Cotton Water Requirements in Humid Areas

Daniel K. Fisher

USDA Agricultural Research Service
Jamie Whitten Delta States Research Center
Stoneville, Mississippi

Evapotranspiration

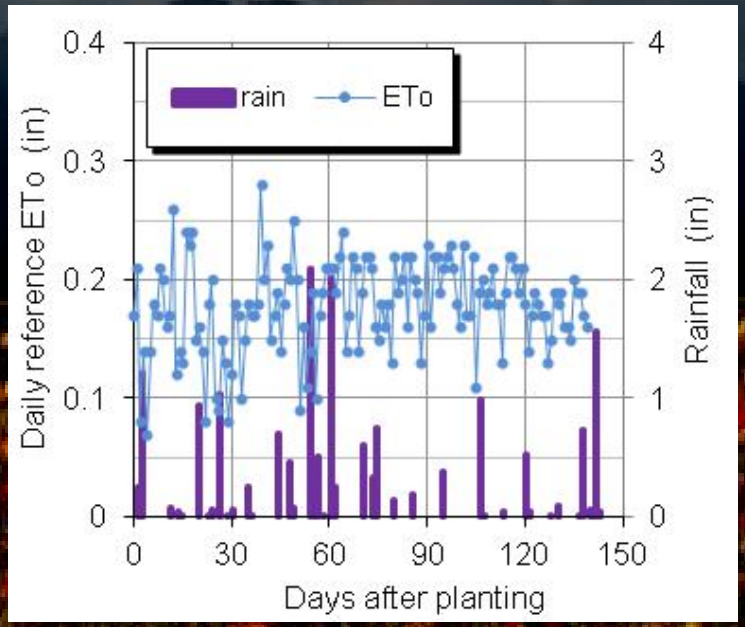
- cotton uses water throughout its lifecycle
  - evaporation
    - from the soil surface
    - significant during early season when plants are small
  - transpiration
    - as it grows and transpires
    - minimal early, increases as plants grow
  - evapotranspiration (ET)
    - combined process
    - quantifies total water used by cropping system

Environmental demand

- evapotranspiration a result of atmosphere, environmental demand
- can vary greatly day to day
  - hot, dry and windy
    - air is drier, mixes
    - more solar energy
    - higher ET
  - cool, cloudy, and calm
    - higher humidity
    - lower solar energy
    - lower ET

Reference ET (ETo)

- a measure of environmental demand
- created to standardize ET estimates, methods
- describes ET from well-watered grass surface
- function of weather variables
  - solar radiation
  - air temperature
  - humidity
  - wind
- varies on daily basis
- varies throughout season



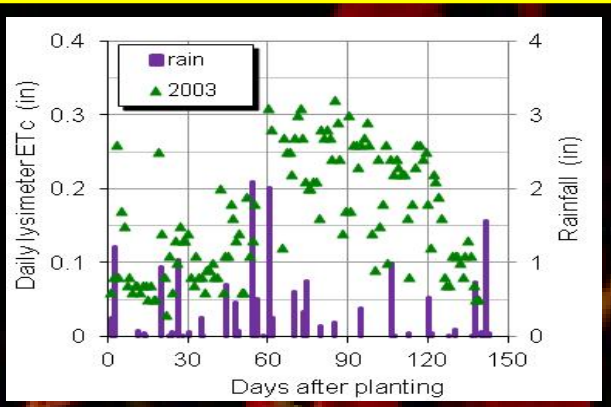
Crop ET (ETc)

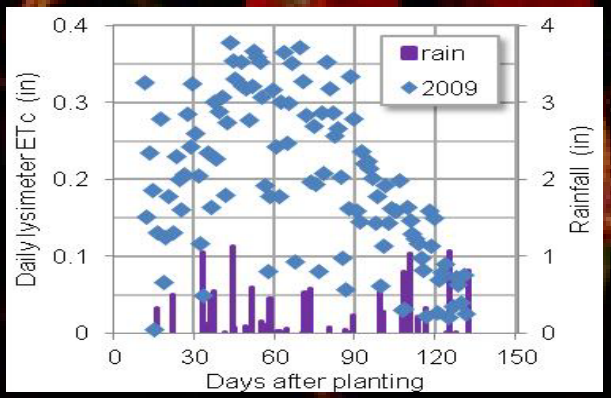
- amount of water used by particular crop
- varies for different crops
- can be measured with weighing lysimeter
  - box of soil with growing crop
  - weighed continuously
  - as water is used, weight decreases
  - measure daily weight change, or ETc

