NWS-CR-TA-88-32

CRH SSD
SEPTEMBER 1988

CENTRAL REGION TECHNICAL ATTACHMENT 88-32

NORTH DAKOTA DROUGHT 1987-88

John W. Enz and Jay K. Larsen
North Dakota State University
Fargo, North Dakota

Donald E. Stoltz
National Weather Service Forecast Office
Bismarck, North Dakota

1. Drought Definition

Drought is defined as a period of below average precipitation which causes serious hydrologic imbalance (crop damage, water supply shortage, etc.). For the Great Plains, precipitation is often erratic and periods of two weeks or more without rain are not uncommon. Because of this "normal" rainfall pattern, it is sometimes difficult to tell when a "normal" dry period has turned into drought. Furthermore, precipitation deficit does not always determine the severity of the drought as measured by crop response. Severity can also depend on the time of year, timing of precipitation, amount of stored soil water, type of crop, stage of growth, and meteorological variables like temperature, humidity, and wind. Our perception of drought severity may vary considerably depending on these factors.

2. September Through May Precipitation

North Dakota's drought conditions began nine months ago in September 1987 and have continued to the present. Comparing precipitation received to the long term average or normal amounts is one way to evaluate the severity of the drought. For example, the total precipitation for September through May was below average everywhere in the state, ranging from 30 to 90 percent of normal (Figure 1). The driest areas, which received only 30 to 40 percent of normal precipitation, are located in the central, south central, and extreme northwest and southwest corners of North Dakota. Richland County in the southeast and small parts of Ramsey and Walsh counties in the northeast are the only areas which received near normal precipitation during this period.

Precipitation deficits range from three to four inches in the western and eastern thirds of North Dakota to five or six inches over most of the center of the state (Figure 2). While it may be surprising that these deficits are not larger, especially since precipitation was less than 50 percent of normal for the nine-month period it must be remembered that precipitation amounts are typically small during the fall, winter, and spring. While nearly 50 percent of the normal rainfall occurs during June, July, and August in North Dakota. Thus, even though many small grain crops are ruined, near normal precipitation during the remainder of the growing season could still "save" longer season crops.

3. Misleading Precipitation Data and the Influence of High Temperatures

Whenever precipitation is totaled for several months, storm size and time of occurrence is hidden. This is especially true in 1988 where precipitation amount tells only half of the story. For example, March precipitation ranged from 130 to 150 percent of normal everywhere except the southeastern part of the state. April was exceptionally dry. There was no rainfall at nearly half the recording stations and most received less than 0.25 inches. Thus, at planting time, there was considerable concern about adequate soil water for germination. Rain in May was near or above normal in the northwest, southwest, and southeast crop reporting districts and only about 0.50 inches below normal in the rest of the districts except for the central district which is extremely dry (Figure 3).

This is hardly the description of a devastating drought, but much of the small grain crop across the state has been decimated. The "rest of the story" is high temperatures. During late May and early June, maximum temperatures of 90°F or more occurred 12 times. On two other days maximum temperatures of 89°F were recorded. Typically only two days with 90°F or above temperatures can be expected to occur by June 15th. These temperatures, ranging from 20 to 25°F above normal, were unprecedented for this early in the season. Even in the 1930's most of the high temperatures did not occur until July and August. Spring small grains are temperature sensitive at several growth stages and cannot tolerate such high temperatures even when water is adequate. They fare even worse when water is limited. Tillering, the process that maximizes the number of heads per plant (head size determines yield potential) was severely curtailed.

In addition, many of the hot days were extremely windy exacerbating the effects of high temperatures. Wind increases the atmospheric demand for water causing greater water stress in the plants. Under these conditions, plants are stressed even if adequate water was available. Unfortunately, many people may only look at precipitation data as a measure of drought severity and miss the devastating effect high temperatures have had on the small grain crop.

4. Development of the Drought

Average state-wide cumulative precipitation for periods beginning in September 1987 and ending with each successive month through May 1988 is shown in Figure 4. Normal state-wide precipitation for this period was 9.16 inches compared to 5.12 inches during the 1987-88 season. This is 56 percent of normal. These numbers were replotted as percent of normal precipitation in Figure 5. In addition, percent of normal precipitation for the same periods has been plotted for selected climatological or crop reporting districts to show the range across the state.

