



IRRIGATION

Irrigation Scheduling

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The purpose of irrigation scheduling is to determine the exact amount of water to apply to the field and the exact timing for application. The amount of water applied is determined by using a criterion to determine irrigation need and a strategy to prescribe how much water to apply in any situation.

Quick Facts...

Irrigation scheduling is the decision of when and how much water to apply to a field.

Its purpose is to maximize irrigation efficiencies by applying the exact amount of water needed to replenish the soil moisture to the desired level.

Irrigation scheduling saves water and energy.

All irrigation scheduling procedures consist of monitoring indicators that determine the need for irrigation.

Irrigation Criteria and Irrigation Scheduling

Irrigation criteria are the indicators used to determine the need for irrigation. The most common irrigation criteria are soil moisture content and soil moisture tension. The less common types are irrigation scheduling to maximize yield and irrigation scheduling to maximize net return. The final decision depends on the irrigation criterion, strategy and goal. Irrigators need to define a goal and establish an irrigation criterion and strategy.

To illustrate irrigation scheduling, consider a farmer whose goal is to maximize yield. Soil moisture content is the irrigation criterion. Different levels of soil moisture trigger irrigation. For example, when soil water content drops below 70 percent of the total available soil moisture, irrigation should start.

Soil moisture content to trigger irrigation depends on the irrigator's goal and strategy. In this case, the goal is to maximize yield. Therefore, the irrigator will try to keep the soil moisture content above a critical level. If soil moisture level falls below this level, the yield may be lower than the maximum potential yield. Thus, irrigation is applied whenever the soil water content level reaches the critical level.

How much water to apply depends on the irrigator's strategy. For example, the irrigator can replenish the soil moisture to field capacity or apply less. If no rain is expected and the irrigator wishes to stretch the time between irrigations, it is advantageous to refill the soil profile to field capacity. If rain is expected, it may be wise not to fill the soil profile to field capacity, but leave some room for rain.

If the irrigator's goal is to maximize net return, an economic irrigation criterion is needed, such as net return. This is the income from the crop less the expenses associated with irrigation.

The importance of irrigation scheduling is that it enables the irrigator to apply the exact amount of water to achieve the goal. This increases irrigation efficiency. A critical element is accurate measurement of the volume of water applied or the depth of application. A farmer cannot manage water to maximum efficiency without knowing how much was applied.

Also, uniform water distribution across the field is important to derive the maximum benefits from irrigation scheduling and management. Accurate water application prevents over- or underirrigation.

Overirrigation wastes water, energy and labor; leaches expensive nutrients below the root zone, out of reach of plants; and reduces soil aeration, and thus crop yields. Underirrigation stresses the plant and causes yield reduction.

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Table 1: Different methods of irrigation scheduling.

Method	Measured Parameter	Equipment Needed	Irrigation Criterion	Advantages	Disadvantages
Hand feel and appearance of soil.	Soil moisture content by feel.	Hand probe.	Soil moisture content.	Easy to use; simple; can improve accuracy with experience.	Low accuracies; field work involved to take samples.
Gravimetric soil moisture sample.	Soil moisture content by taking samples.	Auger, caps, oven.	Soil moisture content.	High accuracy.	Labor intensive including field work; time gap between sampling and results.
Tensiometers.	Soil moisture tension.	Tensiometers including vacuum gauge.	Soil moisture tension.	Good accuracy; instantaneous reading of soil moisture tension.	Labor to read; needs maintenance; breaks at tensions above 0.7 atm.
Electrical resistance blocks.	Electric resistance of soil moisture.	Resistance blocks, AC bridge (meter).	Soil moisture tension.	Instantaneous reading; works over larger range of tensions; can be used for remote reading.	Affected by soil salinity; not sensitive at low tensions; needs some maintenance and field reading.
Water budget approach.	Climatic parameters: temperature, radiation, wind, humidity and expected rainfall, depending on model used to predict ET.	Weather station or available weather information.	Estimation of moisture content.	No field work required; flexible; can forecast irrigation needs in the future; with same equipment can schedule many fields.	Needs calibration and periodic adjustments, since it is only an estimate; calculations cumbersome without computer.
Modified atmometer.	Reference ET.	Atmometer gauge.	Estimate of moisture content.	Easy to use, direct reading of reference ET	Needs calibration; it is only an estimation.

Advantages of Irrigation Scheduling

Irrigation scheduling offers several advantages:

1. It enables the farmer to schedule water rotation among the various fields to minimize crop water stress and maximize yields.
2. It reduces the farmer's cost of water and labor through fewer irrigations, thereby making maximum use of soil moisture storage.
3. It lowers fertilizer costs by holding surface runoff and deep percolation (leaching) to a minimum.
4. It increases net returns by increasing crop yields and crop quality.
5. It minimizes water-logging problems by reducing the drainage requirements.
6. It assists in controlling root zone salinity problems through controlled leaching.
7. It results in additional returns by using the "saved" water to irrigate non-cash crops that otherwise would not be irrigated during water-short periods.

Research in Nebraska, where most water is pumped, shows that irrigation scheduling provides an average 35 percent savings in water and energy. In fuel costs alone, this is a per-season savings of about 550 kwh per acre for a center pivot sprinkler or about 200 kwh per acre for a gated pipe.

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Irrigation Scheduling Methods

All irrigation scheduling methods consist of an irrigation criterion that triggers irrigation and an irrigation strategy that determines how much water to apply. Irrigation scheduling methods differ by the irrigation criterion or by the method used to estimate or measure this criterion. A common and widely used irrigation criterion is soil moisture status.

Table 1 compares different methods of irrigation scheduling by monitoring soil moisture content or tension. The methods described in the table measure or estimate the irrigation criterion.