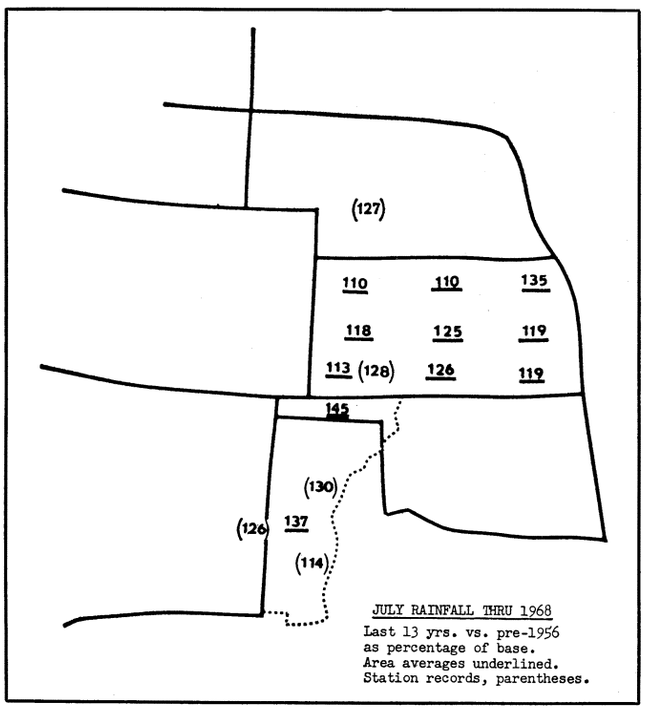
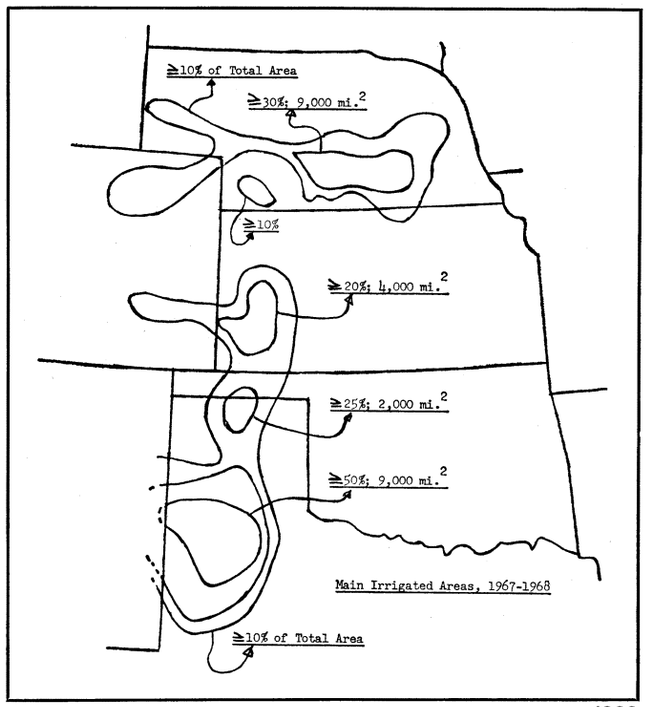




JOOS

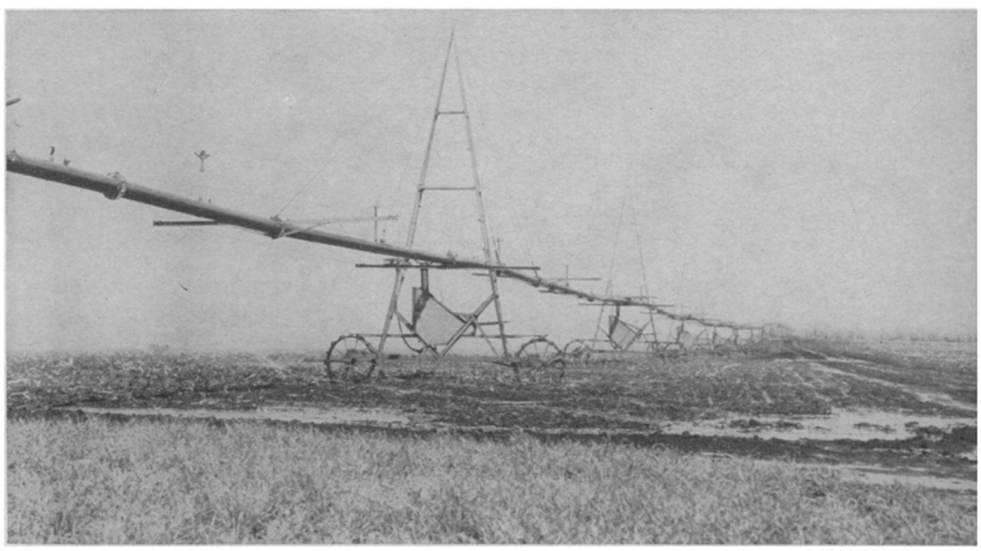
A substantial increase in rainfall on the Great Plains has accompanied the spread of irrigation farming.

