EFFECTS OF CLIMATIC VARIABILITY ON GRAIN YIELDS

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There are three cycles in climate and weather that affect the north central part of the United States. They are (1) a long term cycle of global temperature changes; (2) an 18.5 year wet and dry cycle; and (3) the El Niño cycle.

Global Temperature Changes

The global temperature cycle is about a century long. During each of the past several centuries there has been a cooler period followed by a warmer period. The global temperature cycle is caused by changes in incoming radiation that reaches the earth's surface and the amount of heat that is absorbed in the lower atmosphere.

Global temperature records were started in 1880. There was a warming trend from 1880 to about 1940, and a cooling trend from 1940 until about 1980. The 1980s have been warmer than the 1930s and 1987 was the warmest year on record, breaking the record set in 1981.

There is good evidence that the cooling trend was caused by changes in the transparency of the atmosphere. There was decreasing volcanic activity until 1940 and increasing volcanic activity after 1940 until about 1980.

There has been a gradual increase in greenhouse gases over the past century, particularly carbon dioxide, nitrous oxide, and methane. The very warm 1980s may have been caused by the greenhouse effect.

The important point for agriculture is that we are in a global warming trend, and as long as the warming trend continues we will have more 100 degree days when we have spells of dry weather during the summer months.

A second important point is that other factors can outweigh the greenhouse effect as they did from 1940 to 1980. The global temperature could become cooler again if there are a cluster of years with considerable volcanic activity.

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The Wet-dry Cycle of 18.5 Years

The cycle of relatively wet years followed by relatively dry years is caused by changes in circulation of the atmosphere of the middle latitudes. The drought of 1988 was caused by stationary high pressure systems that diverted the jet stream and the accompanying storm systems farther north away from the Corn Belt.

The drier periods of this century centered on 1900, 1917, 1936, 1955 and 1974. There were clusters of very favorable years right after 1901, the 1920s, 1940s, 1960s and after 1977.

Tree ring studies indicate dry periods right after 1800, 1820s, 1840s, early 1860s and around 1881. The dry cycle has a periodicity of 18.5 years. The next dry cycle should center on about 1992.

The dry periods have been warmer, primarily because the sun's energy heats the atmosphere rather than being dissipated by evaporating moisture from soils. Also because of less cloudiness and the tendency toward warming under high pressure.

There is a negative correlation between summer temperature and yields of corn and soybeans in the U.S. Corn Belt because drier summers are warmer summers.

The El Niño Cycle

An El Niño occurs about every 3 to 5 years. The reverse trade winds phenomenon begins as a warming of the eastern Pacific Ocean surface off the American coast caused by a reversal of easterly trade winds to the west. Warm water migrates eastward resulting in warmer-than-normal water off Mexico and South America.

During an El Niño event, dryness impacts Australia and Indonesia. The southeastern United States has colder and wetter winters, and the Corn Belt has more rain in the spring and early summer. Records from 1891 to 1982 indicate that near normal or better corn yields occurred during El Niño years.

None of the major droughts in the Corn Belt occurred during an El Niño year. The droughts generally occurred in a year after the El Niño faded away.

The droughts of 1974, 1977, and 1980 occurred between El Niño events. The drought of 1983 occurred at the end of the most severe El Niño event. The drought of 1988 occurred the year after an El Niño faded away.

It is becoming recognized that the El Niño is a cycle within itself. The usual pattern until 1977 was for the water along the American coast near the equator to turn colder than normal at the end of the cycle. That didn't happen from 1977 to 1988, but it did turn colder than normal in the summer of 1988.

The period from 1956 to 1973 was a time of rather benign weather in the U.S. Corn Belt. There was no major drought during that 18 year period. But in the past 15 years we have had five droughts, all occurring as a part of an El niño cycle.

The next El Niño is expected in about 1990, give or take a year. Assuming a Corn Belt drought to be a part of the cycle again, we can expect another drought near or in 1992.

One important caution: A major volcanic eruption in the lower latitudes could upset the timetable.

In summary, based on climatological records, my estimate of the situation is that we are in a global warming trend, in a drier part of an 18.5 year cycle, and that we can expect another summer drought after the next El Niño event.

A Climatic Timetable On the next page is a table with 18 years in one column and 19 years in the next. Reading across the table, the years average 18.5 years apart. The years shown as decline were those when grain stocks declined. The years of shortages were those with less favorable weather. The years that followed had more favorable weather and surplus production.

The table indicates that we are likely to experience grain shortages in the world until after 1992.

Reference

Thompson, Louis M. Effects of Changes in Climate and Weather Variability on the Yield of Corn and Soybeans. Journal of Production Agriculture. Vol. 1, No. 1, 1988.

THE 18.5 YEAR CYCLE IN U.S. GRAIN PRODUCTION

1854	1872	1891	1909	1928	1946	1965	1983	
1855	1873	1892	1910	1929	1947	1966	1984	**Uncertain**
1856	1874	1893	1911	1930	1948	1967	1985	
1857	1875	1894	1912	1931	1949	1968	1986	
1858	1876	1895	1913	1932	1950	1969	1987	**Decline**
1859	1877	1896	1914	1933	1951	1970	1988	
1860	1878	1897	1915	1934	1952	1971	1989	
1861	1879	1898	1916	1935	1953	1972	1990	**Shortages**
1862	1880	1899	1917	1936	1954	1973	1991	
1863	1881	1900	1918	1937	1955	1974	1992	
1864	1882	1901	1919	1938	1956	1975	1993	
1865	1883	1902	1920	1939	1957	1976	1994	
1866	1884	1903	1921	1940	1958	1977	1995	**Improvement**
1867	1885	1904	1922	1941	1959	1978	1996	
1868	1886	1905	1923	1942	1960	1979	1997	
1869	1887	1906	1924	1943	1961	1980	1998	
1870	1888	1907	1925	1944	1962	1981	1999	**Surplus**
1871	1889	1908	1926	1945	1963	1982	2000	
	1890		1927		1964			

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CREDITS

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