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# What Rainfall Records Tell

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Longtime rainfall records in North Dakota tell a story worth remembering.

The story is - - - in good years prepare for the bad.

This circular is based on research done by George F. Will. Bismarck, North Dakota, and published originally in a bulletin of the North Dakota Agricultural Experiment Station. The bulletin is long out of print; no copies are available.

The weather record comes from two very old oak trees, growing on sloping land not subject to flooding. These trees were about 370 years old. Their annual growth rings recorded the rainfall over this long period.

With the help of logs found in old Indian villages near Mandan and Bismarck, the annual growth rings give an accurate indication of rainfall in the Bismarck area back to the year 1406.

This study of tree rings as a clue to rainfall is considered a reliable bit of scientific research. It's the best evidence available of the variations in annual rainfall.

## Here is What the Tree Rings Showed

- Any weather experienced in the past 90 recorded years (1875-1965) is not "unusual".

- Differences in weather—day to day, week to week, month to month and year to year—are the rule, not the "exception".

- Series of dry years alternate with series of wet years—but there is no regularity or indication of "cycles".

- There were more long wet periods than long dry periods. Two notable wet periods were 39 wet years (1663-1702), and an extremely wet period of 16 years (1786-1802). This latter wet period may have been when Devils Lake got its last great recharge.

- There is no indication of much longer or more extreme drouth periods than that experienced from 1922 to 1937, although several appear to have been about as long and as severe.

- The period 1938 to 1965 was rather favorable. Lack of extreme heat in summer, along with average or better rainfall, permitted above average crops most of these years. Good years far outnumbered the poor.

**Grass depends mostly on moisture—  
Grain crops need favorable temperatures as well.**

- Hay and pasture of tame and native grasses and alfalfa depend mainly on the amount of moisture entering the ground from October through June.

- High temperatures seldom occur early enough to affect grass yields. Grain crops need moderate summer temperature in addition to good moisture supplies for best yields. Even though moisture is adequate, a few days of high temperature during the period June 15 to early August may seriously reduce grain yields.

## Let Rainfall History Guide You

Be prepared for adversity. Don't forget several years of low production may follow one after another.

Large reserves of feed are needed for severe winters as well as for extended drouth periods. Store feed in good years to meet these future emergencies.

## Tree Rings and Rainfall Records

The following section of this circular is taken direct from the Agricultural Experiment Station bulletin "Tree Ring Studies in North Dakota". It should be of interest to all who farm and live in North Dakota.

No subject of discussion is so common or excites more general interest than that of the weather. It is a topic of outstanding human interest which has engaged the attention of man and offered him food for speculation since primitive man found shelter from rain and snow to be one of the basic essentials of life. In this region of the Northern Plains where agriculture is the basic industry the presence or absence of moisture means success or failure for the population. As a result there are heard dozens of theories to account for the fact that some years are wet and others dry. There is much talk of cycles, sunspots and various other matters including the effect of radio, or of the firing of great quantities of explosives in war zones.

Of established data on precipitation, however, there is a great lack. The U.S. Weather Bureau supplies us with information for part of the Great Plains for only about seventy-five years. Old diaries and journals and Indian Winter counts give scraps of information here and there which are too scattered to prove of much value.

Some of the more pessimistic residents whose memory is rather fresher for drought than for wet years, have advanced the theory that the area is gradually becoming drier and drier. They have pointed to the recent dry years with their dust storms and withering vegetation as definite proof.