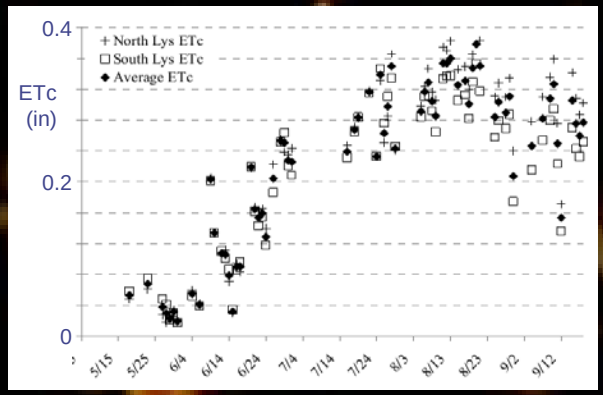
Crop ETc

- lysimeters in southeast
  - Stoneville, MS (USDA)
  - Blackwell, SC (Clemson)
  - St. Joseph, LA (LSU)

	peak ETc	avg peak ETc
MS	0.32 in/day	0.28 in/day
SC	0.38	0.35
LA	0.38	0.33

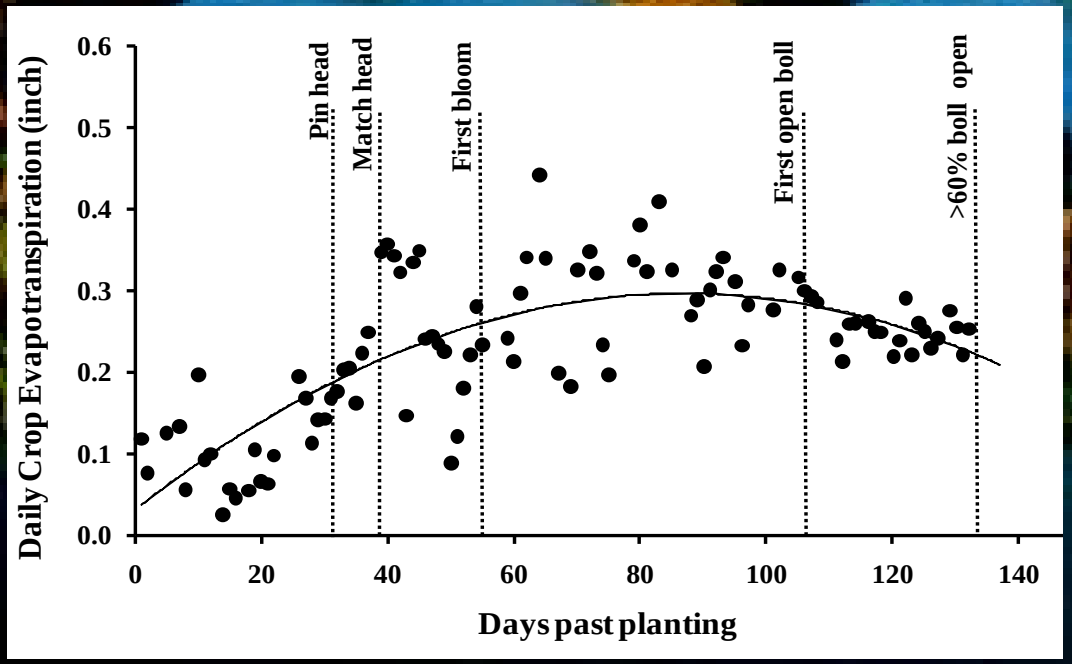






Water use at different growth stages

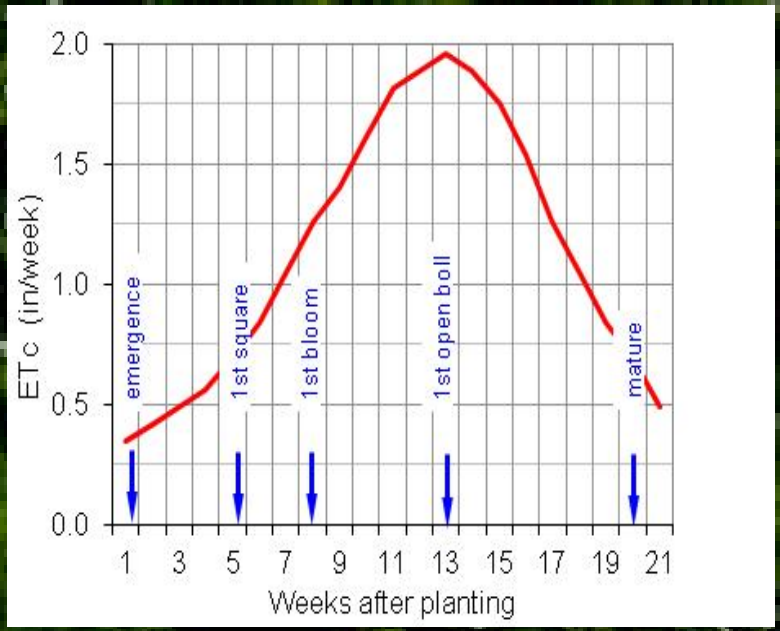
- evaporation early in the season
- transpiration increases
- peaks around 1st open boll
- steadily declines



Weekly water needs

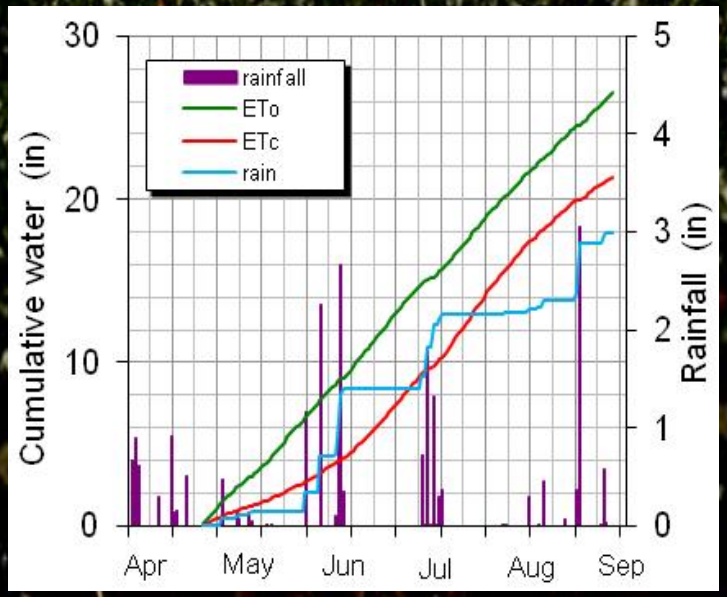
- crop ETc occurs daily
- accumulates to weekly crop water use
- becomes weekly crop water requirements
  - available soil-water reserves