METEOROLOGY

Irrigation and climate

Extensive irrigation on the Great Plains might be boosting rainfall

by Kendrick Frazier



ESSA

Acreage under irrigation in western Kansas: thirteenfold increase since 1947.

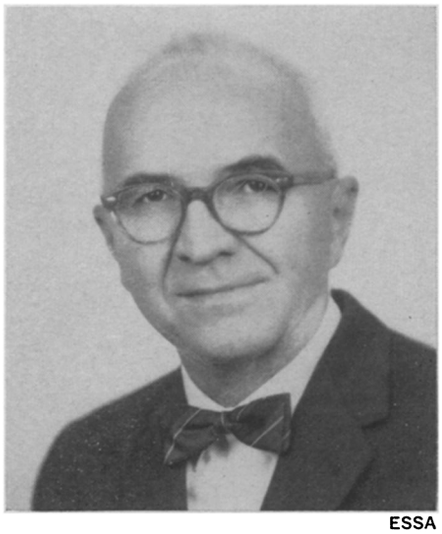
The Great Plains have been transformed in the last three decades. From the dust-bowl days of the 1930's, the plains area has become, in the decades since, the scene of vigorous and successful agriculture.

There are many reasons. The drought ended. Wartime demands for food stimulated rehabilitation. Innovations in machinery made farming more efficient. New methods of tillage helped anchor the soil and reduce erosion. Farm ponds were built and dozens of flood-control reservoirs were constructed. Two hundred million trees were planted; half of them are growing today. Drought-resistant crops like milo and new legumes were planted.

But a list of the most important changes must include irrigation. Crops in vast semiarid regions of Nebraska, western Kansas, the Oklahoma panhandle and northwestern Texas, once subject to the vicissitudes of a highly fickle rainfall pattern, are now regularly nourished with water pumped from abundant underground reserves.

The growth of irrigation has been profound. In the Texas panhandle, where little more than 20 years ago irrigation was practically nonexistent, 5 million acres covering 7,800 square miles are now under irrigation. One area of 8,000 square miles is 50 percent irrigated. Two adjacent counties embracing 1,860 square miles are more than 70 percent under irrigation. In Oklahoma, irrigated acreage has increased twelvefold since 1947. In Kansas it has increased thirteenfold in the same period, and in Nebraska it has increased tenfold since 1930.

All of this water does more than soak into the ground. In the intimate mix of air, earth and water that determines climate some long-range effects might be anticipated. And there might already have been such an effect: a change in Great Plains climate. At least the suggestion is being put forth, though with appropriate tentativeness.



ESSA

Joos: a suggestion, not a claim.

Specifically: The extensive irrigation might be producing greater rainfall in the region once plagued by the ever-present specter of drought.

If this proposition is true—and right now there is no way to prove it one way or another—it would have significant implications. In an area where water is of prime economic importance, man would have increased the amount of natural rainfall.

The hypothesis that irrigation can alter precipitation patterns has not been well received among meteorologists. Two early theoretical studies on the subject, in 1937 and in 1950, argued against a significant influence of irrigation on the hydrologic cycle. Although there is now some reason to doubt their full validity for the Great Plains, they tended to end discussion.

The author of the proposal about Great Plains precipitation, Lothar A. Joos, a regional climatologist with the Environmental Science Services Administration laboratory in Kansas City, Mo., is no exception. He is careful to emphasize that he is only suggesting, not claiming, that the irrigation may be responsible for increases in rainfall noted. But he does feel his explanation is a reasonable one.

