# Irrigation Considerations

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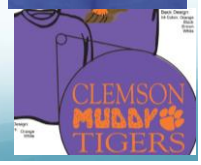
## Support the Clemson University Soil Judging Team

WAYS TO GIVE

- Checks
- Hotel, car rental, airline rewards
- BUY A SHIRT!
  - 1 for $20
  - 2 for $35



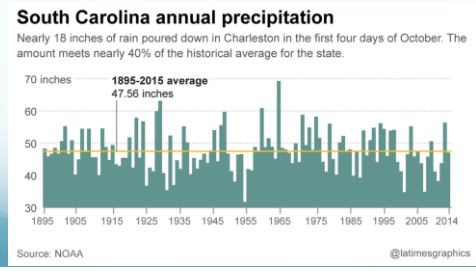

## Key considerations of an irrigation system

- Why install an irrigation system?
- Costs
- Water supply options
  - Water quality
  - Water treatment
- Water quantity
  - Irrigation scheduling options
  - When
  - How much
- Water delivery systems
- Informational resources


## Why install an irrigation system?

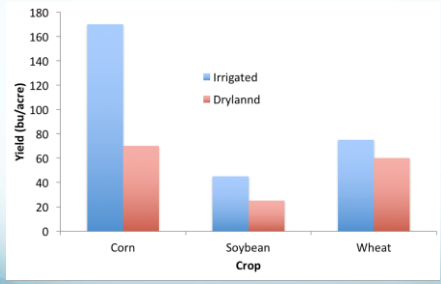
**Reduce risk associated with climate variability**

- **Short term, but more frequent intense events**
  - **Drought**
  - **Floods**




## Why install an irrigation system?

**Increase yields**




From: AC-07 Comparison of Irrigated and Dryland Crop Production in SC. José Payerno & Ahmad Khalilian

## Why install an irrigation system?

**Increase net return**

**Table 2. Average increase in yield and economic return from irrigation over dryland obtained by a farmer in South Carolina during a five-year period (2009 to 2013).**

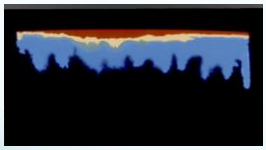
| | Corn | Soybeans | Wheat |
|---|---|---|---|
| **Yield increase (%)** | 100% | 74% | 23% |
| **Crop Price ($/bu)** | $5.00 | $11.50 | $7.00 |
| **Income increase ($/ac)** | $410.50 | $230.00 | $94.50 |
| **Irrigation cost ($/ac)** | $175.00 | $95.00 | |

From: AC-07 Comparison of Irrigated and Dryland Crop Production in SC. José Payerno & Ahmad Khalilian

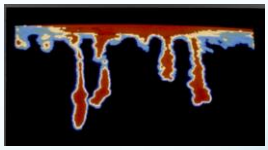
# Why install an irrigation system?

**Reduce risk associated with soil variability**

- Soil water repellency
- Soil textural changes



**Matrix Flow – GOOD**



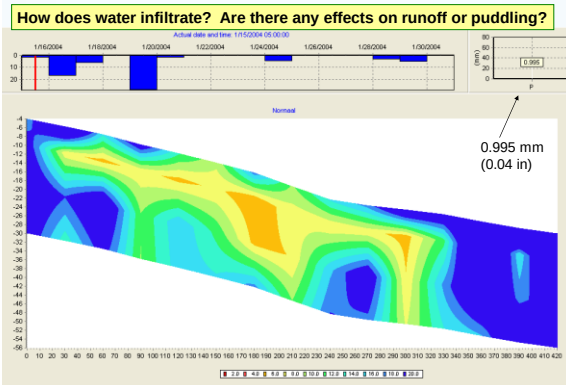
**Finger Flow - BAD**

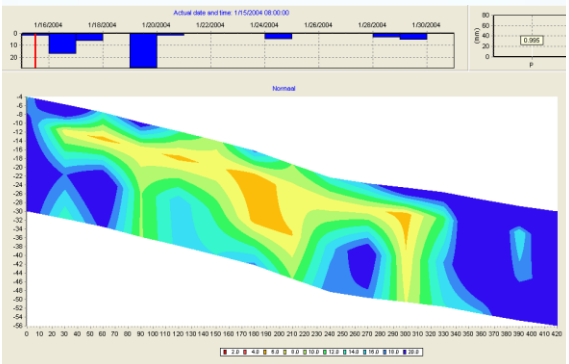
# Why install an irrigation system?

