Irrigation Water Management to Protect Agricultural Resources

Conservation Sheet 449

Natural Resources Conservation Service

Michigan

What is Irrigation Water Management?

Irrigation water management is determining and controlling the rate, amount, and timing of irrigation water in a planned and efficient manner.

How does Irrigation Water Management Work?

Properly applied irrigation water is utilized by the crop and does not create runoff, water induced erosion, ponding, or leaching of pesticides and nutrients.

Soils vary in the rate of water they absorb and the amount of water that can be stored in the root zone. Fine-textured (clay) soils have a slower infiltration rate than coarse-textured (sand) soils. For example, a five-foot deep Plainfield sand absorbs water faster than a Boyer sandy loam.

Timing of irrigation and soil moisture availability also varies by crop. Plants require soil moisture during flowering and rapid periods of growth. Crops also vary in their need for water. For example, alfalfa needs more water than corn.

Where Does Irrigation Water Management Apply?

Irrigation water management applies to all areas that are suitable for irrigation and have a water supply of sufficient quality and quantity. Corn, potatoes, tomatoes,

soybeans, dry beans, hay, sod, fruit and vegetable crops may be irrigated throughout the growing season. In Michigan, irrigation is used to supplement water in addition to rainfall. Irrigation can also be used for frost protection and application of chemicals (pesticides and fertilizer) for the crop. Animal waste effluent may also be applied by irrigation equipment according to a nutrient management plan

Conservation Management Systems

Irrigation water management is generally one of several conservation practices that make up a conservation plan. Irrigation water management components of the conservation plan include the following information:

- Field maps showing soils, pump and well location, and sensitive areas;
- Crop rotation or sequence;
- Irrigation water application rate, timing and method of application including an irrigation schedule;
- Guidelines for operation and maintenance.

Irrigation water management is most effective when used with other conservation practices such as irrigation system design, residue management, conservation crop rotation, cover crops, filter strips, nutrient management and pest management.

Considerations

A system evaluation to determine application rate of each nozzle may be needed to prevent rill erosion or excess ponding and runoff. **Over application of water and inefficiency can be observed in the field as any of the following:**

- *Excess ponding of water.*
- *Runoff during irrigation, which carries sediment.*
- *Rills caused by irrigation water rather than rain, rills appear in field even when precipitation events have not occurred.*
- *Yellowing of plants due to lack of oxygen or Nitrogen deficiency in soil from excessive wetness.*
- *Plant stand loss from ponding or runoff.*
- *Sediment at the bottom of slopes (part of deposition.)*
- *Offsite sediment damage to wetlands, streams and neighboring fields.*

Irrigation Water Management Plans

Irrigation Water Management plans (IWM) specify the system components and operation needed to achieve the water user's objectives. An IWM plan will include a resource inventory map showing field size, crop, pump and well location, prevailing wind direction, and other relevant features. Completion of an irrigation management plan document, an irrigation schedule for the current crop year, and water user records will meet requirements for NRCS- MI conservation practice Irrigation Water Management 449. A System Evaluation may be needed to complete the IWM plan.

In order to manage irrigation water properly it is critical that the water user can measure and record the amount of water delivered to the field. Watching weather forecasts and measuring rainfall received is critical to adjusting irrigation application amounts for changes in field conditions.

The crop information portion of the IWM plan shows the crop to be irrigated along with the crop rotation. Tillage practices are noted here because of its effect on surface roughness which can reduce the potential irrigation runoff. Monitoring the weather is critical to good irrigation management. Select the appropriate method(s) used by the irrigator.

Crop characteristics including rooting depth, consumptive use and evapotranspiration, along with emergence date are recorded as part of an irrigation schedule.

Soils information provides the basis for irrigation management. Water application characteristics of the sprinkler package should be matched to the infiltration capacity of the soil. Identify for the irrigated acres the indicator soil by which irrigation management will be set. The indicator soil may be the predominant soil type by acreage in the field. However, areas with low infiltration rates, high water tables, steep slopes, or of different water holding capacity may be significant factors that will determine irrigation efficiency. In such a case, the indicator soil is the one associated with the limiting factor.

The intake rate of the soil under irrigation is affected by many factors such as soil textures, structure and compaction, and organic matter. Soil intake family numbers relate the time required to infiltrate a given quantity of water in a specific soil type. Examples of time required for infiltration by soil intake family appear as the first table below. Family designations reflect the final intake rate as soils change in moisture content. Intake family and water holding capacity are elements of an irrigation schedule.

