# IRRIGATION SCHEDULING OPTIONS AT A WHOLE FARM LEVEL

**M. Ismanov**
**L. Espinoza**
**University of Arkansas Division of Agriculture Cooperative Extension Service**
**Little Rock, AR**

## Abstract

Learning farm experiences in using check book ET based and different other irrigation scheduling approaches at the whole farm level in Arkansas are the main issue of the topic. The average cotton farmer in the Mid-South works with large numbers of fields. Different crops, soil types, and planting times complicate irrigation scheduling at the whole farm level. This is probably the main reason why many farmers still do not use the irrigation scheduling tools. Results of irrigation scheduling in different counties in Arkansas during the last five years show that a developed PET-based irrigation scheduler is an effective irrigation tool at the whole farm level. Comparison of different ET tools shows that the atmometer is better suited to farm irrigation scheduling purposes in terms of price, accuracy of data, easy installation, and monitoring.

## Introduction

Irrigation practices have sharply changed since the sensor base remote sensing technology began to offer new opportunities in measuring soil moisture, canopy temperature, and ET. Irrigation scheduling experiments in drip, furrow and pivot irrigation systems shows that soil moisture sensors, wireless internet connections, and scheduling tools have worked satisfactorily in experimental fields and in research stations where the number of fields is just a few. However, irrigation scheduling in whole farm level is different due to different conditions. The average cotton farmer in the Mid-South works with large numbers of fields, sometimes more than one hundred fields. Each field is divided into several irrigation sections. There are different soil types, crops, and planting times. All of these factors complicate irrigation scheduling at the whole farm level. This is probably the main reason why many farmers still do not use irrigation scheduling tools. Finding an effective solution to this issue can help farmers to save water and energy resources by applying irrigation scheduling at the whole farm level.

## Materials and Methods

According to the field water balance or check book method, the amount of existing and incoming water in the field should be equal to the amount of outgoing water. Existing water consists of soil moisture which is depends on field water capacity. Incoming water includes rainfalls and irrigation water. Outgoing water includes evapotranspiration (ET), infiltration and runoff water. ET calculated through potential evapotranspiration (PET), which is maximum possible ET in sufficient available water source conditions. PET is calculated by weather station data, standard evaporation pan, and atmometer readings.

Irrigation water amounts were measured by the flow meters. Soil moisture in the fields was monitored by EC-5 Decagon soil moisture sensors, installed at 6 and 12 inch depths and also by the gravimetric method. To determine PET differences and the effective scheme of atmometers and rain gauges installation in the farmlands, more than 20 atmometers and rain gauges were installed in different counties in Arkansas.

## Results and Discussion

The weather history in Marianna AR, during the last 50 years shows that yearly precipitation has varied from 32.7 to 73.5 inches. The ratio of maximum to minimum precipitations is 2.2. Summer precipitation differs more sharply; the same ratio here is more than 5. This means that summer rainfall may change many times from year to year. Summer precipitation trend has not really changed for during the 50 years period. Yearly precipitation trend has slightly decreased. Records show that now we have about an inch less precipitation than we had 50 years ago. The heat unit's accumulation during the summer time has increased in the observing period. The trend of summer heat units has increased to 110 units in the last 50 years

The survey provided by Cotton Incorporated shows that the majority of farmers schedule their irrigation by visual assessment. Just a few of them use irrigation monitoring tools.

We divided the irrigation options into four categories:

1. Farmer's experience
    - Visual assessment,
    - Weekly scheduling,
    - Taking cue from the neighboring farmers.
2. Monitoring soil moisture
    - Hand push probes,
    - Gravimetric method,
    - Tensiometers or gypsum blocks,
    - Soil electric or electromagnetic conductivity sensors.
3. Monitoring plant development or crop appearance
    - Plant response to water deficit: plant height, width, biomass, color,
    - Leaf water potential: color or thickness,
    - Canopy temperature.
4. Field water balance or check book method
    - U of A irrigation scheduler,
    - UGA Easy Pan irrigation scheduler,
    - Using weather monitoring tools: weather station, atmometer, and standard evaporation pan.

The first category is based on the farmer's experience. Many farmers use calendar-based irrigation scheduling or simply take their cue from the neighboring farmers. The second option is based on soil moisture monitoring. This ranges from simple ways of soil moisture measuring to sensor-based monitoring with wireless internet connections. This is one perspective of irrigation scheduling option, but is complicated at the whole farm level due to the large number of fields, sections, planting times, and crop and soil types. We may say the same thing about the third irrigation scheduling option, which is based on monitoring plant or crop appearance depending on water deficit. The fourth category of irrigation scheduling options is based on field water balance or the checkbook method. U of A irrigation scheduler program and UGA Easy Pan irrigation scheduler are based on this method. Field water balance method requires measuring PET by several tools such as weather station, atmometer, and standard evaporations pan. Our experiments show that PET data found by these tools are close to each other, so we can use all of them in irrigation scheduling. A comparison of prices shows that the atmometer is better suited to farm irrigation scheduling purposes in terms of price, accuracy of data, easy installation, and monitoring.

Solar radiation causes PET. The Earth receives 340 $W/m^2$ of solar energy. Just less than half of this incoming solar radiation reaches the surface of the Earth. Half of this energy, or a quarter of the solar energy, is lost on evaporation. Consequently the evaporation and transpiration - ET is the main process that consumes solar energy. It plays a tremendous role in balancing Earth's surface temperature. Theoretically ET should be equal in the same parallels of the Earth. We compared PET in different parts of Arkansas about 135 miles apart from each other. Results show that PET difference between Pine Bluff AR and Marianna AR is just 2 inches during the two months. It is interesting to note that PET in Pine Bluff was less than in Marianna or Edmondson even though Pine Bluff is more southerly than Marianna or Edmondson.

We evaluated different irrigation scheduling options by the field water balance method based on actual ET data. Results show that field water balance method based on actual ET data allows better distribute the irrigation events throughout the irrigation season, keep the water deficit and soil moisture at a uniform level that improves the plant development and water use efficiency.

## Summary

The existence of large numbers of fields and dividing them into several irrigation sections, different crops, planting times, and soil types are complicating the use of the irrigation scheduling tools at the whole farm level.

PET data from Weather Stations, Standard Evaporation Pan, and Atmometers are similar. The Atmometer is better suited to farm irrigation scheduling purposes in terms of price, accuracy of data, easy installation, and monitoring.

Field water balance or water deficit monitoring method helps to evaluate the soil moisture level between irrigation or rainfall intervals and helps to determine the next irrigation time for the field with given water deficit or capacity levels.

## References

Ashraf, M., Saeed, M. M., and Asgher, M. N. Evaporation Pan: A Tool for Irrigation Scheduling. Journal of Drainage and Water Management, Vol.6(1) January-June 2002.

Broner, I. Irrigation Scheduling: The Water Balance Approach. no. 4.707.Irrigation. Crop series.

Carrow, R.N. Canopy Temperature Irrigation Scheduling Indices For Turfgrasses In Humid Climates. University of Georgia, Griffin, GA 3022 International Turfgrass Society Research Journal 7. Overland Park, Kansas. 1993.

Charles, B., Burt. Irrigation water balance fundamentals 1999. Conference on Benchmarking irrigation System Performance Using Water Management and water balance, San Luis Obispo, CA March 1o USCID, Denver, Colo. p. 1-13.

Cotton Farming Magazine. May 2009, Oct. 2011.

Vories, E.D., Tacker, P., Hall, S. 2009. The Arkansas irrigation scheduler. Proceedings of World Enviromental and Water Resources Congress. p. 3998-4007.