraska.

PRECIPITATION (Including Rain and Snow)

It is the amount and distribution of rainfall that will best repay study, for it is the most likely to be the limiting factor in crop growth. A larger proportion of each rainfall is absorbed by a cultivated soil than was absorbed by the prairie soil of early days, and the same rainfall makes more water available in the soil for vegetation now than before cultivation was general. But from records covering more than seventy years the rainfall is fairly well determined for the State, and it seems to be established that there is no noticeable progressive change.

HOW TO MEASURE RAINFALL

The rainfall is measured in a gage like the one shown in the cut. The top, cylindrical portion marked "A" is exactly eight inches in diameter and is provided with a funnel shaped bottom to conduct the precipitation to the measuring tube "C". The diameter of this tube is 2.53 inches, which makes the area of the cross section of the measuring tube just one-tenth that of the receiving funnel. Therefore, the depth of water in the measuring tube is ten times what it would be in the receiver. This magnifying of the depth allows more accurate measurement as .01 of an inch in the collecting funnel would measure 0.1 of an inch in the measuring tube. The overflow "B" is to collect water in a heavy rain after the measuring tube is full. The increased accuracy of measurement is the only reason for the smaller tube. Any receptacle with perfectly vertical sides and which is about 8 inches in diameter can be used as a rain gage.

The depth of water is measured by inserting the measuring stick into the gage through the funnel. When the stick reaches the bottom of the measuring tube it should be held for one or two seconds and then withdrawn and examined to see at what division of the graduation the top of the wet portion comes. It is best to use a measuring stick divided into inches and tenths, and the stick should be slender and small in order to displace as little water as possible. If a vessel with vertical sides is used the reading on the stick will be the rainfall.

The exposure of the rain gage is a very important matter. The most serious disturbing effect in collecting rainfall is the wind. A position should be selected, therefore, which is unobstructed by large trees, buildings, or fences. Low bushes

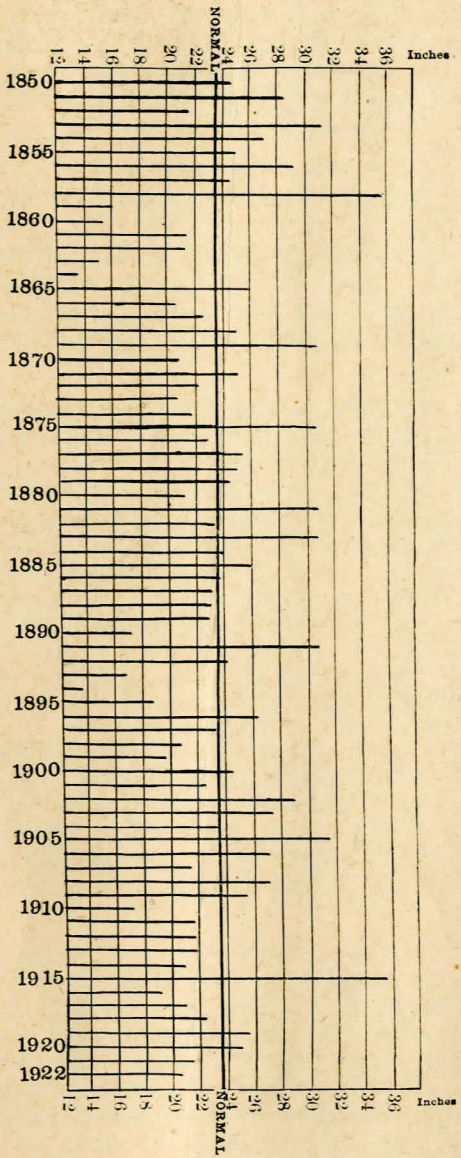

FIG. No. 7.—Average annual precipitation for Nebraska from 1850 to 1922.

and fences or walls that break the force of the wind in the vicinity of the gage are, however, beneficial if at a distance at least as great as the height of the object. Every precaution should be taken to protect the gage from interference of animals or unauthorized persons. The gage is best placed upon the ground with the top level.

DISTRIBUTION OF PRECIPITATION

The average annual precipitation for the State as a whole is 23.59 inches. Most of this is rain, the snowfall for the year averaging only about 29 inches, equal to nearly two and one-half inches of water, or about one-tenth the annual precipitation.

The year is divided into wet and dry seasons. May, June, and July constitute the wet season with 46 per cent of the annual amount, while November, December, January, and February are the four dry months with but 12 per cent of the normal amount. The other 42 per cent falls during the remaining five months or approximately one-twelfth of the annual amount for each month. As this indicates, very little rain or snow falls during the last fall and winter months, the average being less than three-fourths inch of water a month. A slight increase is manifested in March, but the spring rains begin in April, when two to three inches is the normal for most parts of the State.

June is the month of heaviest rainfall. It is also the period when rainfall is most certain, that is, least likely to vary from the average. In an ordinary June, rain falls at one place on eight or nine of the thirty days. This would mean a rain every third or fourth day. This average condition rarely occurs; still several consecutive days without rain in June are unusual.

While the average monthly rainfall for May and July is nearly the same as that for June, there is a greater liability to variation from the average. In May this variation is less likely to be important, as the temperature is lower than in July and the rainfall is less likely to occur in heavy showers when a large percentage of the water would run into the streams without soaking into the ground. Rain falls in May on the average about the same number of days as in June, and drought periods are unlikely to occur. In July the showers are slightly farther apart, and drought periods rather more

frequent. The decrease in rainfall after July is rapid. The average for August is only three-fourths that of July, and for September only three-fourths that of August. In an average August, rain falls at any one place on six or seven days. Heavy rains are much less likely to occur than in June or July, and drought periods are much more frequent.

The rainfall for the crop season, April to August, inclusive, for the State as a whole, averages 16.03 inches. It exceeds 20 inches along most of the Missouri valley and decreases rather regularly to a little more than 10 inches along the Wyoming border.

The accompanying map shows the average annual precipitation (rain and melted snow) for the various parts of Nebraska.

The slightly more than 30 inches along the Missouri River decreases to about one-half that amount, or 15 inches, along the Wyoming line. This is an average decrease of one inch for each thirty miles as one travels westward across the State. In general this ratio holds true for the various months; that is, the rainfall along the Wyoming border is about one-half that along the Missouri River.

This diagram indicates the average annual precipitation for Nebraska from 1850 to 1922. The averages for the first 25 years are computed from rather meager data, but much care has been exercised and they are considered fairly reliable. For the last 47 years the records were sufficient to allow a good reliable State mean to be computed. Comparing the yearly amounts with the normal as shown by the heavy black line it will be noticed that a very large number of years do not depart much from the normal; that there are as many years deficient as in excess; and that this chart does not show any periodicity in the wet or dry years.

WIND

The prevailing winds for the year are from the northwest, but they vary during the season. In winter and, in fact, the seven months, October to April, the direction from which the prevailing wind comes is northwest. In May, June, and July it is south and southeast, and in August and September it is south.

The average hourly wind movement is but slightly more than 9 miles an hour. This also varies with the season, being

most in April, nearly 12 miles, and only one mile less in March and May. It is least in the summer, being about 8 miles an hour in July, August, and September. Wind velocities of 30 to 40 miles an hour are not rare and higher velocities are recorded every year. The highest velocity usually occurs in a thunderstorm and lasts but a short time. In these storms 50 to 80 miles an hour have been recorded.

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