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Irrigation scheduling

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Quick Facts

- Irrigation scheduling is the decision of when and how much water to apply to a field.
- The purpose of irrigation scheduling is to assist the farmer in maximizing 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 some indicators that determine the need for irrigation.

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

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. Different types of irrigation scheduling can be defined according to the irrigator's goal. Two of the more common types are: irrigation scheduling to maximize yield and irrigation scheduling to maximize net return. The final irrigation decision depends on evaluating the irrigation criterion and applying the irrigation strategy according to the irrigation scheduling type. Therefore, for proper irrigation scheduling, the irrigator needs to define a goal and establish an irrigation criterion and strategy.

To illustrate how irrigation scheduling works and the use of the terms mentioned above, consider a farmer whose goal is to maximize yield. The farmer uses soil moisture content as the irrigation criterion. Different levels of soil moisture content can be used to trigger irrigation. For example, when soil water content drops below 70 percent of the total available soil moisture, irrigation should be started.

The level of soil moisture content 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. A critical soil moisture level for a certain crop is such that below this level, the yield will be lower than the maximum potential yield. Thus, irrigation will be applied whenever the soil water content level reaches the critical level.

The decision of 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.

When the irrigator's goal is to maximize net return, a different irrigation criterion is needed, which is an economic criterion. An economic irrigation criterion, such as net return, 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. By applying the exact amount of water, irrigation efficiency is increased. A critical element of successful irrigation scheduling and management is the 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 has been applied.

Also, uniform water distribution across the field is important to derive the maximum benefits from irrigation scheduling and management. The importance of accurate water application is in prevention of over-irrigation or under-irrigation.

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The disadvantages of over-irrigation are as follows:

1) Waste of water, energy and labor.

2) Leaching expensive nutrients below the root zone and thereby depriving the plant of its nutriment.

3) Reduced aeration of the soil consequently reducing crop yields.

Under-irrigation stresses the plant and causes yield reduction.

Advantages of Irrigation Scheduling

Irrigation scheduling has been shown to offer seven advantages to the irrigator:

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 by applying 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 rootzone 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, has shown that irrigation scheduling provides an average 35 percent savings in water and energy. In fuel costs alone, this is a savings of about 550 kwh per acre for a center pivot sprinkler or about 200 kwh per acre for a gated pipe per season.

Irrigation Scheduling Methods

All irrigation scheduling methods consist of an irrigation criterion that triggers irrigation and an irrigation strategy that answers the question of 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.

Different methods of irrigation scheduling by monitoring soil moisture content or tension, are compared briefly in Table 1. The methods described in Table 1 measure or estimate the irrigation criterion. To complete each of these methods to an irrigation scheduling procedure, an irrigation strategy should be defined.

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.	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.	High accuracy.	Labor intensive including field work; time gap between sampling and results.
Tensiometers.	Soil moisture tension.	Tensionmeters including vacuum gauge.	Soil moisture tension.	Good accuracy; instantaneous reading of soil moisture tension.	Labor to read; maintenance is needed; 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 soil 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 estimation; cumbersome calculations if computer is not used.
Modified atmometer	Reference ET	Atmometer gauge	Estimation of moisture content	Easy to use, direct reading of reference ET	Needs calibration; it is only an estimation