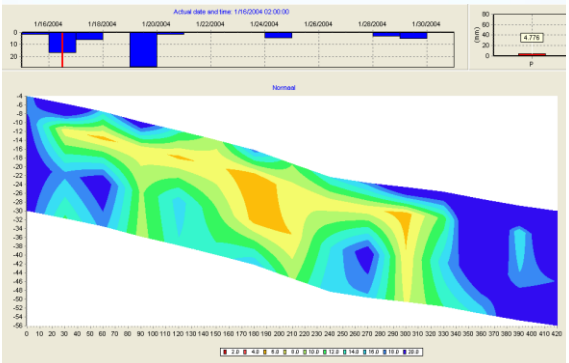
**Reduce risk associated with soil variability**

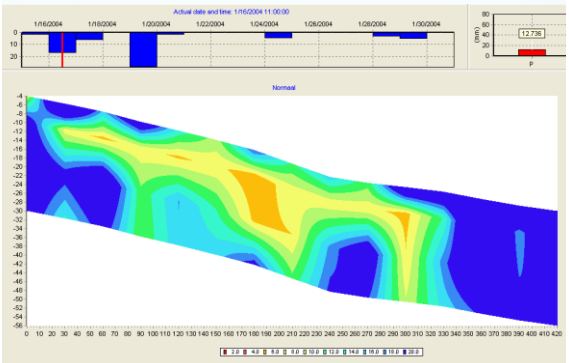
- Soil water repellency
- Soil textural changes