Rainfall statistics he has compiled for the Great Plains states show that large areas, extending from the Texas and Oklahoma panhandles north and northeastward to Nebraska, have received an average of 10 percent to 40 percent more annual precipitation since 1955 than they did in the previous 65 years.

The increases are most prominent in July and next most prominent in June, two months when irrigation is at its heaviest.

At Amarillo, in the Texas panhandle, July rainfall now averages 30 percent greater than during the 64-year period prior to 1956. For the three summer months of June, July and August, the increase is 32 percent. And records of radiosonde readings at Amarillo show that the water content of the lower atmosphere has been increasing.

At North Platte, Neb., a center of irrigation, the sum of June and July rainfall is running 29 percent above the normal for the earlier 81 years. Long-term averages of rainfall in Kansas show increases of 10 percent to 35 percent since 1955 compared with the previous 69 years.

"Recent wet weather in the Great Plains," says Joos, "has occurred simultaneously with a remarkable expansion of irrigated agriculture over very large areas. I don't deny the possibility that the current wet spell would have occurred naturally and without help or hindrance by the hand of man. On the other hand, where is the evidence that this is a naturally occurring wet cycle?"

Irrigation affects the soil surface in several ways. The moistened soil is much darker in color than unirrigated fields; thus it soaks up about 15 percent more sunlight. This energy is used in the evaporation or transpiration of water. And the presence of the moisture greatly increases the rate at which the soil and the crops release water vapor to the atmosphere, also through evaporation and transpiration.

Each gram of water vapor carries with it a latent heat of 580 calories. This heat is subject to release when convection carries the moist air to the cooler layers of the atmosphere where condensation can take place. Release of the energy stimulates the vigor of updrafts, generally increasing the instability of the atmosphere.

It is this energy content of the evaporated water, not the water itself, that is the essential key, argues Joos.

The added water vapor from the irrigated land acts as a trigger, he suggests. The release of its heat into an updraft helps initiate a thunderstorm or adds vigor to those already started.

Only a handful of field studies have been conducted on possible effects of irrigation and changing land use.

In 1955 Dr. Werner Schwerdtfeger, now at the University of Wisconsin, reported significant increases in annual rainfall—at least by one third—in eastern Argentina and associated this increase with the development of cultivated crops. The effect apparently continues.

He feels the responsible factor in Argentina was probably the conversion of a formerly barren region to one of extensive cropland and orchards and suggests that similar changes in vegetation patterns on the Great Plains, not irrigation, may be responsible for any rainfall effects there.

At the Snake River Conservation Research Center of the Agricultural Research Service in Idaho, Drs. James L. Wright and Marvin E. Jensen have been studying microclimatic effects of the extensive irrigation along the Snake River. They have found a 10-degree F. lowering of the midafternoon air temperature between the surrounding desert and the irrigated area and some increase in humidity, but they have no data on any long-range precipitation effects.

Dr. Wright is skeptical about a causal link of irrigation and rainfall on the Great Plains. "Taking into account the capacity of the atmosphere, I would say the irrigated area would have to be very large—a thousand miles or so."

A lack of any evident link of irrigation to increased rainfall in other areas would not rule out such a relationship over the Great Plains. The plains states have many special characteristics. Tornadoes, for instance, are almost totally a United States phenomenon. Most of them occur in the Great Plains tornado belt as a result of the complex interaction of moist air from the Gulf of Mexico with winds off the Rocky Mountains.

The plains region is a transition zone, Joos notes, between subhumid climates to the east and the semiarid climates farther west and southwest. Kansas climate, for instance, ranges from humid to semiarid, and the nature of the growing season at one place often changes considerably from season to season.

Perhaps the small shift in circulation patterns apparently responsible for these seasonal changes can be prompted by increased evapo-transpiration from irrigation.

"This happens," Joos suggests, "on days when thunderstorms are almost ready to occur and need only a slight increase in potential instability to start the process."

Whether this is what is causing the recent wet weather in the Great Plains cannot yet be confirmed. Irrigation there is still too recent a process. "The critical thing is the length of the statistical record," says Joos. "The expansion of irrigation in these areas is so new that the effects were not even noticeable until about the last three years."

But the verdict may not be pending indefinitely. "If I am correct about irrigation effects on rainfall patterns," he says, "it will become fairly obvious in the next five years or so." □