But with all the speculating and theorizing, there has been no definite knowledge of Northern Great Plains weather for more than the seventy-five years of record. In the Southwest it has been demonstrated that tree rings give a definite story of wet and dry years. Such information has revealed much in the history of the aboriginal inhabitants of the region that had previously been a complete mystery. Mention has already been made of the correspondence between the tree rings and the actual Weather Bureau records for a period of some fifty-four years. In spite of the fact that the official records are averaged for the whole state whereas

the tree ring record is for a local area only, the correspondence is very close, forty-one of the fifty-four years being in agreement. This is in spite of the fact that local showers often occur in very small areas and that the rainfall in a given year may vary considerably between areas only a few miles apart. Consequently it seems reasonable to assume that the alternate periods of rainfall or drought as reflected in the tree rings of the master oak are reasonably valid for a very considerable area. In considering the facts to be given, therefore, it must be remembered always that the data comes from one small area and that there will be minor variations in certain years in spite of the general agreement for an area as large as the state of North Dakota. It should be remembered, also, that the records of tree ring growth will naturally be smoother, with less variation from year to year, than the actual rainfall records, since effects of a wet year may carry over to some extent into a succeeding dry year.

With the above statement noted, we come to a consideration of the precipitation record as read from a tree ring chart of some five hundred and forty years, from the year 1406 to 1940 inclusive. In considering the tree ring records, no attempt is made to read any seasonal records, as the rings of the master oak are too minute to permit an accurate differentiation. It should nevertheless be noted that there is a differentiation between spring and summer growth. The light colored, somewhat porous appearing portion of the ring represents the spring growth which is produced by rains of the previous fall and winter precipitation. The dark portion of the ring, rather more compact in appearance marks the summer growth produced by the rains of May and June largely. The summer growth is terminated by a distinct dividing line easily seen, the lighter wood of the next Spring's growth lying immediately beside it. Thus each yearly ring is a combination of light and dark wood. The proportion of each will vary from year to year with the seasonal distribution of precipitation.

As the long chart is studied it becomes perfectly clear that years of drought and moisture seem to run in series, sometimes separated

by from one to several years of average rainfall. In order to better read the record still another method of arrangement has been brought into use. This method is to make a continuous line graph following the yearly lines above and below the median and continuing along the median for average years. This method gives a much better visual picture of the precipitation variations. The successive wet and dry periods are placed in much better perspective.

As one looks over the graph it appears impossible to work out any definite pattern as to the number of years in succeeding series. That number varies greatly from one year to a maximum of thirty-nine wet years and twenty dry years. At certain points in the graph there are very short successions of one to three wet years followed by an equally small number of dry years. This is especially notable in the years from 1752 to 1784. For the most part, however, the periods are considerably longer, most of them of not less than five years.

Below is given a chronological list of the alternate periods. Further facts with regard to the data will be presented farther on.

The first period of nine years—1406 to 1415 was dry. From 1415 to 1433 there were eighteen wet years. The two years 1434 and 1435 were dry, followed by two wet years. The fourteen years from 1438 to 1452 were dry. Following came a wet period from 1452 to 1471—nineteen years. The fourteen years from 1471 to 1485 were dry. Then came three wet years. From 1488 to 1501 there were thirteen dry years. These were followed by four wet years. Then from 1505 to 1518 there were thirteen dry years. The seven years from 1518 to 1525 were wet. The six years from 1525 to 1531 were dry. Eight years from 1531 to 1539 were wet. Following were four dry years, then three wet. There were six dry years from 1547 to 1553. The nine years from 1553 to 1562 were wet. Then came a longer dry period of fourteen years from 1562 to 1576. The following wet period was one of the longest in the record—twenty years, from 1576 to 1596. This was followed, 1596 to 1611, by fifteen dry years. Then came

twelve wet years, from 1611 to 1623. Then came two dry years, followed by one wet year, and then one dry year and two average years. The next four years were wet. The sixteen years from 1633 to 1649 were dry, this being one of the longest dry periods. They were followed by five wet years from 1649 to 1654. From 1654 to 1663 there were nine dry years. Then came by far the longest wet period in the record. There were thirty-nine years of high rainfall from 1663 to 1702. One dry year followed, then again three wet years. The thirteen years, 1707 to 1720 were dry. Then came three wet years followed by four average ones. From 1728 to 1735 there were seven dry years; three wet years followed. Then there were two dry years, one of them extremely dry. From 1739 to 1744 there were five wet years. The eight years from 1744 to 1752 were dry. The years from 1752 to 1786 varied almost from year to year and totaled ten wet years and nine dry years and four average years. The sixteen years from 1786 to 1802 were extremely wet—perhaps the wettest of the whole period. Again the years from 1802 to 1831 varied from year to year with many of average rainfall. There were seven wet