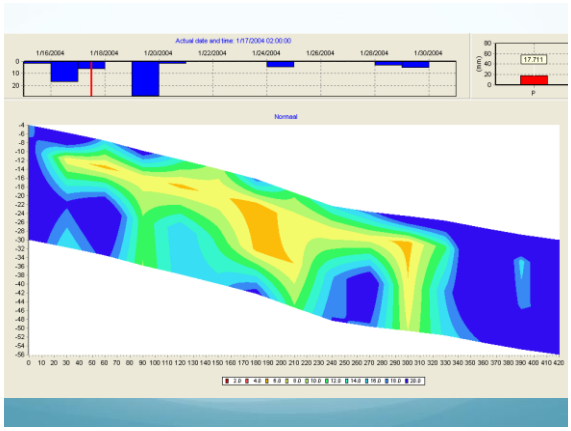

**How does water infiltrate? Are there any effects on runoff or puddling?**





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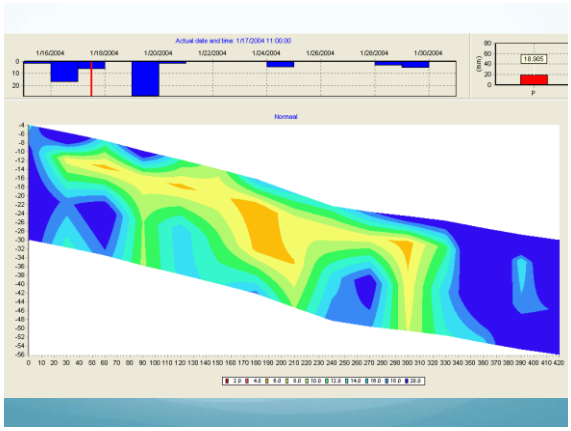
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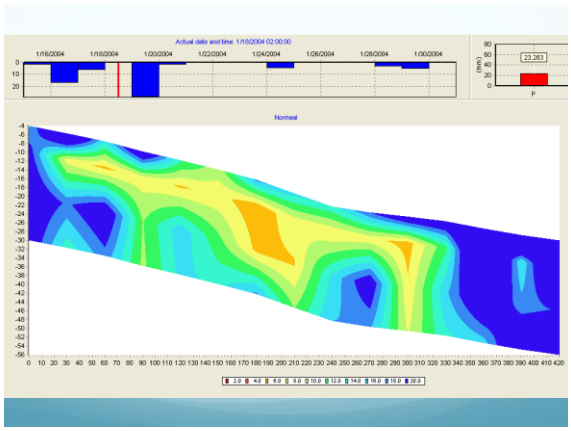
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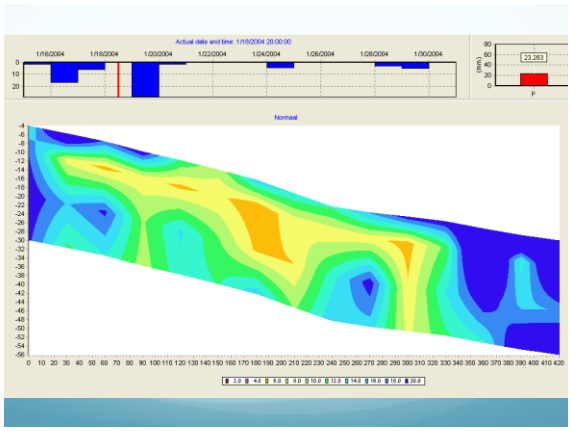
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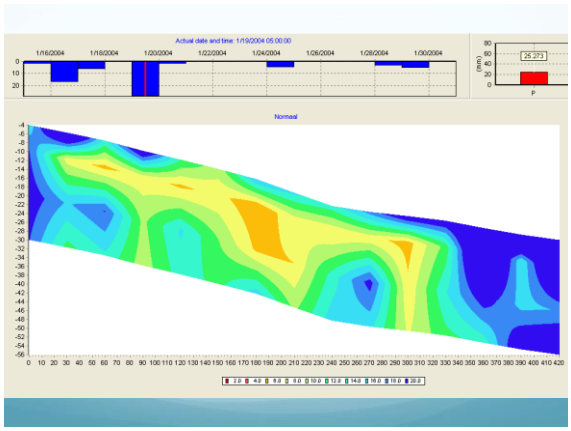
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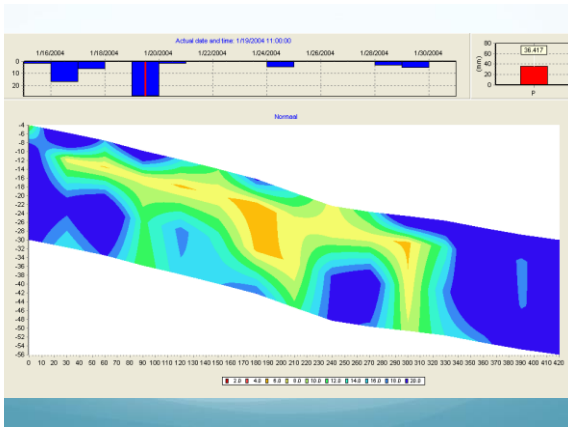
