

NORTHERN WATER EFFORTS TO IMPROVE IRRIGATION SCHEDULING PRACTICES

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ABSTRACT

Northern Water formally established an IMS (Irrigation Management Service) in 1981 to promote improved on-farm water management. A principal IMS effort has been the advancement of irrigation scheduling practices through field-by-field demonstrations of improved practices. This was supported by establishment of a district-wide weather station network along with promotion of accurate on-farm water measurement.

The field-by-field demonstrations of improved irrigation scheduling utilized the root zone water balance method, or checkbook method, coupled with soil moisture sensors. These efforts proved effective and received good acceptance by local growers.

Water measurement is a key to improved irrigation management. Needed measurements include flow deliveries to the field, crop water use (calculated from weather station data), available water stored in the crop root-zone, local rainfall, tail water runoff, etc. Such measurements allow calculation of on-farm irrigation efficiency. This is a major step beyond just scheduling irrigations. It allows for an estimation of the volume of water used beneficially.

The full benefits of improved irrigation scheduling are directly tied to the flexibility in water available for deliveries to the farm turnout or field. However, improved delivery flexibility comes at a cost. An appropriate balance must be achieved.

Northern Water's IMS programs have experienced considerable success. However, institutional and economic barriers continue to curtail needed improvements in some areas.

BACKGROUND

Northern Water is comprised of 1.6 million acres in eight counties on the East Slope of the Rocky Mountains. Irrigated land totals approximately 693,000 acres. Northern Water has aggressively promoted improved on-farm water management for more than 26 years. From its inception in 1981, IMS has been

focused on education, training, and demonstration. It shares information regarding new technologies, increases public awareness, and enables producers to implement practical improvements with confidence. It does not focus on policies or politics. To date cooperators have not paid any fees to participate in the program. With a foundation based on information and technology, it has avoided the controversy and resistance often associated with political mandates and regulatory enforcement.

WEATHER STATION NETWORK

Northern Water operates a network of remote, solar powered, automated weather stations throughout its service area for disseminating crop water use information. The Weather Station Network is currently composed of 22 stations. Station sites are carefully selected to ensure readings representative of cropped field conditions, always well within a surface-irrigated field of alfalfa hay or over large areas of well-irrigated urban turf grass. Stations are approximately 25 to 30 miles apart to provide the best practical coverage and are operated year-round. In recent years, station density has increased near metropolitan areas. Each station collects air temperature, relative humidity, wind speed and solar radiation data. These data are used to calculate ETR (reference evapotranspiration) on a daily basis using the ASCE standardized Penman-Montieth combination equation for alfalfa. Precipitation, wind direction, and soil temperature are also collected. The weather station data is automatically transmitted hourly to Northern Water headquarters via cdma modem (cellular 1xRTT network). Each sensor at each weather station is checked and calibrated annually to ensure data accuracy and to maintain high network reliability. Station performance is monitored regularly and any problems detected are promptly corrected.

ETR is factored or adjusted using crop coefficients based on plant growth stages to calculate crop ET or water use for all of the area's major crops. Weather summaries and crop water guides are readily available via the Internet at www.ncwcd.org and also via a telephone voice-messaging system or "Call Center." The "Call Center" can be accessed using a touch-tone telephone by dialing (970) 593-1605 or (888) 662-6426 (NOCO₂H₂O) toll-free. Voice instruction and menu options allow the user to quickly access information for a selected area.

Accurate and reliable crop ET information supports efficient irrigation scheduling, thereby allowing producers to determine how much water to apply given their specific crop and irrigation practices. Crop ET information is widely accepted and its use continues to grow.

ON-FARM WATER MEASUREMENT

Northern Water began promoting low-cost electronic flow monitoring in 2000 under grant funding from the U.S. Bureau of Reclamation. These flow measurements allow calculation of on-farm irrigation efficiency. This is a major step beyond just scheduling irrigations. It allows estimation of the volume of

water used beneficially. It provides needed tools and information that increase the effectiveness of efforts to improve irrigation scheduling practices.