  - from rainfall
  - or provided by irrigation

early season	0.5 in/wk
developing	1-1.5 in/wk
peak period	>2 in/wk



Seasonal total water needs

- ETo (reference ET)
  - environmental demand
- ETc (crop ET)
  - depends on particular crop
  - cotton: 20 - 25 in/yr
- rainfall
  - sufficient during season?
- irrigation
  - may be needed

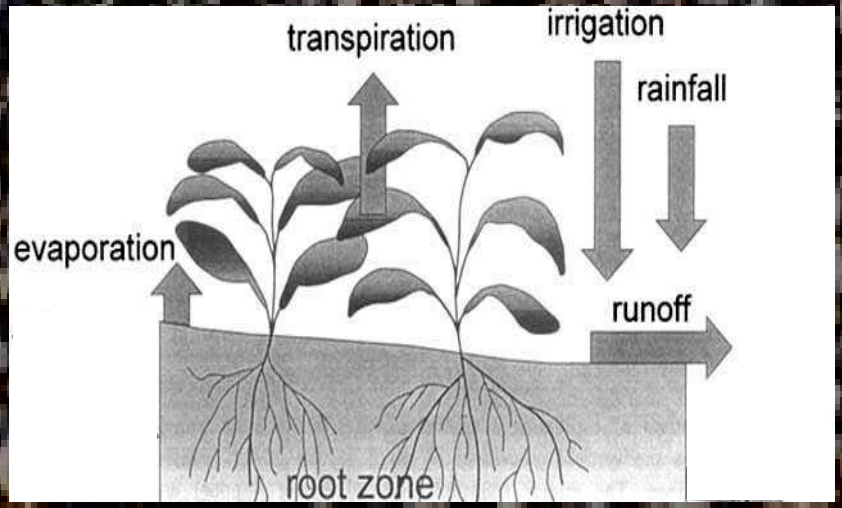


Water use/resources

- want to use, manage water resources
  - ensure crop has adequate amount
  - available at appropriate times
  - use water efficiently
- need to keep track of water resources
  - amount used by cropping system
  - rainfall
  - irrigation
- ensure availability for crop

