Irrigation Water Conservation Strategies for Limited Resource Farmers

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Irrigation Water Conservation Strategies for Limited Resource Farmers

Introduction
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Introduction Cont.

- Only 2.5% of water on earth is freshwater.
- 2% is in the form of ice!
- Only ~0.5% of water on earth is available freshwater
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Water Conservation Strategies

- Precision irrigation,
- Selecting drought resistant crops,
- Making use of the available recycled water,
- Decreasing evaporation e.g. by use of plastic mulch,
- Decreasing soil drainage by using soil amendments,
- Increasing irrigation efficiency or irrigation scheduling.
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Irrigation systems

- To irrigate effectively, the right amount of water has to reach the right place at the right time.

- Different irrigation methods will supply different irrigation rates.

- Generally gravity systems supply more water than sprinkler and micro-irrigation systems.
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Irrigation Systems Cont.

<table>
<thead>
<tr>
<th>System</th>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface (Gravity)</td>
<td>Flood</td>
<td>Water is diverted from ditches to fields or pastures</td>
</tr>
<tr>
<td></td>
<td>Furrow</td>
<td>Water is channelled down furrows for row crops or fruit trees</td>
</tr>
<tr>
<td></td>
<td>Border</td>
<td>Water is applied to sloping strips of fields bordered by ridges</td>
</tr>
<tr>
<td></td>
<td>Surge</td>
<td>Valves control delivery of water to fields in intermittent surges</td>
</tr>
<tr>
<td>Sprinkler (Pressurized)</td>
<td>Pivot &amp; linear systems</td>
<td>High pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low pressure</td>
</tr>
<tr>
<td></td>
<td>Side rolls</td>
<td>Mobile pipelines deliver water across fields using sprinklers</td>
</tr>
<tr>
<td></td>
<td>Solid set</td>
<td>Pipes placed on fields deliver water from raised sprinkler heads</td>
</tr>
<tr>
<td>Micro-irrigation (Pressurized)</td>
<td>Surface</td>
<td>Emitter along pipes or hoses deliver water directly to the soil surface</td>
</tr>
<tr>
<td></td>
<td>Sub-surface</td>
<td>Emitter along pipes or hoses deliver water below the soil surface</td>
</tr>
<tr>
<td></td>
<td>Micro-sprinklers</td>
<td>Emitter on short risers or suspended by drop tubes sprinkle or spray water above the soil surface</td>
</tr>
</tbody>
</table>
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Irrigation Scheduling

What is irrigation scheduling?

- Irrigation scheduling is a tool for preventing the over-application of water while optimizing crop growth.

- Many producers know how long it takes to irrigate fields and avoid crop stress during average conditions.

- However, with erratic rainfall, it becomes difficult to apply enough water to fill the effective root zone without unnecessary deep percolation or runoff.
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Why schedule irrigation?

- Irrigation scheduling maximizes irrigation efficiency, hence saving water.
- Irrigation scheduling saves energy.
- Another additional benefit of irrigation scheduling is improved environmental quality by minimizing leaching and salinization.
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How do I schedule irrigation?

- At the start of the season, producers should plan a strategy that encompasses decisions about when and where to irrigate and how much water to apply.

- The strategy should be based on a good understanding of crop water use.

- There are three popular irrigation scheduling methods: i) ET-based, ii) Soil based and iii) Crop based
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ET-based irrigation scheduling method

Terminologies:

- Evapotranspiration (ET)

  - ET is the loss of water from a vegetative surface through the combined processes of plant transpiration and soil evaporation.

  - ET is equivalent to and frequently referred to as consumptive use.
Terminologies: Cont.

- Reference Evapotranspiration (ETo)
  - ETo is an estimate of the water used by a well-watered reference crop (grass cover).

- Crop Coefficient ($K_c$)
  - $K_c$ is a correction factor called crop coefficient and is required to convert ETo to ET for a specific crop.
  - Hence, $ET = ETO \times K_c$
ET-based irrigation scheduling methods:

- "Smart" irrigation scheduling controllers:
  - Consist of irrigation scheduling devices that use weather data, site, crop and irrigation system characteristics to schedule irrigation.
  - If programmed properly, they are a convenient and require minimum labor and maintenance.
  - But cost may be prohibitive (> $1,000).
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Brands of smart ET-based irrigation scheduling controllers