and seven dry years in the series. The six years from 1830 to 1836 were wet. They were followed by fifteen dry years from 1836 to 1851. The twelve years from 1851 to 1863 were wet. They were followed by three average years, then came two wet years, and again two average ones. From 1870 to 1876 there were six wet years. From 1877 to 1891 there were fourteen dry years, followed by two wet. The six years from 1894 to 1900 were dry. Then came two wet years, succeeded by three dry, the years 1906 to 1909 being average. From 1910 to 1920 there were ten wet years. This was followed by one average and fifteen very dry years from 1922 to 1937. The next three years in this immediate locality were moderately wet.

Although the number of dry periods over seven years long is four greater than the number of wet, the longest periods are wet ones. There is one wet period of thirty-nine years, one of twenty years and one of eighteen and one of nineteen years. The longest dry period is of sixteen years but there are seven dry periods of thirteen to sixteen years inclusive and only one wet one. This does not give the complete picture as there are dry and wet

periods both interrupted by periods of the opposite kind lasting only one to four years. For instance the period from 1471 to 1501, shows a total of twenty-seven dry years interrupted at the mid-period by only three wet years. Also the period from 1877 to 1900 contains twenty dry years and only three wet ones. On the other hand from 1786 to 1836 there are twenty-nine wet years to seven dry ones, and from 1416 to 1438 there are twenty wet to two dry years.

When we come to the shorter periods, however, the wet ones are considerably in the majority. In the periods under seven years in length there are sixteen wet periods and only ten dry with a total in years of fifty-four wet years and thirty-three dry. Altogether of long and short periods there are twenty-nine wet to twenty-seven dry. The average length of the periods is 8.8 years for the dry and 8.3 years for the wet. In evaluating these figures it is well to bear in mind that the years classed as medium or average, according to figures given in "Crop Yields and Weather" were years in which an average crop of wheat and corn was produced. This would mean that there were a total of three hundred and two years out of five hundred and thirty four which would have produced an average or better crop and only two hundred and thirty eight years that might have produced less than an average crop.

It is of interest to briefly review some of the above figures with reference to longer periods. So far as has yet been determined there are in the series no outstanding repetitions over long periods. Let us, therefore, adopt an arbitrary period of approximately two hundred years and look at the results. In the period from 1406 to 1611 there were seventeen more dry years than wet, dividing this we find fifty-one dry to forty-two wet years from 1406 to 1501 and from 1501 to 1611 fifty-eight dry to fifty-one wet. In the next two hundred years we have 1611 to 1802 with some thirty-one more wet years than dry, divided we get from 1611 to 1707 some sixty-one wet to twenty-eight dry, and from 1707 to 1802 there are forty wet to forty-two dry. From 1802 to 1940 there are seven more wet than dry years but from 1900 to 1940 there are six more dry than

Perhaps a statistical arrangement of these wet and dry periods will give a more easily read record. An attempt to make such an arrangement is given below: (This arrangement is not in exact accord with the preceding paragraph because this tabulation omits the "average" years mentioned in that paragraph.)

