Tools for Irrigation Stewardship

Lyndon Kelley, MSU Extension

• Irrigation System Uniformity

• Preventing Irrigation Runoff (comparing irrigation application rate to soil infiltration rate)

• Irrigation Scheduling

• Record keeping

• Avoiding water use conflicts
Irrigation Scheduling

Right to Farm GAAMPs

• Irrigation scheduling for each unit or field

• Irrigation scheduling is the process of determining when it is necessary to irrigate and how much water to apply

• Irrigation water is applied to replace the water used by the plant.
Irrigation Scheduling

- Method to determine the appropriate amount of water to be applied to a crop at the correct time to achieve healthy plants and conserve water
- Can measure soil moisture
- Or estimate evapotranspiration (ET) using weather data and pan evaporation
- Potential ET measured by weighing lysimeter
Primary Factors

- Know available soil water for each unit
- Known depth of rooting for each crop
- Know allowable soil moisture depletion at each stage of plant growth
- Use evapotranspiration data to estimate crop water use
- Measure rainfall in each field
- Use container capacity for nursery crops
Determining irrigation requirements

• The plant water requirement includes the water lost by evaporation into the atmosphere from the soil and soil surface and by transpiration, which is the amount of water used by the plant.

• The combination of these is evapotranspiration (ET).
Methods to Estimate Soil Moisture

- Feel an Appearance
- Electrical resistance – electrodes on blocks in soil
- Tensiometers – measures soil moisture tension
<table>
<thead>
<tr>
<th>Moisture deficiency</th>
<th>Coarse (loamy sand)</th>
<th>Sandy (sandy loam)</th>
<th>Medium (loam)</th>
<th>Fine (clay loam)</th>
<th>Moisture deficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>in/ft.</td>
<td>(field capacity)</td>
<td>Appears very dark, leaves wet outline on hand, makes a short ribbon.</td>
<td>Appears very dark, leaves wet outline on hand, will ribbon out about one inch.</td>
<td>Appears very dark, leaves slight moisture on hands when squeezed, will ribbon out about two inches.</td>
<td>in/ft.</td>
</tr>
<tr>
<td>0</td>
<td>Leaves wet outline on hand when squeezed.</td>
<td>Dark color, forms a plastic ball, slicks when rubbed.</td>
<td>Dark color, will stick and ribbons easily.</td>
<td>Quite dark, will make thick ribbon, may slick when rubbed.</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Appears moist, makes a weak ball.</td>
<td>Quite dark color, makes a hard ball.</td>
<td>Slightly dark, forms a hard ball.</td>
<td>Fairly dark, will make a good ball.</td>
<td>2</td>
</tr>
<tr>
<td>.4</td>
<td>Appears slightly moist, sticks together slightly.</td>
<td>Fairly dark color, makes a good ball.</td>
<td>Slightly dark, forms a weak ball.</td>
<td>Slightly dark, forms a weak ball.</td>
<td>.4</td>
</tr>
<tr>
<td>.6</td>
<td>Appears to be dry, will not form a ball under pressure.</td>
<td>Slightly dark color, makes a weak ball.</td>
<td>Lightly colored by moisture, will not ball.</td>
<td>Lightly colored, small clods crumble fairly easily.</td>
<td>.6</td>
</tr>
<tr>
<td>.8</td>
<td>Dry, loose, single-grained flow through fingers. (wilting point)</td>
<td>Very slight color due to moisture, loose, flows through fingers. (wilting point)</td>
<td>Slightly dark color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition. (wilting point)</td>
<td>Slight color due to moisture, powdery, cracked, sometimes has loose crumbs on surface. (wilting point)</td>
<td>.8</td>
</tr>
<tr>
<td>1.0</td>
<td>(field capacity)</td>
<td>Lightly colored by moisture, will not ball.</td>
<td>Lightly colored, small clods crumble fairly easily.</td>
<td>Slight color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition. (wilting point)</td>
<td>1.0</td>
</tr>
<tr>
<td>1.2</td>
<td>Dry, loose, single-grained flow through fingers. (wilting point)</td>
<td>Slightly dark color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition. (wilting point)</td>
<td>Slight color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition. (wilting point)</td>
<td>Somedarkness due to unavailable moisture, hard, baked, cracked sometimes has loose crumbs on surface. (wilting point)</td>
<td>1.2</td>
</tr>
<tr>
<td>1.4</td>
<td>(field capacity)</td>
<td>Slight color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition. (wilting point)</td>
<td>Slight color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition. (wilting point)</td>
<td>Somedarkness due to unavailable moisture, hard, baked, cracked sometimes has loose crumbs on surface. (wilting point)</td>
<td>1.4</td>
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<tr>
<td>1.6</td>
<td>(field capacity)</td>
<td>Slight color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition. (wilting point)</td>
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<td>Somedarkness due to unavailable moisture, hard, baked, cracked sometimes has loose crumbs on surface. (wilting point)</td>
<td>1.8</td>
</tr>
<tr>
<td>2.0</td>
<td>(field capacity)</td>
<td>Slight color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition. (wilting point)</td>
<td>Slight color due to moisture, powdery, dry, sometimes slightly crusted but easily broken down in powdery condition. (wilting point)</td>
<td>Somedarkness due to unavailable moisture, hard, baked, cracked sometimes has loose crumbs on surface. (wilting point)</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Irrigation Scheduling
Checkbook Method
Think of your soil as a bank