Water balance

- keep track of water available in root zone
- moves in and out constantly
  - main components
  - outgoing water
    - evaporation
    - transpiration
    - runoff
  - incoming water
    - rainfall
    - irrigation
- have idea if sufficient for crop needs



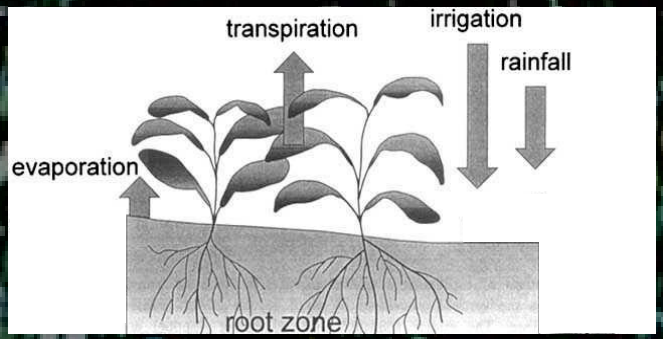
Accounting of water resources

- use water balance model
  - checkbook method
    - keep track of withdrawals, deposits
    - know your balance (or total expenditures)
  - deposits
    - rainfall
    - irrigation
  - withdrawals
    - evapotranspiration

Water balance model

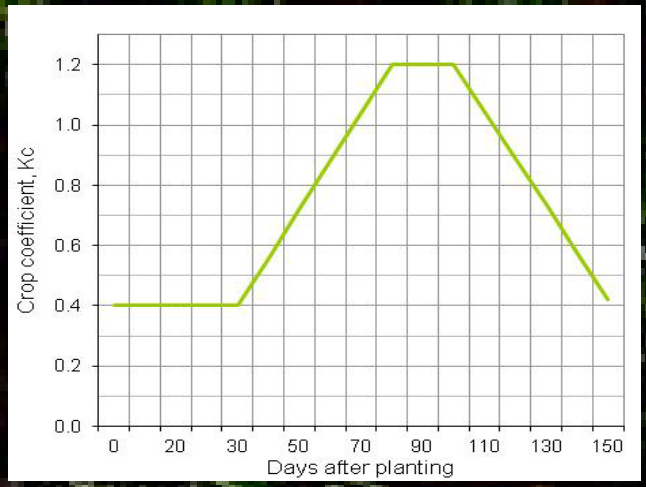
- components can be estimated, measured
  - $SWD_i = SWD_{i-1} + I + Pe - ETc$

    SWD_i = today's soil-water deficit
    SWD_{i-1} = yesterday's deficit
    I = irrigation water applied
    Pe = effective precipitation
    ETc = crop evapotranspiration
  - irrigate when critical SWD level is reached



ETc estimation

- function of weather and crop
- weather
  - environmental demand, ETo
- crop
  - crop coefficient, Kc
  - crop specific
  - relative to reference ET
  - different growth stages
  - ETc = Kc * ETo

