Understanding Irrigation Efficiency with Different Systems: How it’s Defined, Why it’s Important

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Irrigation Efficiency; Why it’s Important

Three main sources of water that sustain California:
- Mountain snowpack
- Water stored in reservoirs
- Water pumped from underground aquifers.

All three sources are connected, and when the California Governor declared a drought emergency on January 17, 2014, all three had been depleted by an extended dry period.

Source: California Department of Water Resources
California state wide snowpack is projected to shrink drastically


25% of Sierra snowpack will be lost by 2050

Department of Water Resources, State of California

Source: Tapan Pathak, Climate Adaptation in Agriculture - CE Specialist, University of California Merced
Irrigation Efficiency; Why it’s Important

Lake Mead Water Levels — Historical and Current

June 2015: 1075.08’
Last time below 1075’ elevation was in April 1937

Source: http://www.arachnoid.com/NaturalResources/
Improving Irrigation System Efficiency

• Reduce losses (nutrients, pesticides, water)
• Limited water supplies and increased demands
• What is efficiency?
  • Distribution system efficiency (district level, canals, reservoirs, etc)
  • On farm or field application efficiency (AE), distribution uniformity (DU), and other parameters
Irrigation Methods in California:

1- Surface irrigation (flood):
   - Border strip (flat) irrigation (slope 0.1-0.2%)
   - Furrow irrigation (slope)
   - Basin irrigation (zero slope)

2- Sprinkler Irrigation (various types)

3- Drip Irrigation (various types)
   - Surface drip
   - Subsurface drip
Vegetable Crops
- Sprinkler irrigation (common)
- Drip irrigation
- Furrow irrigation (declining fast)
Advantages/savings:
Water, fertilizers, labor, TMDL
Field Crops

Mostly surface irrigation methods:

- Border (flat) irrigation
  Runoff rate: 5-20% (vary)

- Furrow (bed) irrigation
  Runoff rate: 15-30% (vary)

Surface runoff:
Nutrient losses: surface runoff & deep percolation
Pesticides losses: mostly surface runoff &
  some with deep percolation

* Usually no runoff with basin irrigation
Surface Irrigation

Applied water = Root zone storage + runoff + deep percolation

Subsurface

Surface runoff (B)

Root zone storage (A)

Deep percolation (C)
On-Farm Water Conservation

= Higher Application Efficiency (AE)

Application Efficiency (AE) = \frac{A}{A+B+C}

To achieve higher efficiency, reduce B and/or C

BUT

Need to have a balance,
Deep Percolation sometimes is needed for salinity control
(700 ppm ~ 0.96 tons of salt/ac-ft)
Runoff is needed for Uniformity (100% AE means under irrigation)
Distribution Uniformity (DU)

\[ DU = \frac{\text{Average depth in low quarter}}{\text{Average depth applied}} \]

Many other efficiency parameters

BUT

KEEP IT SIMPLE, AE and DU are all you need
Surface Irrigation Management Under Drought

- The key is to reduce surface runoff and deep percolation when water supplies are limited
- May result in under irrigation and yield loss
- May result in salinity buildup
- Water availability and water quality (water salinity)
- Is leaching needed when water is available again?
On-farm Practices

• Minimize/eliminate Runoff or Tailwater (management)
• Recycle Runoff water (may need energy)
• Reduce deep percolation (may not be always practical, water table control)
• Irrigation management
Tailwater Recovery Systems

• For water conservation
• Improving the quality of drainage water (TMDL)
Irrigation management – applying the right amount of water
Average PO4 load in runoff water per irrigation during the first six irrigations after P application in 2006

- Broadcast-Standard Irrig.
- Broadcast-Reduced runoff
- Water run-Standard irrig.
- Water run-75%

PO4 (lb/ac per irrig.)
Sprinkler Irrigation Systems

Applied water = Root zone storage + runoff + deep percolation?

To Increase Efficiency: Eliminate

1- Runoff
2- Deep Percolation
Drip Irrigation Systems

Applied water = Root zone storage + runoff + deep percolation?

To Increase Efficiency:
- Improve system uniformity (DU)
- Eliminate:
  1. Runoff
  2. Deep Percolation
How Much Water do I need to Apply?

- Need to know crop water use (ETc) since last irrigation
- ETc from (Reference evapotranspiration and crop coefficient)
- Typical application rates (Imperial Valley):
  - Surface: ~ 3-4 in/irrigation
  - Sprinkler: ~ 0.5-1.2 in/irrigation
  - Drip: ~ 0.5 in/irrigation
Crop Water use: Soil moisture

- Total soil water
  - Plant Available water
  - Drip
  - Sprinkler
  - Surface

- Saturation (S)
- Field Capacity (FC)
- Yield threshold (YT)
- Permanent wilting point (PWP)
- Oven dry
Flow rate (cfs) and total applied water
Low Distribution
Low DU and Irrigating on a Windy Day- Bad combination
Summary

- Tailwater recovery systems can save water - issues with salinity and temperature

- Irrigation management and irrigation scheduling are key factors for water conservation and improving efficiency (apply the right amount of water at the right time)

- Regular inspection of the irrigation system (pressure, flow rate, filtration system, leaks, etc).

- Avoid sprinkler irrigation on windy days (little impact on drip and surface irrigation)
Thank You

Food Grows Where Water Flows
Your Farm Bureau Neighbors
California Farm Water Coalition