Rainfall and irrigation water are deposits into the bank.

Plant water use is a removal from the bank.
Rain Gauges

- Basic unit – 2 inch opening
- Cost less than $10.00
- 1-800-647-5368
Think of your soil as a bank

Water holding capacity:
The soil (bank) can hold only a given volume of water before it allow it to pass lower down.

Soil type:
Heavier soil can hold more water / foot of depth than light soils

Intake rate:
Water applied faster than the soil intake rate is lost.

Rooting depth:
The plant can only get water to the depth of it’s roots.

Deletion:
Plants may can pull out only 30 – 60% of the water

Water lost from the bottom of the profile can wash out (leach) water soluble nutrients and pesticides.
Estimates of ET

- Net radiation
- Max and min temperatures
- Relative humidity
- Wind

Purdue Agronomy web site – MichIa Irrigation Scheduler:
www.agry.purdue.edu/irrigation/IrrDown.htm
Estimates of ET

U of Wisconsin web site - Next/rad radar:
http://www.soils.wisc.edu/wimnext/

• Net radiation
• Max and min temperatures
• Relative humidly
• Wind

Provides the maximum water removal for the day
Estimated ET (Inches/day) for 16 November 2003
New Assistance Coming

Dr. Jeff Andresen and Steve Miller (MSU) are working to make available scheduling Tools

• Spreadsheet that uses the Wisconsin data for the base Et. and calculate accumulative removal by crop use.

• Update of the original NRCS “Scheduler”
<table>
<thead>
<tr>
<th>JOB NAME</th>
<th>VALUE</th>
<th>CROP CODE</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNIT IDENTIFICATION NUMBER</td>
<td>FIN</td>
<td>1</td>
<td>POTATOES</td>
</tr>
<tr>
<td>TODAY'S DATE (i.e. June 15 = 6.15)</td>
<td>TD</td>
<td>9.1</td>
<td>SOYBEANS</td>
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<tr>
<td>TOTAL ROOT DEPTH (feet)</td>
<td>PRD</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>TOTAL ROOT DEPTH AVAILABLE WATER (inches)</td>
<td>PWHC</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>STARTING PROFILE MOISTURE CONTENT (%)</td>
<td>EPMC</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>PROJECTED YIELD (units/acre or %)</td>
<td>PY</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

**OUTPUT - SUMMARY**

- TODAY'S DATE IS: 254
- TODAY'S EVAPOTRANSPERSION RATE IS: 2E-16 inches
- TODAY'S PROFILE MOISTURE CONTENT IS: 2E-12 percent of capacity
- TODAY YOU CAN SAFELY ADD: 0.45 inches
- YOU CAN ADD 1 INCH OF WATER IN ANOTHER: 4E+15 day(s) if rain does not occur