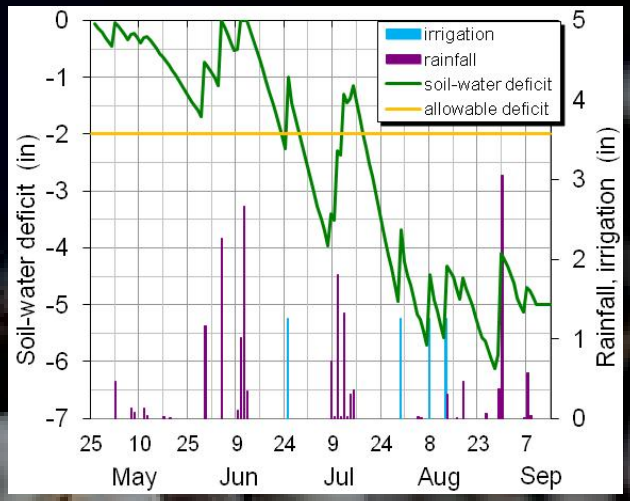


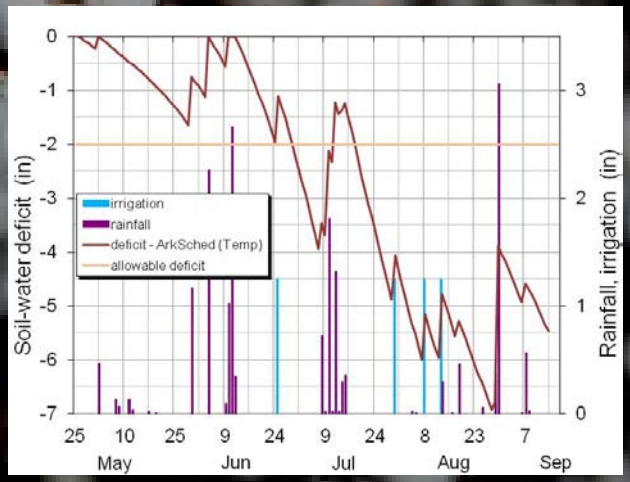
Irrigation scheduling programs

- many scheduling options available
  - Mississippi, Tennessee
    - internet-based tools
  - Arkansas
    - Arkansas Irrigation Scheduler
    - stand-alone computer program
      - uses checkbook/water-balance method
      - requires minimal user input
    - estimates ETc
    - tracks daily soil-water depletion
    - user decides when to irrigate

Irrigation scheduling

- scheduling model output
  - spreadsheet model in Excel
    - weather data, estimate ETo
    - Kc function to calculate ETc
    - estimate effective precipitation
    - update daily SWD
  - Arkansas Irrigation Scheduler
    - air temperature, estimate ETo
    - precipitation
    - daily SWD, predict few days
    - guidance on allowable limit





Soil-moisture sensors

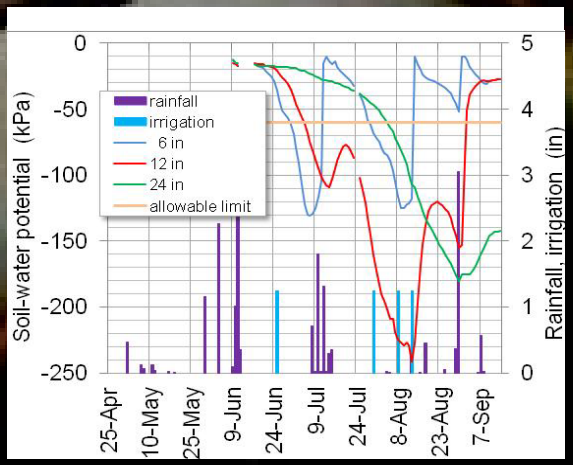
- another scheduling tool
- install sensors in root zone in the field
- sensors monitor water status directly
  - no theoretical models, estimates, data input
  - respond to actual field conditions
  - takes labor to install and maintain
  - expense involved
- usually used for real-time scheduling

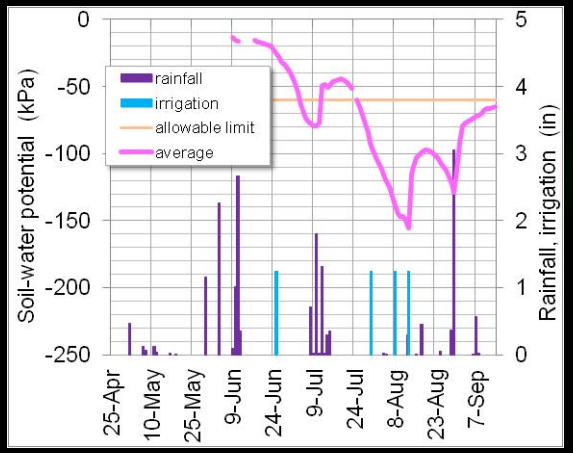
Passive sensor-based monitoring

- used for post-season analysis
  - install sensors, monitoring equipment
  - go about normal production operations
  - passively collect data throughout season
- after season ends, analyze data
  - crop water use
  - irrigation performance

Soil-moisture monitoring

- sensors installed in irrigated plot
  - Watermark matric-potential sensors
    - 3 depths
    - 6, 12, 24 in below surface
  - automated measurements
    - data collected every hour
  - average of hourly readings
    - similar to water balance model





Cotton water requirements

- crop needs adequate water
  - responds to environmental demand
  - water use changes throughout season
- need to be aware of needs, resources
  - crop water needs
  - available soil-water resources
- monitoring and scheduling tools
  - track water resources
  - predict irrigation requirements

Further information

- Cotton Irrigation Management for Humid Regions
  - Section 4: Cotton water requirements
  - Section 7: Irrigation scheduling tools