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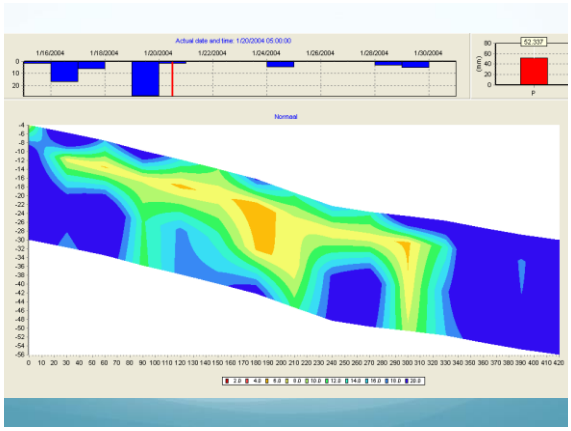
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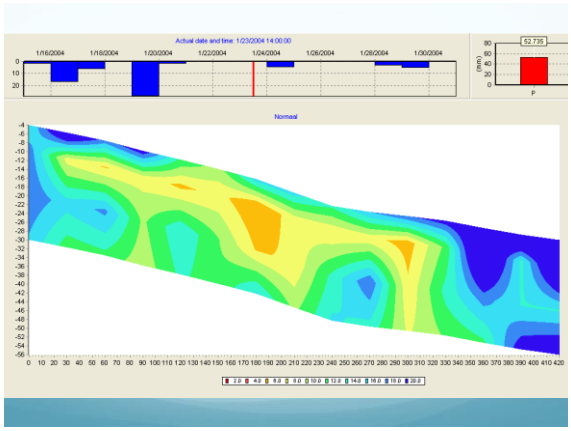
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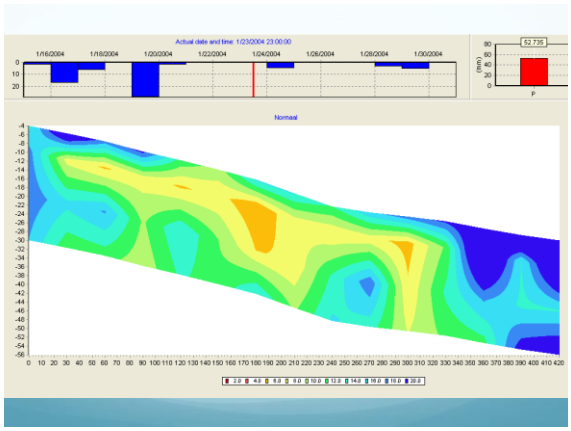
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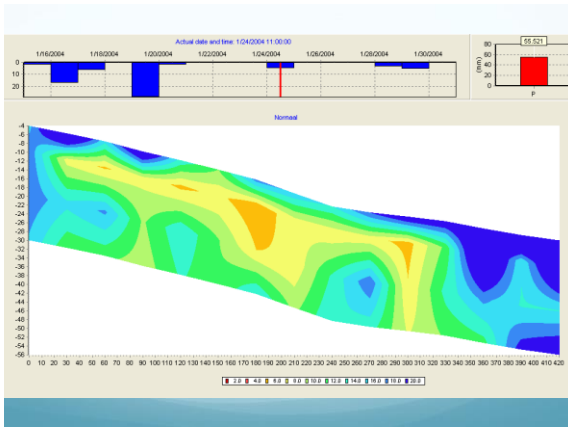
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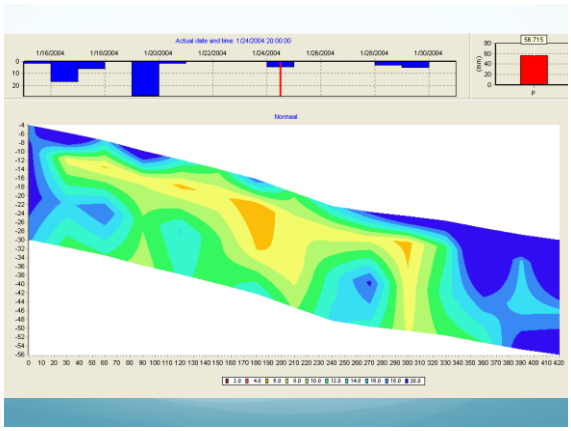
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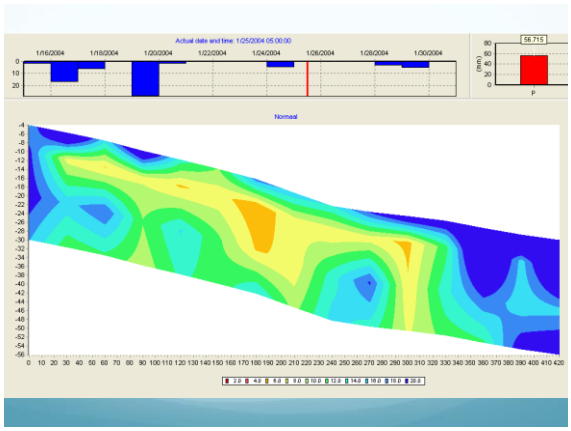