State average precipitation for the various combinations of months beginning with September ranged from 39 to 59 percent of normal (Figure 5). Precipitation in January and March was above average resulting in nearly 10 percent above normal increase while nearly zero precipitation in April caused a 13 percent decrease (Figure 5). By the end of May the cumulative precipitation was 56 percent of normal. Percent of normal precipitation for the same September through May period in the nine climatological districts ranged from 46 to 63 percent (Figure 5). The east central and northeast districts were the wettest and the north central and west central districts were the driest.

5. Palmer Drought Index

Another method used to evaluate dry and wet conditions is the Palmer Drought Index. This index was developed to compare conditions from one location to another even though normal precipitation amounts may be quite different. Thus, a minus 4 drought should have the same relative impact in North Dakota as it would in Georgia. Although the index has implications for agriculture, it is more properly used to estimate the effects of precipitation deficits on water resources such as stream flows, lake levels, and ground water recharge.

The current Palmer Drought Indices for each crop reporting district are shown in Figure 6. According to this index the driest area is the southeast where it would require 7.51 inches of precipitation to bring the index to zero.

6. Historical Perspective

There have been relatively few years when it has been as dry as 1988. For the nine crop reporting districts, September 1987 to May 1988 ranks anywhere from the second to the eighth driest period in about 100 years of record. Generally, 1980 and 1934 were drier than 1988 state-wide. Other years that consistently rank in the top ten for most drought-affected districts are 1977, 1961, 1958, 1939, and 1936. In addition, 1976 and 1952 were among the driest for several districts. However, these years were not accompanied by the high spring temperatures experienced in 1988. It is interesting that recorded precipitation during the summers of 1977 and 1980 were normal or above.

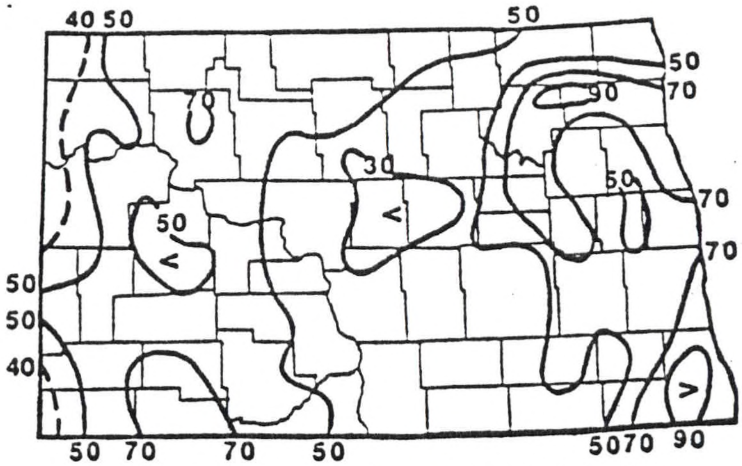


FIGURE 1. PERCENT OF NORMAL PRECIPITATION, SEPTEMBER, 1987-MAY, 1988

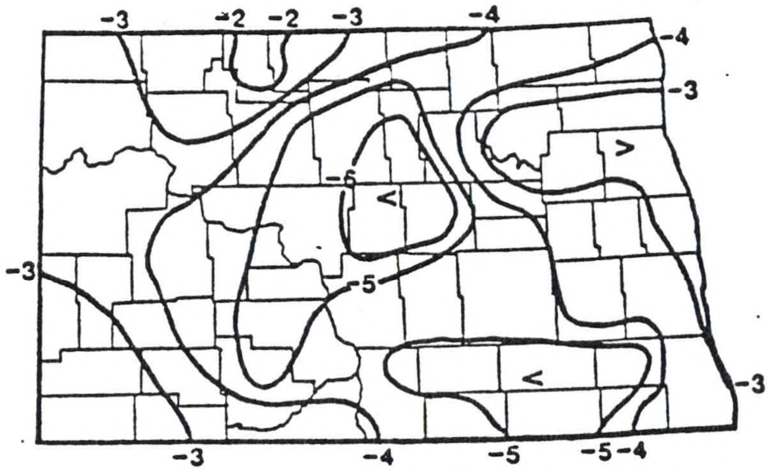


FIGURE 2. DEPARTURE FROM NORMAL PRECIPITATION (INCHES), SEPTEMBER, 1987-MAY, 1988.