Record the indicator soil and available water holding capacity for each soil mapping unit as found in the Soil Survey or Web Soil Survey table of Physical and Chemical Properties. Use the following tables to find the maximum average application rate in inches per hour based on soil texture and slope. Correct the intake rate for the percent crop residue by multiplying the application rate by the crop residue adjustment factor.

The maximum application rate should not exceed 1 inch per hour.

The irrigation type and delivery system is recorded on the IWM plan sheet. Also include the specifications of the pump and well capacity. Pump capacity must be included as this one of the limiting factors of a delivery system. In most cases, the system will have a backflow prevention device however, document that the device is in place, especially when chemigation, including animal wastewater, is used.

Water users should make sure that each irrigation application is uniformly applied. The catch can analysis system can be used to measure the system uniformity and can also be used to measure the actual application rate. Record the method used to measure these along with the results and date of last uniformity check. Indicate the method used to measure irrigation water actually applied.

Record the type of sprinkler or spray package to be used. Manufacturer/ brand name and part number or identification will be needed to run CPNozzle to evaluate the potential irrigation induced runoff.

Instantaneous application rate is an important element of sprinkler performance. It is the intensity of water application at a point in the field at a given time. It is not the average application, but what you would feel if you were standing under the sprinkler system. At any one moment all of the water in the stream lands in a small segment of the total wetted area. Instantaneous application rates can exceed the infiltration capacity of the soil.

When application rates exceed infiltration rates one potential result is irrigation water runoff. Runoff will occur if surface storage, as influenced by soil moisture content, crop

residue and surface roughness, cannot temporarily hold the water until it infiltrates.

A system evaluation, CPED and CPNozzle evaluation assist the water user in matching sprinkler packages to field conditions. Water users should monitor irrigated fields for signs of water accumulating and/or runoff.

Irrigation scheduling method is recorded on the IWM plan sheet. The water user will document planned application rates, actual application rates, rainfall and irrigation amounts, field determination of available water and irrigation timing in an irrigation schedule.

Maximum application rates (in/hr) by Soil Texture and Slope

Soil Texture and Profile	Percent Slopes			
	0-5	5-8	8-12	12-16
Coarse sand to 6 ft	2.0	1.5	1.0	0.50
Coarse sandy over more compact soil	1.5	1.0	0.75	0.40
Light sandy loams to 6 ft	1.0	0.80	0.60	0.40
Light sandy loams over more compact soil	0.75	0.50	0.40	0.30
Silt loams to 6 ft	0.50	0.40	0.30	0.20
Silt loam over more compact soils	0.30	0.25	0.15	0.10
Heavy textured clays or clay loams	0.15	0.10	0.08	0.06

Based on average soil conditions with good ground cover for all crops except grasses and alfalfa. For bare ground and poor soil conditions, reduce the values by 25%. For grasses and alfalfa the values may be increased by 25%. When deep irrigation with large drop size is planned (guns), reduce the maximum application rate by 25%. *National Engineering Handbook Part 623 Chapter 11.*

Irrigation Rate Adjustment for Crop Residues

Percent Cover at Planting	Corn Residue	Soybean, Wheat, Rye or Alfalfa Residue
	Residue Adjustment Factor	
80-90		1.4
60-80		1.3
60-75	1.4	
50-60	1.3	
40-60		1.2
30-40		1.1
20-30	1.1	

Adjusted Application Rate= Maximum application rate * Crop residue adjustment factor.

Hours to Infiltrate by Soils Intake Family

Soils Intake family	Acre-inches of Irrigation Water applied				
	1	2	3	4	5
	Approximate Infiltration time in hours				
0.1	2.8	10.5	22.3	34.0	49.0
0.3	1.0	3.5	6.8	10.0	14.0
0.5	0.63	2.0	3.8	5.5	7.6
0.75	0.48	1.5	2.8	4.1	5.6
1.0	0.33	1.0	1.8	2.6	3.6
1.25	0.28	0.8	1.5	2.2	3.0
1.5	0.23	0.7	1.2	1.8	2.4
1.75	0.2	0.6	1.1	1.6	2.2
2.0	0.18	0.52	0.9	1.33	1.78

