NCWCD IRRIGATION SCHEDULING PROGRAM - CONVERTING TO A WEB-BASED ACCESSIBLE PROGRAM

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ABSTRACT

In an effort to assist residents with conserving water, Northern Colorado Water Conservancy District (NCWCD) established an Irrigation Management Services Department. One of the goals is to promote increased efficiency during an irrigation event. In agriculture, NCWCD assists the farmer, through an irrigation scheduling program, by monitoring their soil moisture and providing a report of the moisture status. NCWCD provides soil moisture content and ET data relative to their crops along with suggested days until the next irrigation is needed. This allows the farmer to adjust their irrigation sets to maximize the use of their irrigation water and better utilize beneficial rainfall. NCWCD is presently integrating a web-based interface to their irrigation scheduling program.

IRRIGATION SCHEDULING PROGRAM

NCWCD has chosen the moisture depletion monitoring method for irrigation scheduling over the checkbook method, because of the difficulty in accounting for every drop of water entering and leaving the fields, including deep percolation. In addition, with the checkbook method, it is difficult to reestablish a calibration point or a starting point without saturating the soil profile or actually measuring the moisture content when calculations are off. Irrigation scheduling by the moisture depletion monitoring method is based on measured moisture level readings and crop water use data. The program is structured around the

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analysis and relationship of the water holding capacity of the soil and the water needs of the crops. Four parameters determine the amount of water available within the soil profile, to the crops before stress occurs. The first is the effective depth of the root profile at the time of the reading. The second is the allowable depletion level for the growth stage of the crop, in percent of total available water. The third is the ET of the crop. Forth is the total holding capacity of the soil based on its profile and texture.

The District provides assistance with monitoring the soil moisture within agriculture fields. At the beginning of the season farmers subscribe to the irrigation scheduling program which include the use of tensiometers, readings once a week, and a printout of the status of the moisture within the field at each reading. At the time farmers' register with the program, the district enters their name, address, telephone number and password. Each field is assigned a weather station, usually within 25 miles. From soil maps or soils analysis, soil water storage capacities, soil types, texture, horizons, and parameters are defined and entered. The crops grown, along with depletion levels based on crop needs, soil texture or laboratory analyses are entered. A planting date or a green line date is also entered with the expected maturity date.

From the data entered at registration, the crop root growth is calculated and tracked throughout the growing season. The second parameter is provided from historical crop growth curves for northern Colorado. A weather station network provides the necessary Data to calculate ET parameters for the crops grown. The weather station network comprises ten alfalfa and three grass referenced-based weather stations plus two additional stations located at local golf courses. Each station reports twice a day via cellular telephone to the NCWCD headquarters.

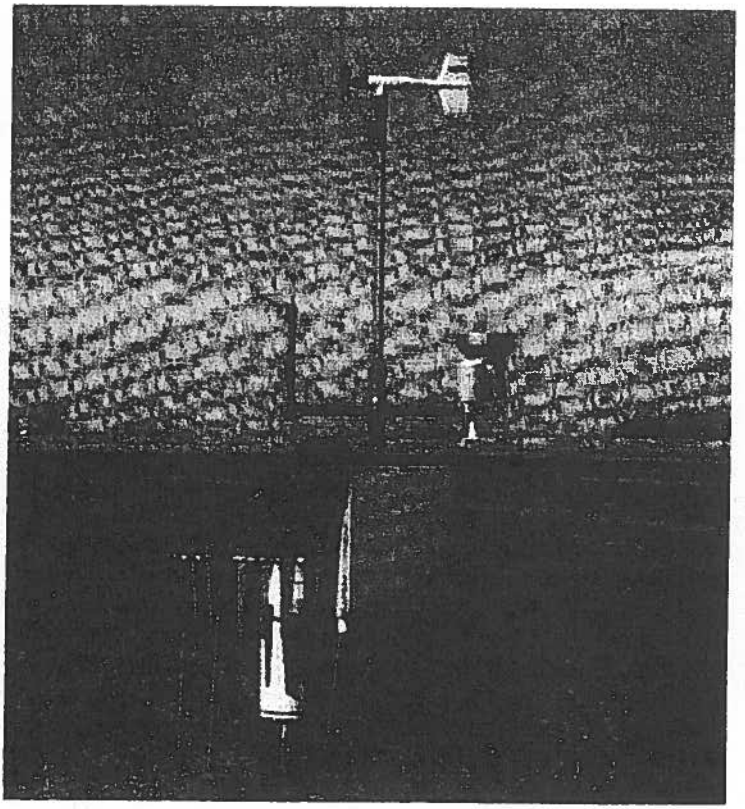

Fig.1. Typical Alfalfa Reference Weather Station.