1406-15	1415-33	1434-35	1436-37	1438-52	1452-71	1471-85	1485-88
Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.
9	18	2	2	14	19	14	3
1488-1501	1501-05	1505-18	1518-25	1525-31	1531-39	1539-43	1543-47
Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.
13	4	13	7	6	8	4	3
1547-53	1553-62	1562-76	1576-96	1596-1611	1611-23	1623-25	1626 1627
Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.
6	9	14	20	15	12	2	1 1
1627-31	1633-49	1649-54	1654-63	1663-1702	1703	1703-06	1707-20 1720-23
Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs. Wet yrs.
4	16	5	9	39	1	3	13 3
1728-35	1735-38	1738-40	1740-44	1744-52	1752-86	1786-1802	1802-30
Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Wet yrs.	Wet yrs.
7	3	2	4	8	10	16	7
					Dry yrs.		Dry yrs.
					9		7
1830-36	1836-51	1851-63	1865-67	1870-76	1877-91	1891-93	1894-1900
Wet yrs.	Dry yrs.	Wet yrs.	Wet yrs.	Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.
6	15	12	2	6	14	2	6
1900-02	1902-05	1910-20	1922-37	1937-40			
Wet yrs.	Dry yrs.	Wet yrs.	Dry yrs.	Wet yrs.			
2	3	10	15	3			

wet. Carrying the estimate from 1940 to 2000 to balance with previous periods, the maximum probable dry years would be thirty-four to twenty-eight wet years.

After reviewing these figures there seems to be little in the way of general rules to be deduced. Long dry periods may be followed by long wet periods or by short ones and the reverse seems to be true. The mere fact that there has been a long series of dry years seems to have no influence on succeeding years and it may or may not be followed by long wet periods. Over the longer number of years there seems to be a slight preponderance of wet over dry years in this part of the State with a slightly larger proportion of wet years in the eastern part of the State and a larger number of dry years in the western part though the series in all areas seem to follow the same pattern.

In Dr. Weakly's paper on western Nebraska tree ring records, there appears a considerable preponderance of dry over wet years, just the opposite of findings in North Dakota. Furthermore a comparison of the time occurrence of the different periods seems to show that there has been little agreement between the two areas. Nevertheless Dr. Weakly's words in summing up are as valid for this area as for the one with which he deals. He says: "In short, there have always been frequent dry years or short periods of dry years which have been of relatively minor importance to the country, and there have been the less frequent, protracted droughts which have profoundly affected the country and its inhabitants. It is probable that during some of the protracted droughts of the

past the country approached an absolute desert in character—hence the deterioration of native grass cover and the dust storms of the past few years do not indicate a permanent change in climate for this section, but more probably a recurrence of conditions that have prevailed before."

Checking into the recurrence of the periods of the same length in each category there is obtained the following table:

Length of period	Wet periods	Dry periods
39 years.....	1	..
20 years.....	1	..
19 years.....	1	..
18 years.....	1	..
16 years.....	1	1
15 years.....	..	3
14 years.....	..	3
13 years.....	..	4
12 years.....	2	..
10 years.....	2	..
9 years.....	1	3
8 years.....	1	2
7 years.....	2	1
6 years.....	2	3
5 years.....	2	0
4 years.....	2	1
3 years.....	5	1
2 years.....	4	3
1 year.....	1	2

There are recorded a total of two hundred and forty-one wet years and two hundred and thirty-eight dry years. There are, however, only thirteen wet periods lasting seven years or longer while there are seventeen dry periods of seven years or more. There remains to make up the approximately 55 years classed as average. Since years shown as average in our master chart agree well with the average years as shown in the official Weather Bureau records it may

be considered that they would agree generally throughout the record.

In this connection it may be noted that the drought period of 1922 to 1937 is one of the four longest in the five hundred and thirty four years of the tree ring record.

Continued study of tree rings from timbers taken in different parts of the region will serve to steadily increase our long time knowledge of conditions in the various sections. Further study of the data given above may serve in time to give determinations of relationship between wet and dry periods and to discover some rhythm in their recurrence which is not so far apparent.

If certain statements on pages 2, 3 and 4 referring to recent severe drouth periods seem out of place, remember that these three pages are a reprint of a 1946 bulletin.

**Cover Picture - ANNUAL GROWTH RINGS -  
Nature's Record**