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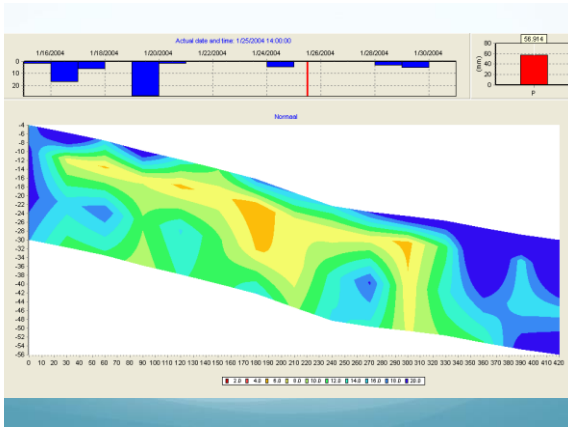
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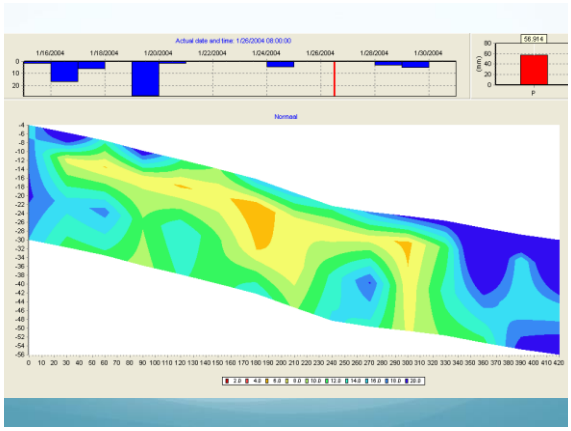
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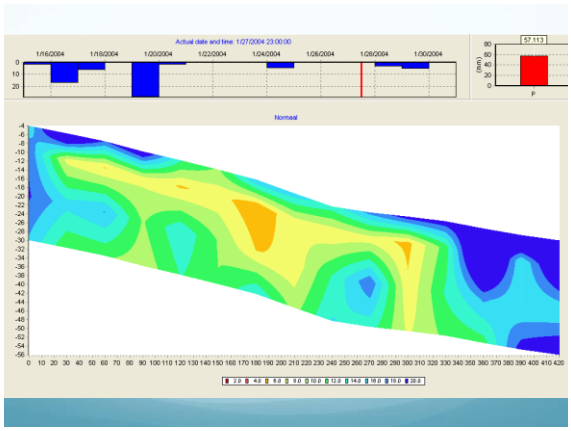
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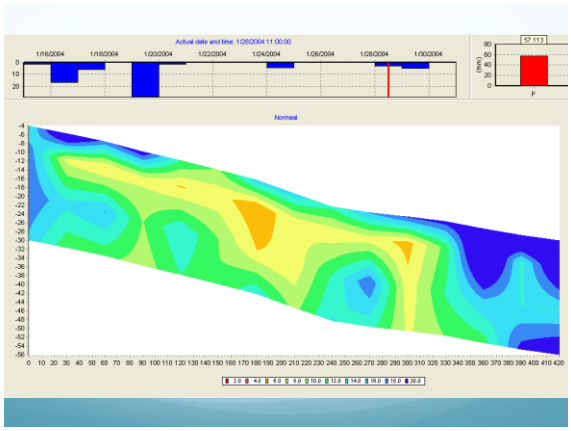
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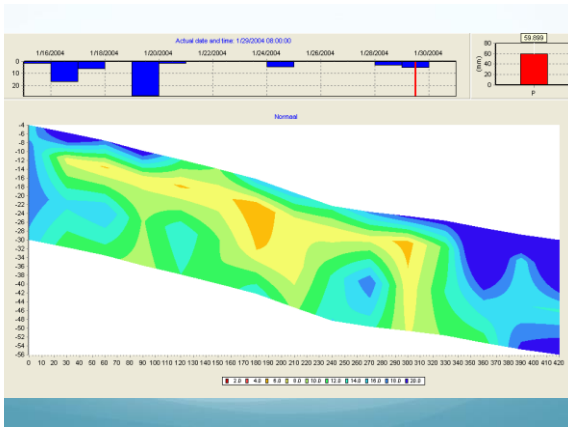
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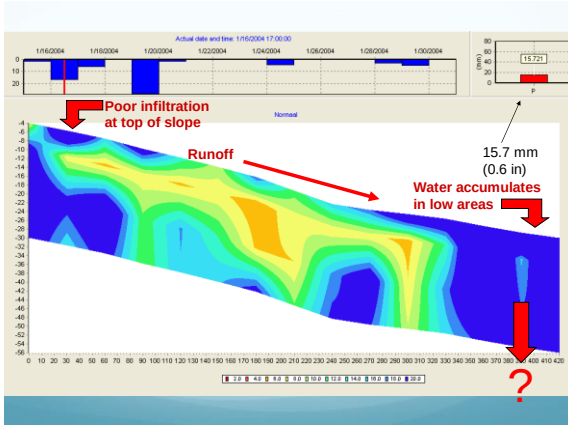
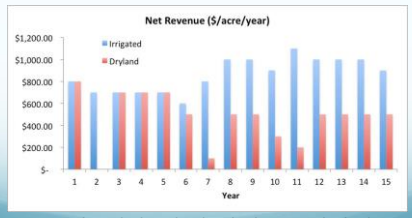