Each station collects wind speed and direction, precipitation, relative humidity, air temperature, soil temperature, and solar radiation. Each station is solar powered with battery backup. Data derived is then processed and made available through a touch-tone dial system, Satellite subscription service (Data Transmission Network:DTN) and a web site. Information is also available through mailings and local newspapers. From data collected, NCWCD calculates an ET value for each weather station based on its alfalfa or grass reference. At the beginning of each day, the results of the previous week and the previous day are

calculated, and based on historical data, a prediction for the next weeks water use is calculated and displayed for every crop for each weather station. The forth parameter, Total water holding capacity of the soil is determined from soil charts or laboratory analysis.

After these four parameters are established, tensiometers are used to determine the amount of moisture available, within the root zone to the crop.

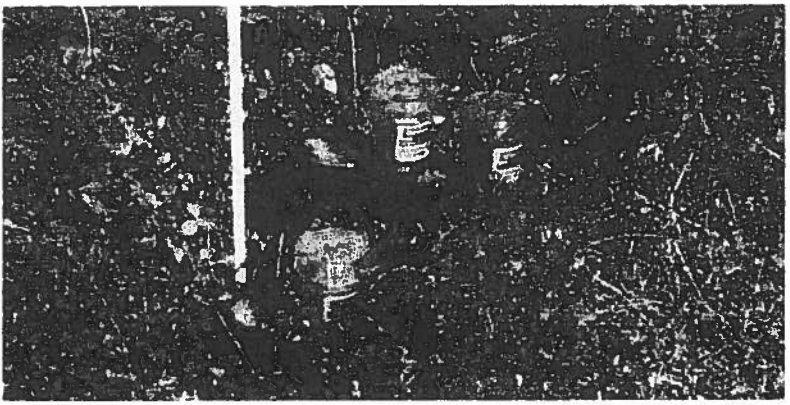

Fig 2. Typical Tensiometer Installation Site

As growing degree-days accumulate, crop water use curves are adjusted based on growth stage observations. The data entered at registration, with tensiometer readings, ET data, and crop water use curves are compiled and processed to produce the reports delivered to the farmer. The program determines how many days the crop will take to reach the pre-determined depletion level assigned to that crop and field.

Due to the quantity of farmers signed-up for this program, the district has been unable to address all the request of the farmers. With approximately 100 fields each year, one intern can read and report each field once a week. When the crop requirements and the farmers' irrigation needs do not correlate with the

scheduled day to read the tensiometers, the farmer receives an inadequate report and cannot make the most intelligent irrigation decisions. In an attempt to address these deficiencies and to extend the reach of our services to the eastern areas of our district, NCWCD is integrating their present irrigation scheduling program with a web-based interface. The web-based interface will also allow farmers the ability to access the program at any time, and enable them to receive the services at a greater frequency than once a week. This allows farmers the capability to read their own tensiometers, run the irrigation scheduling program via the internet, download their results, and immediately receive a printout of the moisture status and an historical graph of the moisture levels.

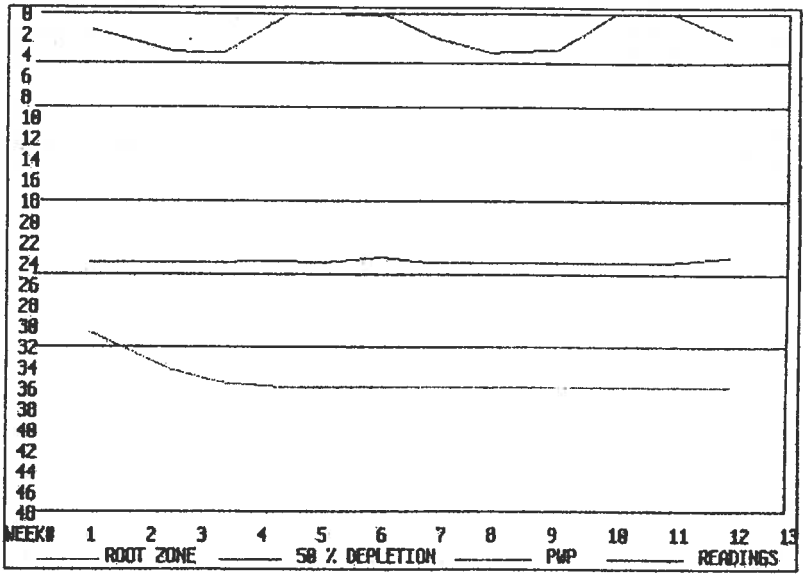

Fig 4. Historical Graph of Moisture Status within Soil Profile.(Provided to the farmer color coded)

