Basic Surface Irrigation Theory in Irrigated Pasture

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Questions

• Am I flood irrigating my pastures efficiently?
  – How do I recognize an inefficient flood system from an efficient system?
  – Is the current flood system design and operation efficient and productive?
  – If not, what types of improvements might I consider?
Concept: Uniform and Efficient Flood Irrigation
Concept: Distribution of Flood Irrigation Water

- Begin Irrigation
- Applied water
- Infiltrated water
- Ground surface
Concept: Water Distribution Midway in the Irrigation Set

- Applied water
- Ground surface
- Infiltrated water
Concept: Water Distribution at Irrigation Cutoff

- Stored water in border
- Infiltrated water
Concept: Water Distribution soon after Irrigation Cutoff

- Partial Water Recession
- Stored water in border, continues to infiltrate or is drained as tailwater
- Infiltrated water
Concept: Water Distribution Hours After Irrigation Cutoff

Complete Water Recession

Resulting distribution when all applied water infiltrates
Example of semi-efficient flood irrigation (50-60 %)

Water retained in 24 “ Root Zone

Slight Deficit
Example of low flood irrigation efficiency

(20 – 30 %)

Water retained in 24 “Root Zone

Water percolation past root zone
**Consequences of low irrigation efficiency:**

- Delayed water district delivery rotation among its users
- Negative effects on forage yields and forage composition due to extremes in growing conditions
  - Prolonged standing water after irrigation
  - Excess crop stress prior to next irrigation
- Higher electric bills, if using groundwater

**Benefit of low irrigation efficiency:**

- Groundwater recharge but only if irrigating with surface water
- Need to be alert about leaching nitrates, etc...
Recognizing Uniform and Non-Uniform Flood Irrigation

Irrigation systems that apply water uniformly have a chance of being efficient

Advance Ratio > 2 indicates reasonable uniformity

Total time the water ran on an irrigation set

Time it takes for water to first reach the end of the field

Advance Ratio = \( \frac{398 \text{ minutes}}{158 \text{ minutes}} = 2.5 \)
How to determine how much water has been applied.

\[
\frac{(Q \div 449) \times T}{A} = D
\]

Q = gpm (gallons per minute) flow rate
T = hours irrigation set time
A = acres in irrigation set
D = depth (inches) of water applied
(How close to 4 inches is it?)

If flow is measured in cfs, no need to divide by 449 in equation.
What types of flood irrigation improvements might be considered?

- Reduced check length
- Tailwater reuse
- Increased flow per foot of check
  - More flow, narrower check
- Increased field slope
- Border check maintenance
Reduce check length

- Often the most effective option
- Also often the least popular option

<table>
<thead>
<tr>
<th>Field</th>
<th>1250’ Field</th>
<th>600’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation Amount</td>
<td>9.1”</td>
<td>5.4”</td>
</tr>
</tbody>
</table>
Why does reducing check length improve irrigation efficiency?
Infiltration rate of soil

![Graph showing the infiltration rate of soil over time. The initial rate is 5.0 inches/hour, and the basic rate is 0.10 inches/hour.](image)
Tailwater Return System

- Accept tailwater over deep percolation
- Be prepared to manage tailwater
Increase the flow per foot of border check

Case study: More flow per foot of check width.
- Narrow checks
- Increase flow

<table>
<thead>
<tr>
<th>Irrigation Applied</th>
<th>Wide check (200’)</th>
<th>Narrow check (100’)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5.1”</td>
<td>4.3”</td>
</tr>
</tbody>
</table>
Increase the field slope & maintain checks

<table>
<thead>
<tr>
<th></th>
<th>0.001 slope</th>
<th>0.002 slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Applied</td>
<td>5.1”</td>
<td>4.8”</td>
</tr>
</tbody>
</table>
Which irrigation system improvements make the most sense?

• It depends upon your situation
  – How efficient or inefficient is the existing system
  – Economics
    • Costs of irrigation improvement
    • Opportunity for improved pasture performance and grazing capacity
The role of soil moisture monitoring and evapotranspiration (ET) information?