## Costs of an irrigation system?

**Dependent on:**

- Water source
- If treatment is needed
- Size
- Type

- Significant initial investment
- May take some years to economically see the return




From: AC-07 Comparison of Irrigated and Dryland Crop Production in SC. José Payerno & Ahmad Khalilian

## Water Supply Options?

**Sources:**

- Wells (Deep, Shallow)
- Storm water ponds
- Municipal
- Surface water (creeks, rivers, lakes, AIW)
- Treated wastewater

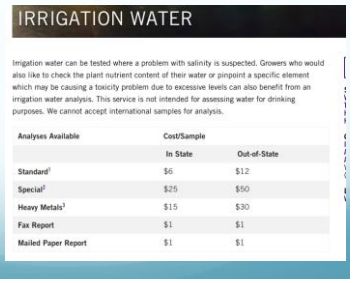
## Water Supply Options?

**Always test water sources:**

- Private contract labs
- Clemson Agricultural Services Lab

**Quality also influences:**

- Water quantity
- Pesticide efficacy



IRRIGATION WATER

Irrigation water can be tested where a problem with salinity is suspected. Growers who would also like to check the plant nutrient content of their water or pinpoint a specific element which may be causing a toxicity problem due to excessive levels can also benefit from an irrigation water analysis. This service is not intended for assessing water for drinking purposes. We cannot accept international samples for analysis.

| Analyses Available | Cost/Sample | |
|---|---|---|
| | In State | Out-of-State |
| Standard[1] | $6 | $12 |
| Special[2] | $25 | $50 |
| Heavy Metals[3] | $15 | $30 |
| Fax Report | $1 | $1 |
| Mailed Paper Report | $1 | $1 |

## Water Supply Options?

**Sources will determine water quality:**

- Common issues are:
  - Bicarbonates
  - Salinity
  - Sodium
  - Pure water
  - pH
  - Iron



- Can influence plant growth directly,
- Through promoting poor soil structure,
- Impacting irrigation system performance.

## Water Supply Options?

**Water treatment:**

- Can be costly
- Issue dependent

## Irrigation Application

**Irrigation efficiency:** proportion of the water that is beneficially used to the irrigation water applied.

**Distribution uniformity:** the evenness or uniformity or irrigation water applied over an area

## Factors Influencing IE

- **Sprinkler system:**
  - nozzle performance
  - pressure
  - head spacing
  - piping system
  - installation
  - maintenance
- **Soil conditions**
- **Environmental conditions (Wind Drift)**

| Wind Speed (mph) | % Lost to Evaporation |
|---|---|
| 15 | 18 |
| 20 | 30 |
| 40 | 93 |

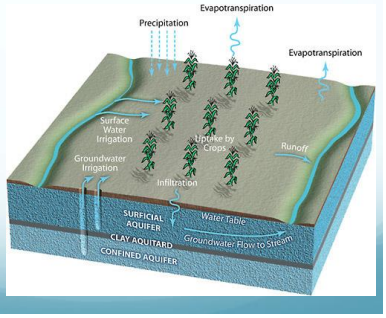
## Water Quantity

**Irrigation Scheduling Options**

- **Many different techniques**
- **Some more expensive than others**

## Water Quantity

- Irrigation water use is **NOT** the same as plant water use (ET)
- ET = P + Ir – If – R




## Evapotranspiration (ET)

- Evaporation of water from the soil or plants surfaces and transpired from leaves.
  - It is typically measured in inches or cm
- Weather conditions affect ET:
  - Solar radiation
  - Temperature
  - Wind
  - Humidity


## Irrigation scheduling: Plant Water Use

Potential evapotranspiration (PET)

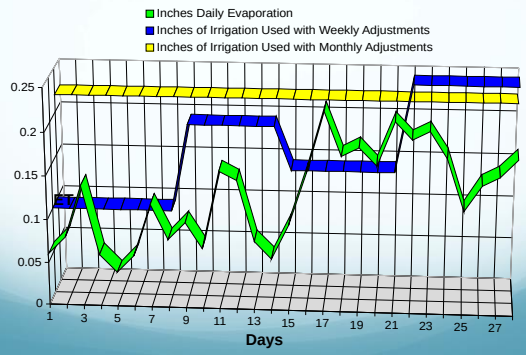
Affected by air temperature, sunlight, wind, humidity, available water in the soil

## Effective Rainfall

- Measurement of rain is as important as the measurement of ET
- Rainfall replenishes soil moisture
- Rainfall that runs off is NOT effective rain
  - **Soil percolation rate and slope limit effective rain.**
- Rain that soaks below the roots is NOT effective rain

## Rain shut off sensors

## Typical Irrigation System Adjustments



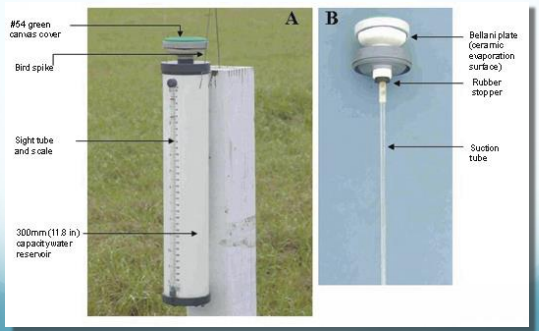

## Irrigation scheduling: Measuring ET

Irrigation can be based on ETp calculated from weather stations measuring

- solar radiation
- temperature
- humidity
- wind speed

**Can lead to over watering if do not consider soil moisture**

## Atometers




## Determine irrigation quantity accurately

Weather stations that determine ET:

- Caution: predictive ET ≠ Actual ET
- Many models: Pan, McCloud, Penman, Jensen and Haies
- Models assume:
  - non-stressed conditions,
  - no limiting factors, and
  - uniform canopy

Photo: Campbell Scientific

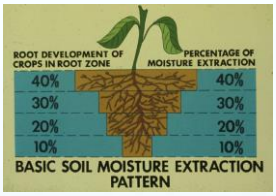
## Does it make sense to apply that much water at once?