**OUTPUT - DAILY**

<table>
<thead>
<tr>
<th>DATE</th>
<th>TEMP</th>
<th>DEV</th>
<th>ETC</th>
<th>RAIN</th>
<th>IRR</th>
<th>DEPL</th>
<th>PMC</th>
<th>PM GRAPH</th>
<th>YWI</th>
<th>YWOI</th>
<th>%PMC</th>
<th>WOI</th>
<th>DSP NO.</th>
<th>TRD</th>
<th>PMC</th>
<th>PGS</th>
<th>KC</th>
<th>P</th>
<th>PTEC</th>
<th>AETC</th>
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<td>134</td>
<td>55</td>
<td>0.136</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100</td>
<td>$$$$$###</td>
<td>100</td>
<td>100</td>
<td>$$$$</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>0.5</td>
<td>0</td>
<td>0.7464</td>
<td>0.334</td>
<td>0.1364809728</td>
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<td>135</td>
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<td>0.138</td>
<td>0.1</td>
<td>0.0377</td>
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<td>100</td>
<td>100</td>
<td>92.451</td>
<td>100</td>
<td>100</td>
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<td>1</td>
<td>1</td>
<td>0.5</td>
<td>0.462</td>
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<td>0.7493</td>
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<tr>
<td>136</td>
<td>56</td>
<td>0.139</td>
<td>0.1768</td>
<td>64.65</td>
<td>$###</td>
<td>100</td>
<td>100</td>
<td>64.649</td>
<td>3</td>
<td>0.5</td>
<td>3.33</td>
<td>1.33</td>
<td>0.7522</td>
<td>0.322</td>
<td>1.39011335</td>
<td>1 Career in = 0.1364809728</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>137</td>
<td>56.5</td>
<td>0.14</td>
<td>0.14</td>
<td>0.0013</td>
<td>99.74</td>
<td>100</td>
<td>100</td>
<td>99.745</td>
<td>100</td>
<td>100</td>
<td>0.64</td>
<td>2</td>
<td>0.755</td>
<td>0.332</td>
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<td>138</td>
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<td>99.74</td>
<td>100</td>
<td>100</td>
<td>99.745</td>
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<td>100</td>
<td>0.64</td>
<td>2</td>
<td>0.755</td>
<td>0.332</td>
<td>0.140282889</td>
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<td></td>
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<tr>
<td>139</td>
<td>57.4</td>
<td>0.143</td>
<td>0.1441</td>
<td>71.18</td>
<td>$###</td>
<td>100</td>
<td>100</td>
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<td>0.5</td>
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<tr>
<td>140</td>
<td>57.9</td>
<td>0.144</td>
<td>0.2882</td>
<td>42.35</td>
<td>$$$$</td>
<td>99.994</td>
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<td>42.356</td>
<td>4</td>
<td>0.5</td>
<td>0.212</td>
<td>0.331</td>
<td>0.7633</td>
<td>0.331</td>
<td>1.441161515</td>
<td>0.1441161</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **MSU**
- **HELP**
- **Variables**

**Notes:**
- $###$: Moisture content
- $$$$$: Water yield
- $$ $$: Temperature coefficient
- $$$$: Evapotranspiration coefficient
- $$ $$: Crop growth coefficient
- $###$: Yield
- $$ $$: Daylight coefficient
- $$ $$: Total precipitation coefficient
Irrigation System Uniformity

An 1” application should be 1” everywhere in the irrigated field

- 10% or less deviation from the average is ideal.
- Over applied area will likely be over applied each application
- Under applied areas will likely be under applied each application

A 30% deviation on a field in an 8” irrigation application year will have areas receiving as little as 5.6” and as great as 10.4”

Repair all visible system leaks and problems first.
Irrigation System Uniformity

Basic system evaluation

Collect enough uniform container to place every 10 feet the length of the system or across the application pattern.