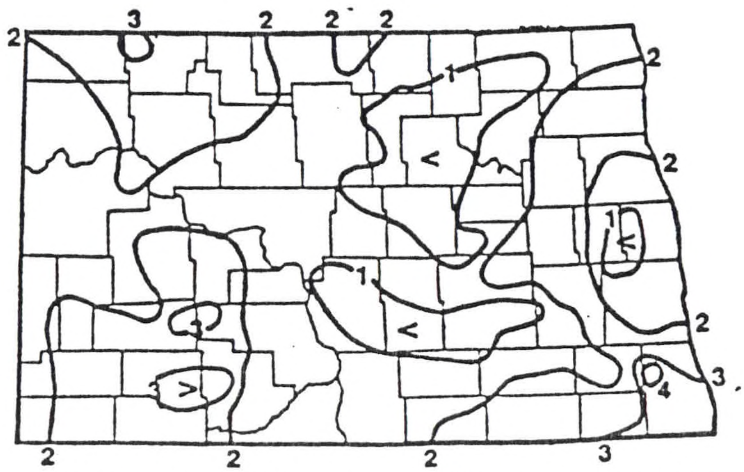


FIGURE 3. TOTAL PRECIPITATION (INCHES), MAY, 1988

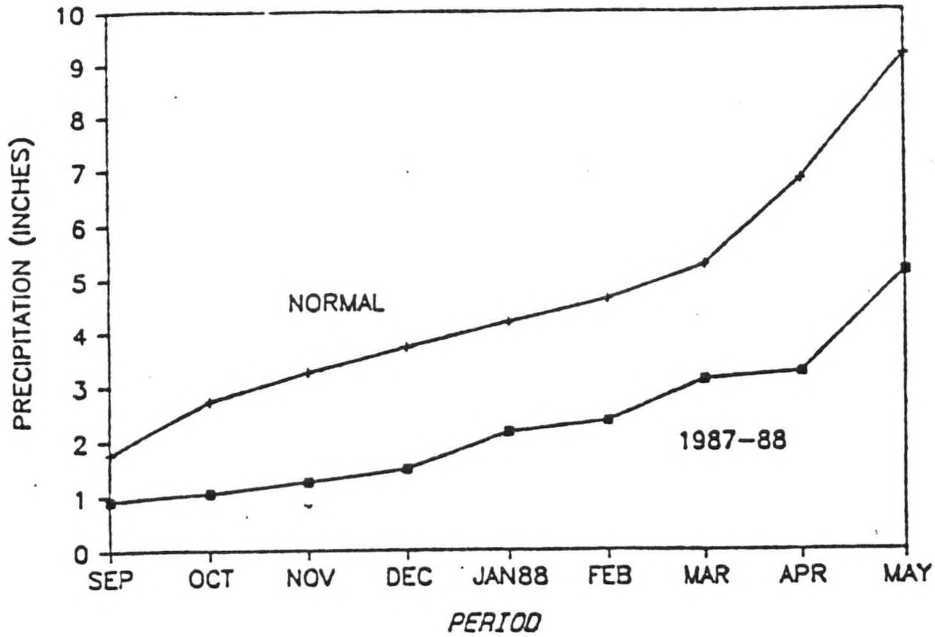


FIGURE 4. AVERAGE STATEWIDE CUMULATIVE PRECIPITATION (INCHES) FOR PERIODS BEGINNING SEPTEMBER 1987 AND ENDING WITH INDICATED MONTH