<table>
<thead>
<tr>
<th>ET-based Irrigation scheduling controllers</th>
<th>Subscriptions*</th>
<th>Mode of operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toro Intelli-sense</td>
<td>Yes</td>
<td>Remote weather station</td>
</tr>
<tr>
<td>Rainbird ET Manger</td>
<td>Yes</td>
<td>Remote weather station</td>
</tr>
<tr>
<td>Weathermatic Smartline</td>
<td>No</td>
<td>Onsite sensors</td>
</tr>
<tr>
<td>Hunter ET system</td>
<td>No</td>
<td>Onsite sensors</td>
</tr>
<tr>
<td>ET Water Smart</td>
<td>Yes</td>
<td>Remote weather station</td>
</tr>
<tr>
<td>Irritrol Systems</td>
<td>Yes</td>
<td>Remote weather station</td>
</tr>
<tr>
<td>Aqua Conserve</td>
<td>No</td>
<td>Onsite sensors/Historical</td>
</tr>
</tbody>
</table>

* Monthly subscription to the weather data service provider and ranges from $45 to 50.
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ET-based irrigation scheduling methods: Cont.

- Do-it-yourself ET-based irrigation scheduling

  - The approach is based on three steps:
    - accessing daily or monthly ET$_o$ data from the nearest weather station or from a public weather network database (e.g. Alabama Masonet Weather Data)
    - obtaining $K_c$ for the crop of interest, and
    - determining ET.
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Soil based irrigation scheduling method

**Soil Moisture Terminologies:**

- The following terms are commonly used to describe how soil moisture is quantified.
  - Soil water content
  - Soil water potential or soil moisture tension
  - Plant available water (PAW)
Soil Moisture Terminologies: Cont.

Soil water content:

- This is a measurement of the amount of water in a known amount of soil;

- It can be expressed as % water by weight or volume of soil, or inches of water per acre of soil.

- Example: when you irrigate 1 acre-inch you are supplying 27,000 gallons of water.
Soil Moisture Terminologies: Cont.

Soil water potential:

- This is a measurement of how tightly water is held by the soil.
- It is expressed in units of pressure called bars.
- The drier the soil, the tighter the water is held and the harder a plant must work to draw water from the soil.
Soil Moisture Terminologies: Cont.

- **Field capacity:**
  - This is soil water content after gravity has removed any freely draining, excess water.

- **Permanent wilting point:**
  - This is soil water content at which most plants can not recover from wilting.
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- Soil Moisture Terminologies: Cont.

- Plant available water (PAW):
  - This is the amount of water in the soil between the soil's field capacity and its permanent wilting point.
  - It is expressed as inches of available water per foot of soil.
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Soil based irrigation scheduling method

- The method is based on soil water (or moisture) measurement.

- There are several soil moisture tools and devices available on the market.

- Each of these devices has distinct advantages and limitations.
Soil moisture measurement methods:

- **Tensiometers:**
  - Tensiometers are devices that measure soil water potential.
  - They are air-tight, water-filled tubes with a porous cup and a vacuum gauge.
  - Water moves between the porous cup and surrounding soil.
Soil moisture measurement methods: Cont.

- **Tensiometers:**
  - Tension registers on the gauge at indicating water availability in the soil.
  - Tensiometers operate best at field capacity.
  - Average cost for a tensiometer is $50-$100
Soil moisture measurement methods: Cont.

- **Gypsum blocks:**
  - They measure soil water potential.
  - They consist of two electrodes embedded in a block of porous gypsum.
  - Electrodes are connected to a portable meter resistance where the readings are recorded.
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Soil moisture measurement methods: Cont.

- **Gypsum blocks:**
  - Gypsum blocks operate over a wider range of soil moisture tensions than tensiometers.
  - But they tend to deteriorate over time and may even need to be replaced yearly.
  - Cost: $1.25 for block and $300 for meter.
Soil moisture measurement methods: Cont.

- **Time Domain Reflectometry (TDR):**
  - TDR measures the soil water content.
  - Measures signal reflection.
  - Wet soil returns the signal more slowly than dry soil.
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Soil moisture measurement methods: Cont.

- **Time Domain Reflectometry (TDR):**

  - TDR gives fast, accurate readings of soil water content, and requires little to no maintenance.
  - But it may require more work in interpreting data and calibration.
  - The cost ranges from $100 to $500.
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Plant based irrigation scheduling method

- Plants use many different responses to keep their water supply and demand in balance.

- Hence, most plant-based irrigation scheduling methods are based on these direct measurements of one or more of these responses.
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Plant based irrigation scheduling method

- Direct methods: Plant water status
  - wilting
  - leaf water potential

- Indirect methods: water status
  - fruit or stem diameter
  - leaf thickness
  - xylem cavitation
Conclusion about irrigation scheduling methods

- For successful irrigation scheduling, you need to know:
  - your soil,
  - your soil-water status,
  - your crops, and
  - your crop stress status as determined by the weather.