- Hint: soil texture!

If you can, better to integrate soil moisture!

## Where do plant get their water?

Soil root zone- where there is available water!




Example: Sands

- Holds 1.5" water per ft of soil
- Half is available (0.75")

## Irrigation based on soil moisture

Know the available soil moisture of your root zone soil!

| Soil texture | Available soil moisture in/ft (m/m) | (%) |
|---|---|---|
| Sand | 0.7 (0.058) | 6 |
| Loamy Sand | 1.1 (0.092) | 9 |
| Sandy Loam | 1.4 (0.117) | 12 |
| Loam | 1.8 (0.150) | 15 |
| Silt Loam | 1.8 (0.150) | 15 |
| Sandy Clay Loam | 1.3 (0.108) | 16 |
| Sandy Clay | 1.6 (0.133) | 14 |
| Clay Loam | 1.7 (0.142) | 11 |
| Silty Clay Loam | 1.9 (0.158) | 13 |
| Silty Clay | 2.4 (0.200) | 20 |
| Clay | 2.2 (0.183) | 18 |

**Does not account for organic matter.**

## Irrigation based on soil moisture

### Organic Soils

| Soil texture | Available soil moisture in/ft (m/m) | (%) |
|---|---|---|
| Peats and mucks | 2.5 (0.208) | 21 |

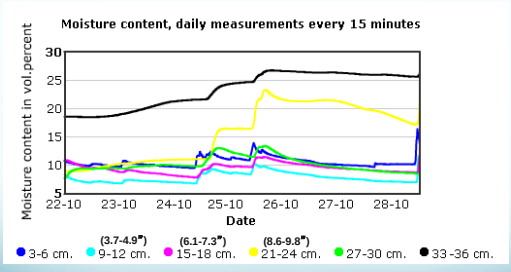
## Soil Moisture Monitoring


## Get actual soil moisture content recordings

## Benefit of soil moisture sensor

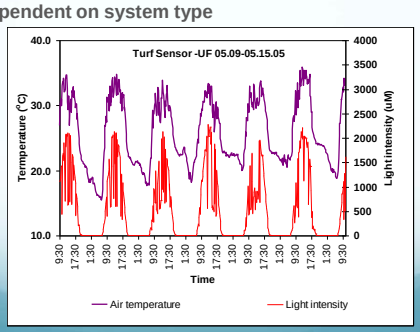
Different soils = different water holding capacities

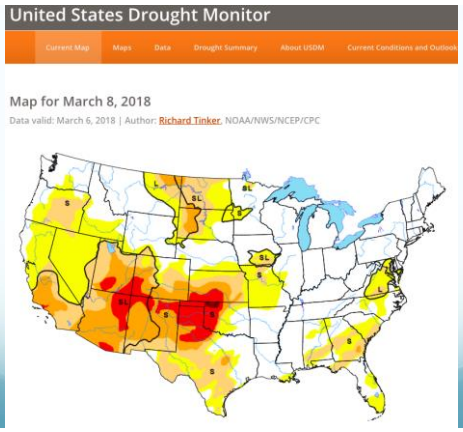

## What soil moisture info can do for irrigation scheduling




## When to Irrigate?

- **Best time is in morning before plants get to work!**
- **Dependent on system type**




## Drought Informational Websites:

- SC Climate, Energy and Commerce Advisory Committee www.scclimatechange.us/
- SC Drought Response Council www.dnr.sc.gov/climate/sco/Drought/drought_current_info.php
- Clemson drought update http://hgic.clemson.edu/hottopics/details/drought.htm

## Water Delivery Systems

- Many different
  - Types
  - Scale
- Keep it production system relevant
  - Hoop house
  - Large / small scale
  - Greenhouse
  - Pasture
  - Row crop
  - Nursery

## Water Delivery Systems

**Overhead: Large scale / mobile**

- Center pivot
- Traveling gun
- Lateral
- Can incorporate variable rate (VRI)


## Water Delivery Systems

**Overhead: Large scale / stationary**

- Can incorporate variable rate (VRI)