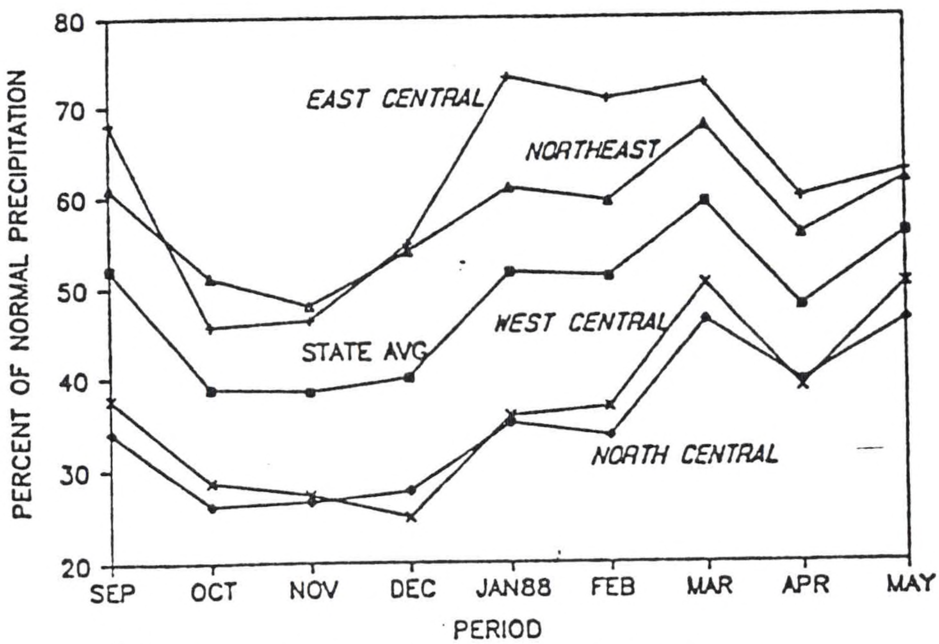
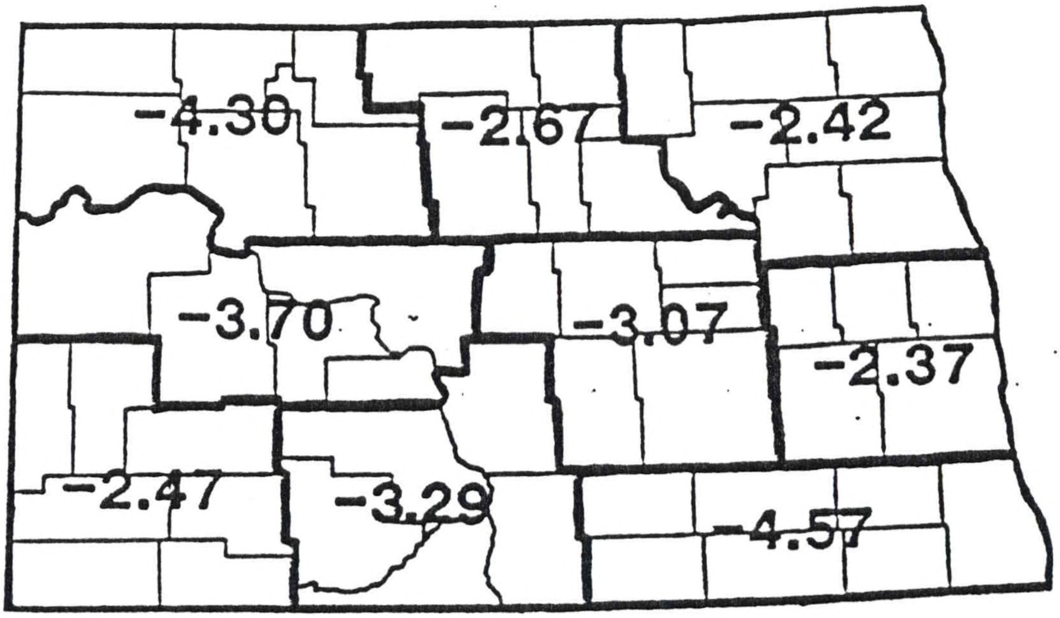


FIGURE 5. CUMULATIVE PRECIPITATION (%) FOR PERIODS BEGINNING SEPTEMBER 1987 AND ENDING WITH INDICATED MONTH FOR SELECTED CROP REPORTING DISTRICTS.



.4to-.4 NEAR NORMAL
-.5to-.9 INCIPIENT DROUGHT
-1.0to-1.9 MILD DROUGHT
-2.0to-2.9 MODERATE DROUGHT
-3.0to-3.9 SEVERE DROUGHT
BELOW -4.0 EXTREME DROUGHT

.5to.9 INCIPIENT MOIST SPELL
1.0to1.9 MOIST SPELL
2.0to2.9 UNUSUAL MOIST SPELL
3.0to3.9 VERY MOIST SPELL
ABOVE 4.0 EXTREME MOIST SPELL

FIGURE 6. PALMER DROUGHT INDEX VALUES, JUNE 4, 1988