Local interest in on-farm electronic flow monitoring has increased in recent years. Lower purchase costs for equipment, coupled with increased confidence in irrigation decisions, are key factors.

Additionally, increased urbanization of the Northern Water service area has increased the operational challenges and constraints facing local ditch companies. As productive agricultural lands are sold for development and the associated water rights transferred to cities, irrigation and ditch companies are faced with reduced flow rates, decreased exchange opportunities, and shorter delivery seasons. On-farm efficiency is largely affected by the flexibility in water deliveries available to the farm turnout or field. Improved flow measurement, remote monitoring, and gate automation are increasingly required for successful water delivery operations.

FIELD-BY-FIELD IRRIGATION SCHEDULING DEMONSTRATIONS

Since 1981, Northern Water has provided field-by-field demonstrations of irrigation scheduling practices to growers within its boundaries. These demonstrations have aided irrigation decision-making and supported efficient use of available water. They provided irrigators with a better understanding of soil moisture management throughout the growing season. They often gave the grower needed confidence to lengthen the time between irrigations.

The field-by-field irrigation scheduling demonstrations consistently utilized the root zone water balance method, or checkbook method, coupled with soil moisture sensors. Soil moisture holding capacity and an allowable depletion percentage were estimated. Readings from the soil moisture sensors were used to calculate remaining available moisture. Changes in soil moisture readings were compared to the calculated crop ET from Northern Water's weather station network to validate the accuracy of both data. To estimate the number of days before the next irrigation was needed, the remaining soil moisture in the crop root zone was divided by the predicted daily crop water use from the nearest weather station. The success of these field-by-field irrigation scheduling demonstrations was directly dependent upon the quality of the crop water use information obtained from the weather station network.

These efforts targeted assistance to 50 area producers annually, with one to two fields per cooperator each season. Cooperators generally participated in the program for two to three seasons, after which new cooperators replaced past participants. Regular status reports were either e-mailed or hand delivered to cooperators.

Through 2003, tensiometers were the primary soil moisture device utilized by the program. Instruments were manually read and serviced during a weekly site visit.

However since 2004, efforts expanded to include automated electronic soil moisture sensors. Automation allowed continuous monitoring and recording of soil moisture at multiple levels within the crop root zone. Several manufacturers now market lower cost electronic soil moisture sensors, data loggers, and telemetry equipment. Cooperator support for automated soil moisture monitoring was dramatic.

CONCLUSIONS

Utilization of the root zone water balance method, or checkbook method, coupled with soil moisture sensors proved both effective and reliable for field-by-field irrigation scheduling. The success of these efforts was directly reliant upon the availability of accurate crop water use information, obtained from the District-wide weather station network. Additionally, proper measurement of water delivered to the farm turn-out or field was similarly important.

Soil moisture monitoring significantly improved with the transition from manual instruments to electronic sensors coupled to a data logger with cellular telemetry. Reduced costs and increased reliability of automated instruments has assisted in the adoption of these improved methods.

The full benefits of irrigation scheduling efforts are directly tied to the delivery flexibility of available water to cropped fields. If deliveries are restricted in available frequency, flow rate, or duration irrigators are often unable to implement improved irrigation scheduling practices. The consequence is reduced on-farm irrigation efficiency. Reduced delivery flexibility may result from ditch or canal operations, lack of capacity in irrigation equipment (wells, pumps, screens, etc.), water right administration, drought conditions, etc. Delivery flexibility may be increased through more senior water rights, use of groundwater wells, on-farm storage ponds, canal automation, etc.

Irrigation delivery constraints can prevent an irrigator from providing the proper amount of water at the right time to minimize crop water stress. Minimal restrictions may be overcome by maximizing soil moisture storage in the crop root zone as a buffer against time periods when water availability is limited or restricted.

Northern Water continues to maintain a strong commitment to assisting local irrigators to implement improved irrigation scheduling practices and realize increased on-farm water use efficiency.