## Water Delivery Systems

**Overhead: small –med scale / mobile**

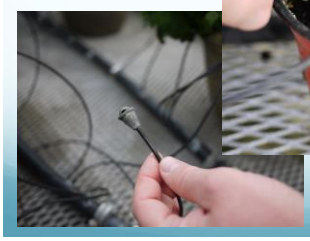
Can incorporate variable rate (VRI)


## Water Delivery Systems

**Flooding: Greenhouse / Hoop house / Field**


## Water Delivery Systems

**Micro Drip / Mist**

## Water Delivery Systems

**Subsurface Drip Irrigation (SDI)**

- Application of water and chemicals directly to the root zone


## SDI Applications

- Around trees
- Raised beds
- Medians
- Nurseries
- Greenhouses
- Turf (residential, sports)
- Vineyards
- Roof top gardens
- Wall gardens

## SDI Advantages

- Reduction in water use:
  - Evaporation from surfaces
  - Wind drift
  - Not irrigating full soil profile
- Potential water quality protection of receiving waters
  - Less runoff
  - Less deep percolation

## SDI Advantages Cont'd

- Reduced surface problems:
  - No infiltration problems
  - No crust formation
  - Less salt accumulation at surface
  - Less optimal conditions for disease
- Can irrigate any time:
  - Weather
  - While harvesting
- For slopes

## Water Delivery Systems

**Subsurface Drip Irrigation (SDI)**

- For both large and small scale!

Table 1. Cotton production with SDI compared to dry land during three years in South Carolina (cotton price = $ 0.80/lb).

| Year | Yield Increase | Income Increase |
|---|---|---|
| 1997 | 370 lb/ac (37%) | $296/ac |
| 1998 | 534 lb/ac (56%) | $427/ac |
| 1999 | 577 lb/ac (103%) | $462/ac |
| Average | 494 lb/ac (65%) | $395/ac |

From: AC-07 Comparison of Irrigated and Dryland Crop Productionin Sc. Jose Payerno & Ahmad Khalilian

## SDI Disadvantages

- Can be costly
- System problems:
  - Digging required
  - Fewer visual indicators of system operational performance
  - Surfacing or tunneling of the emitter flow to the soil surface (chimney effect)
  - Rodent problems more difficult to solve

## SDI Disadvantages Cont'd

- System development:
  - Less technological advances than other irrigation systems
  - Less # of turn-key operations
  - What about afterwards?
- Misc:
  - Dripline spacing
  - Salinity may be increased above dripline
  - Soil surface disruption is limited

Clogging of dripline emitters is the primary reason for SDI system failure.

## SDI Basic System Overview

Installing laterals

## Irrigation Information Resources

- IA: Irrigation Association
- Clemson University Extension
- CIMIS: CA Irrigation Management Information System
- USDA-NRCS

## Support the Clemson University Soil Judging Team

WAYS TO GIVE

- **Checks**
- **Hotel, car rental, airline rewards**
- **BUY A SHIRT!**
  - **1 for $20**
  - **2 for $35**


## New CIG Demonstration: Influence of Soil Sampling on Fertility Recommendations and Crop Yields

**Partners:**

- **Clemson University**
- **Dillon Soil & Water Conservation District**

- **2.5 yr project**
- **Coleman Farm, Dillon SC**
- **Began in October '16 with wheat crop**

## New CIG Demonstration: GOAL

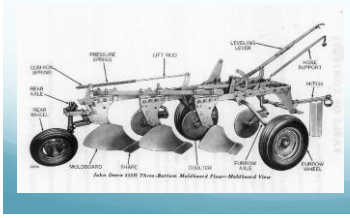
A side-by-side demonstration of

- cover and cash crop response,
- and economic return

of fertility recommendations based off of different soil sampling depth strategies for a field that has been implementing soil health principles.

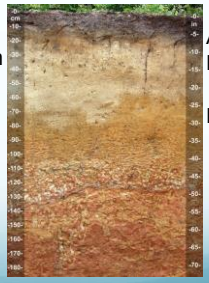
## New CIG Demonstration: INTRO

- Current soil sampling strategies are based off of use of out dated plowing techniques.
- Moldboard plows:
  - clay: 4” deep
  - Sand: 6 ¾” deep



## New CIG Demonstration: INTRO

- SC soil composition changes with depth
  - Texture
  - Water content
  - Nutrient retention



A: SL / LS
E: LS/ S

Bt: C, deep!

## New CIG Demonstration: DEMONSTRATION DESIGN

Five Sampling Strategies:

A. 0-6”
B. 0-12”
C. 0-24”
D. Full depth to impeding layer /abrupt texture change
E. Clay horizon to 24” from surface.

[redacted]