CENTER PIVOT IRRIGATION ENERGY CONSERVATION PROJECT FOR WESTERN NEBRASKA

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BACKGROUND

The energy consumed for center pivot irrigation is a major component of the total energy used in the Midwest. The energy use for irrigation depends on five parameters; the net volume of water required to meet crop water use, the distance water must be lifted from the water source to the irrigation system, the pressure needed to distribute the water across the field, the performance rating of the pumping plant used to lift and pressurize the water, and the irrigation efficiency.

Little can be done to change the pumping lift once an irrigation well has been installed. The net volume of water required is primarily due to the rate of crop water use. If the water pumped matches the crop requirements, then reducing the net water volume reduces yield which is usually uneconomical. The procedures for pumping plant testing and modification have been well developed and documented, so improving the performance of the pumping plant can be accomplished using current knowledge. The pressure and application efficiency are the primary variables that can be changed to reduce energy use for center pivot irrigation.

The irrigation efficiency has a major effect on energy consumption. Irrigation efficiency is the portion of the total water applied that is available for crop use. Factors in addition to runoff that are important in determining the irrigation efficiency of center pivot irrigation systems include: irrigation scheduling, evaporation of water before it infiltrates into the soil, and drift of sprinkler irrigation from the target area. Scheduling methods exist in numerous forms to predict when to irrigate and how much water to apply. The efficiency factors that are less defined include runoff, evaporation and drift effects.

To address the factors of runoff, evaporation and drift, a research project was targeted for the Panhandle of Western Nebraska in order to conduct this research in an arid environment where there is less potential for rainfall during the irrigation season.

OBJECTIVES

The objective of this project is to generate information about the potential energy savings that are possible through implementation of low pressure center pivot irrigation and associated tillage practices. To accomplish that goal it was necessary to determine the amount of runoff and the irrigation efficiency that result from various irrigation application systems.

PROCEDURES

Research plots were established on two center pivots located near Alliance Nebraska to address two specific questions. First, what is the spacing requirement between drop tubes placed in a corn canopy? Second, how does a true LEPA system compare to spray devices located in and above the crop canopy? The sites selected represent the soils and slopes common to the pivot irrigated land in the region. Each site was selected based on the type of information that was to be collected during the planned two year test period.

Site 1 was a field that was previously furrow irrigated with a constant slope of about 1%. The field was planted in straight rows, half in corn and half in sugar beets. Spans three, four, five and six were used in this project. Span six was fitted with drop tubes and spinners at truss rod height. Devices were spaced at a 8.6 ft. The remaining spans were fitted with drop tubes and in-canopy spinners at 42 in height. Devices were spaced at 4.3 ft for span five, 8.6 ft for span four and 12.9 ft for span 3. Soil moisture was measured for each crop in each row within four replications of a spray pattern for each application device used. A neutron probe was used to measure the soil moisture to a depth of five feet on a seven to ten day cycle.

Site 2 was a field that in one area had a slope of approximately 3%. Corn was planted in a circle with 30-inch 8-row equipment. Spans five, six, and seven were used and equipped with different devices. Span five was setup with LEPA jugs or Quad sprays set for the bubble mode. Devices were spaced every other row on 5 ft centers. The devices were set at approximately 18 in height from level ground surface. Span 6 was equipped with spinners at 42 in height and spaced in every other row on 5 ft centers. Span 7 was also equipped with spinners but the devices were located on 10 ft centers and at truss rod height.

Tillage treatments of conventional tillage and reservoir tillage were used in alternate 8-row passes across the test area. Four replicates of each tillage system were established within each center pivot span being tested. Soil moisture content was determined within each replication at four locations spaced 100 ft apart following the curvature of the rows. The location of the four sample sites were chosen to reflect the top and the bottom of the hill where the slope was minimal and two equally spaced sites on the main sloping portion of the hill. The neutron probe was used to monitor soil moisture to a depth of five feet on a seven to ten day cycle.

RESULTS

1991 was the first year of this research project. The primary emphasis during the first year was to equip the center pivots chosen with the necessary hardware that was needed. At site 1, all of the irrigation devices and soil monitoring equipment was installed prior to the first irrigation of the season. At site 2, soil moisture monitoring equipment was installed prior to beginning any irrigation. The installation of the irrigation devices at this site was delayed because of a storm that required replacement of the center pivot at the beginning of the irrigation season. To avoid crop loss irrigation water was applied to fill the profile before the devices were installed.

In addition to soil moisture measurements tests were conducted to determine the amount of runoff occurring in the furrows down the slope. Flumes were used at the bottom of the hill to determine the amount of runoff occurring under the different tillage and irrigation devices. Results from the first year of study are still being analyzed to determine appropriate methods of interpreting and presenting the data. At this stage however, several observations were made in the field during data collection that are worth noting.

In an attempt to wet less of the corn canopy, devices were placed on drops at a 42 in height at site 1. Because the field was planted in straight rows, the drops would cross rows during most of the time while the system was operating. The result in the field was devices were hanging up on corn plants and prior to release were operating in a near vertical position. The result was most of the corn canopy was being wetted similar to where the devices were located at truss rod height. This same thing occurred, but to a lesser degree, at site 2 where the field was planted in a circle.

Also at site 1 when the system was perpendicular to the rows, the center row between the drops for the span where the devices were spaced at 12.9 ft remained nearly dry when the canopy was above the height of the devices. This would indicate that with this wide of spacing the water being applied was not uniformly distributed on the soil surface due to interference by the corn plants.

At site 2, a hard rain occurred prior to irrigation but after the reservoir tillage operation. The result was a decrease in the height of dikes between the reservoirs and the depth of the reservoirs. However, when irrigating, the reservoir tillage plots retained more of the water in both the spinner and the Quad spray treatments compared to these same treatments without reservoir tillage. Water movement in the furrows was observed in all plots approximately 100 ft in front of the moving center pivot system.

Upon completion of this project, it is hoped that the information obtained will aid in developing the recommended system capacity for various application devices based on soil, crop and climatic conditions in Western Nebraska. It is also hoped that the information gathered will assist in the selection and design of low pressure center pivot irrigation systems.