- Insight about when to irrigate
- Information about how much water to apply
Soil Moisture Resistance Blocks (Watermark)

**AS A GENERAL GUIDE, THESE READINGS TELL YOU:**

<table>
<thead>
<tr>
<th>Centibars</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10</td>
<td>Saturated Soil</td>
</tr>
<tr>
<td>10-20</td>
<td>Soil is adequately wet (except coarse sands which are beginning to lose water)</td>
</tr>
<tr>
<td>30-60</td>
<td>Usual range for irrigation (except heavy clay soils)</td>
</tr>
<tr>
<td>60-100</td>
<td>Usual range for irrigation for heavy clay soils</td>
</tr>
<tr>
<td>100-200</td>
<td>Soil is becoming dangerously dry for maximum production. Proceed with caution!</td>
</tr>
</tbody>
</table>

**Cost:**
- About $350 for meter
- About $40 per sensor

**Numerous Retailers:**
- [http://www.forestry-suppliers.com/](http://www.forestry-suppliers.com/)
Field Observation of Soil Moisture – NRCS Handout

Sandier  More Clay

Wetter

Drier
Real-time evapotranspiration (ET) information

<table>
<thead>
<tr>
<th>Past Week of Water Use</th>
<th>Accum'd Seasonal Water Use</th>
<th>NOAA Forecasted Week of Water Use</th>
<th>Crop (Leafout Date)</th>
<th>Past Week of Water Use</th>
<th>Accum'd Seasonal Water Use</th>
<th>NOAA Forecasted Week of Water Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.49</td>
<td>7.88</td>
<td>1.14</td>
<td>Pasture</td>
<td>0.48</td>
<td>6.84</td>
<td>1.12</td>
</tr>
<tr>
<td>0.49</td>
<td>7.90</td>
<td>1.11</td>
<td>Alfalfa</td>
<td>0.48</td>
<td>6.87</td>
<td>1.08</td>
</tr>
<tr>
<td>0.39</td>
<td>6.03</td>
<td>0.86</td>
<td>Olives</td>
<td>0.37</td>
<td>5.21</td>
<td>0.85</td>
</tr>
<tr>
<td>0.33</td>
<td>5.18</td>
<td>0.75</td>
<td>Citrus</td>
<td>0.32</td>
<td>4.51</td>
<td>0.72</td>
</tr>
<tr>
<td>0.36</td>
<td>2.96</td>
<td>0.87</td>
<td>Almonds (2/12) *</td>
<td>0.35</td>
<td>2.76</td>
<td>0.86</td>
</tr>
<tr>
<td>0.36</td>
<td>1.41</td>
<td>0.91</td>
<td>Prunes (3/15) *</td>
<td>0.35</td>
<td>1.34</td>
<td>0.90</td>
</tr>
<tr>
<td>0.13</td>
<td>0.13</td>
<td>0.00</td>
<td>Walnuts (4/1) *</td>
<td>0.15</td>
<td>0.15</td>
<td>0.59</td>
</tr>
<tr>
<td>0.45</td>
<td>5.48</td>
<td>1.20</td>
<td>Urban Turf Grass</td>
<td>0.45</td>
<td>4.79</td>
<td>1.18</td>
</tr>
</tbody>
</table>

Accumulations started on February 12, 2014 or on the approximate leafout date for a specific orchard crop as indicated in parentheses. Offsets for beginning this report are based on the season’s last significant rainfall event where the soil moisture profile is estimated to be near its highest level for the new season.

* Estimates are for orchard floor conditions where vegetation is managed by some combination of strip applications of herbicides, frequent mowing or tillage, and by mid and late season shading and water stress. Weekly estimates of soil moisture loss can be as much as 25 percent higher in orchards where cover crops are planted and managed more intensively for maximum yield. *

1.11 Past Seven days Precipitation (Inches) 1.05
5.29 Accum’d Precip (Inches) 5.13

<table>
<thead>
<tr>
<th>PAST WEEKLY APPLIED WATER IN INCHES, ADJUSTED FOR EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
</tr>
<tr>
<td>0.8</td>
</tr>
<tr>
<td>0.7</td>
</tr>
<tr>
<td>0.7</td>
</tr>
<tr>
<td>0.7</td>
</tr>
<tr>
<td>0.3</td>
</tr>
</tbody>
</table>

The amount of water required by a specific irrigation system to satisfy evapotranspiration. Typical ranges in irrigation system efficiency are: Drip Irrigation, 80%-85%; Micro-sprinkler, 80%-85%; Sprinkler, 70%-85%; and Border-furrow, 50%-75%.

For further information concerning all counties receiving this report, contact the Tehama Co. Farm Advisor’s office at (530) 527-3161.
Example Watermark Soil Moisture Levels in Pasture, July – Tehama County

![Soil Water Potential Graph]

- Watermark Dataloggers

University of California
Agriculture and Natural Resources
Summary

• Greatest opportunity to achieve better pasture production in irrigated pastures may start by improving irrigation system efficiency (target about 4 inches per irrigation).

• Once irrigation system applies water efficiently, then ask if it is possible to improve forage production and quality with better timing of irrigations.
Thank You!

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