NCWCD IRRIGATION SCHEDULING PROGRAM

FARMER'S NAME: Scott Meining
FARMER'S ADDRESS: Gilcrest

737-2928

DATE: 0 / 0 / 0
FIELD I.D. NUMBER 33
READING ENTRY NUMBER 12

CROP: CORN
PLANTING DATE: 111

ALLOWABLE DEPELTION % FOR THIS CROP: 50%
PRESENT AVERAGE ROOT DEPTH: 36 IN

	SOIL DEPTH	FIELD CAPICITY H2O	AVAILABLE H2O
1ST HORIZON:	18 IN	3.25 IN/FT	1.60 IN/FT
2ND HORIZON:	30 IN	3.27 IN/FT	1.54 IN/FT

	TOTAL FC	AVAILABLE H2O	PWP POINT
1ST HORIZON:	4.87 IN	2.39 IN	2.48 IN
2ND HORIZON:	8.19 IN	3.86 IN	4.33 IN

TOTAL AVAILABLE H2O 6.25 IN

TOTAL ALLOWABLE DEPLETION 3.12 IN

H2O AVAILABLE > PERMENANT WILTING POINT----IN & % REFERENCE TO DEPLETION LEVEL
TENSIOMETER READING FOR 1ST LAYER: 36 AVAILABLE H2O 1.83 IN +0.64 IN +53%
TENSIOMETER READING FOR 2ND LAYER: 63 AVAILABLE H2O 2.39 IN +0.46 IN +24%

AVAILABLE MOISTURE GREATER THAN ALLOWABLE DEPLETION WITHIN ROOT ZONE. 0.90 IN
CROP E.T. YESTERDAY (1 DAY) .11
CROP E.T. SINCE LAST READINGS .9
PROJECTED E.T. FOR NEXT WEEK 1.04
DAYS UNTIL NEXT IRRIGATION 6 DAYS

TENSIOMETER READINGS	REMAINING AVAILABLE MOISTURE @ 50% DEPLETION	
READING	1ST LAYER	2ND LAYER
4	1.20	1.93
7	1.20	1.93
10	1.20	1.93
13	1.20	1.93
16	1.20	1.93
19	1.09	1.79
22	0.98	1.62
25	0.89	1.46
28	0.81	1.33
31	0.74	1.22
34	0.68	1.11
37	0.62	1.02
40	0.57	0.93
43	0.52	0.86
46	0.47	0.78
49	0.43	0.72
52	0.39	0.65
55	0.36	0.60
58	0.32	0.54
61	0.29	0.49
64	0.26	0.44
67	0.23	0.40
70	0.21	0.35

Fig 3. Moisture Status Report Provided to Farmers Once a Week.

THE WEB BASED INTERFACE

The language selected to write the software was Microsoft Visual Basic in conjunction with Crystal Reports for the outputs. To run a software package with multiple inputs such as the irrigation scheduling program described, a properly designed database is necessary. Microsoft Access is the software language selected to handle the database chores. Customer information, crops, soils, and weather data tables were designed. Tables to hold data for each field and for the tensiometer readings were designed. In addition, links to the crop water use guide processed from weather data collected by the weather station network were created.

Concerns

1. The district wanted the ability to log all the soil moisture readings into a database while providing security and privacy to each farmer: By designing the district database to hold all the information and allowing the farmers access at the time they log on to the web, the district can update the interface, monitor the performance of the program, and make change accordingly. Password access will provide the security desired.

2. The district also wanted the ability to integrate the data from the weather station network into files that can be accessed by the farmers when they log-on to the web: The design and structure of the database again solves this problem.

3. And NCWCD wanted to provide a way for the district to monitor the status of the fields (a watchdog), oversee program use, and detect potential problems: Having the program run from within the district's web site, will facilitate troubleshooting the program, repairing corrupted or damaged files and avoiding erroneous inputs.

SUMMARY

The past four years, the program has scheduled three hundred fifty fields with one hundred seventy farmers. The past two years, the goal of attaining one hundred fields per year was not reached because of the lack of interest due to increased rainfall. The crops covered were alfalfa, both new seeding and established stands, barley, dry edible beans, corn, onions, potatoes, pasture, sugarbeets, winter and spring wheat, and watermelons. A variety of nursery grown cut flowers were added in 1999. The Irrigation scheduling program has been popular with farmers when drier seasons are experienced and less popular when adequate rainfall is encountered. The soil moisture content within the root zone of fields monitored and the calculated ET has tracked within expected deviations. This indicates that the soil moisture parameters have been properly selected and responses of soil moisture to crop use can be accurately predicted.

The Internet interface portion of the program has been delayed due to problems coordinating Microsoft Access, Microsoft Visual Basic and Crystal Reports. As my expertise and experience in writing code progresses, these issues should be resolved.