Spread the container every ten feet from the center point to the outside edge of the application area.

Run the machine at standard setting over the container.

Measure and record the water volume caught by each container.

Note sample point varying greater than 10% of the average.
Preventing Irrigation Runoff

(comparing irrigation application rate to soil infiltration rate)

Sprinkler package or nozzle selection along with pressure dictates water application rate.

Factors that increase runoff:

• Small Wetted area or throw of sprinkler
• Low Pressure
• Larger applications volumes
• Soil compaction
• Heavy soils
• Slope
• Row hilling
Instructions for completing the *Evaluating Potential Irrigation Runoff* form:

1. Identify the areas of the irrigated field that has the lowest infiltration rates. (heavy soils, slopes, surface compaction).

2. Select a transit line in the wetted area just behind the machine that covers the identified lowest infiltration rates of the field identified above.
Instructions for completing the *Evaluating Potential Irrigation Runoff* form – continued

3. Pace or measure 50 feet between observations starting at the pivot point and progressing to the furthest reaches of the machine.

4. Record observations for each location; look at several (4-5 areas) representing the row contour and differences in row traffic of the location. Record any specific concerns that may affect the application (drips or leaks) or affect the soils ability to take in water (compaction, row contours)

Key for *Observation* column
- A - no observed puddling, ponding or sheen between rows
- B - puddling, ponding or sheen between rows identified, but no observed runoff or flow of water
- C - observed runoff or flow of water
Avoiding water use conflicts

Except for cost, well water is the preferred water source for irrigation.

A well owner may not diminish the use of well water of his neighbors.

If a neighbor’s well use is impaired you legally must rectify the situation if responsible.
Good irrigator response to neighbor’s well problems:

- pump from another location – (There is no restriction on transport or use from other locations from wells).
Consider Using Surface Water

**Riparian Doctrine – Surface Water**
- Reasonable use rule - allowing diminished flow for extraordinary use such as recreational, municipal, industrial or agriculture use, as long as other riparian owner Natural Uses where not impaired

- Extraordinary uses have been considered equal.
Proactive Options for Agricultural

Legal aspects of groundwater use have not changed – A well owner may not diminish the use of well water of his neighbors.

A prudent response to a neighbors substantiated complaint of being negatively effect by an irrigation well is to offer to deepen their well and consider it an irrigation cost.

Identify the neighbor you may affect and layout a plan of action to prevent or provide remediation of the problem if it occurs.
Proactive Options for Agricultural

Identify the neighbor you may affect and layout a plan of action for remediation of the problem if it occurs.

- You can get scanned well logs off of the internet (1999 and older) by Township and section at:
  - www.deq.state.mi.us/well-logs

- Well logs that are 2000 and newer are available on WELLOGIC at:
  - http://dwrp.deq.state.mi.us/wellogic
  - You need a username and password for wellogic, (issued to registered well drillers and agencies)
GW DISPUTE RESOLUTION PROCESS: PA. 177

WELL DRILLERS ASSESSMENT

COMPLAINT FILING

ON-SITE INVESTIGATION

COMPLAINT VERIFICATION

RESOLUTION

CIRCUIT COURT APPEAL

DEQ ISSUES ORDER

PROPOSE REMEDY
Does your well affect neighbors?
Identify neighbor your Well may effect

Devise a plan for them to contact you if Well problems arise

If a well problem arises

Contact well driller for assessment of well

Circuit court avoided

Well driller proposes remedy

Farmer is a neighborhood hero

Formal complaint filing avoided

Large well user pays

RESOLUTION
Ground Water Dispute Resolution Prior to PA. 177

WELL DRILLERS ASSESSMENT

COMPLAINT FROM NEIGHBOR

COMUNICATION BETWEEN WELL OWNERS

ON-SITE INVESTIGATION

RESOLUTION

CIRCUIT COURT

PROPOSE REMEDY

COMPLAINT VERIFICATION