Conversion Factors

1 gallon (gal)	= 231 cubic inches (in3) = 0.13368 cubic feet (ft3)
1 gallon of water weighs	= 8.345 pounds (lb)
1 million gallons (mg)	= 3.0689 acre-feet (ac-ft) = 133,700 cubic feet (ft3)
cubic foot water	= 1728 cubic inches (in3) = 7.48 gallons
1 cubic foot of water weighs	= 62.4 pounds (lb)
1 acre-foot (ac-ft)	= amount of water to cover 1 acre 1 foot deep = 43,560 cubic foot (ft3) = 325,850 gallons = 12 acre-inches (ac-in)
1 acre-inch	= 27154 gallons typically rounded to 27000 gallons
1 acre-inch per day (ac-in/da)	= 18.7 gallons per minute (gpm)
1 million gallons (mg)	= 3.0689 acre-feet (ac-ft)
1 million gallons per day (mgd)	= 1.547 cfs = 695 gallon per minute (gpm)
1 cubic foot per second (cfs)	= 448.83 (typically rounded to 450) gallons per minute (gpm) = 7.48 gallons per second = 0.646 million gallons per day (mgd) = 0.992 (typically rounded to 1) acre-inch per hour (ac-in/hr) = 1.983 (typically rounded to 2) acre-feet per day (ac-ft/d)

References

Michigan NRCS irrigation website:
www.mi.nrcs.usda.gov/technical/engineering/Irrigation.html

NRCS Irrigation Website
http://www.wsi.nrcs.usda.gov/products/W2Q/water_mgt/Water_management.html

NRCS Irrigation Tool Box
http://www.wsi.nrcs.usda.gov/products/W2Q/water_mgt/Irrigation/irrig-training-toolbox.html

University of Nebraska- Lincoln. 1992. G92-1124 Converting Center Pivot Sprinkler Packages: System Considerations.
http://digitalcommons.unl.edu/extensionhist/1204

University of Nebraska-Lincoln. 1996. G96-1305 Water Runoff from Sprinkler Irrigation: A case Study.
http://digitalcommons.unl.edu/extensionhist/1208

Irrigation Water Management Plan

Conservation Plan Map with Fields, Acres, Pump/Well Location complements this plan.

Name: _____ County:_____ Date:_____
Tract/Field(s): _____ Acres under Irrigation: _____

Resource Concerns: _____
Objectives: _____

WATER SOURCE (circle one):
Pond Lake River Ditch Well Other_____
List quantity or quality issues/limitations (ex: pond takes 3 days to recharge)
_____

SYSTEM COMPONENTS
Type of System (circle one): Pivot Big Gun Linear Move Micro Solid Set Other_____
System Length (ft.) excluding delivery component _____ Age of System (yrs.) _____
Age of Sprinklers (yrs.) _____
Capacity (GPM): Well _____ Pump _____ System Pressure (PSI) _____
Power Source (circle one): Electric Diesel Other_____
System Includes (circle all that apply):
Flow Meter Injection Equipment (chemigation) Filters Backflow Protection
Nozzle Package (circle one):
Impact Sprinklers Stationary Deflection Pads Rotating Pads Oscillating Pads

SOIL INFORMATION

	Soil Type & Texture	Slope %	Max. Application Rate (in./hr.)	Residue (type/%)	Residue Adjusted Max. Appl. Rate	AWC (to crop root zone/inches)
Predominant Soil						
Indicator Soil						

CROP INFORMATION

Year	Crop	Emergence Date	Rooting Depth (in.)	Prior Tillage	Target Yield

Crop growth stage and evapotranspiration rates vary over the growing season. This data can be found in the supporting data used in irrigation scheduling.

IRRIGATION SCHEDULING
Method(s) used to monitor weather (circle all that apply):
Local News Forecasts DTN Weather Station Rain Gauge
MI Automated Weather Network (MAWN website) Internet Weather Site _____
Method(s) used to determine when and how much to irrigate (circle all that apply):
Checkbook Method Michiana Irrigation Scheduler MSU Scheduler Excel Version
Soil Moisture Monitoring Other_____

Method(s) used to determine amount of water applied per application (circle all that apply):
Catch Cans Rain Gauge System Evaluation CPED/Manufacturers Software Other_____
Results of checks (inches):_____ Planned* _____ Actual _____
*Planned application rates may vary during the growing season due to critical growth periods.
Method(s) used to determine soil moisture (circle all that apply):
Soil Moisture by Feel Tensiometer Moisture Probe Resistance Sensor Other_____

SYSTEM EVALUATION

Irrigation induced sheet and rill erosion will be evaluated by:
CP Nozzle MSU Evaluating Potential Runoff Form Field Observation Other_____
Measured System Coefficient of Uniformity* (CU%):_____ **Date of Last CU check**:_____
*leave blank if a uniformity check has not previously been conducted
Uniformity (CU%) of application will be evaluated by (circle one):
On-site visual checks MSU Catch Can Analysis (Preferred) CPED/Manufacturers Software (Preferred) Other_____

OPERATION AND MAINTENANCE / RECORDS

- Irrigation Schedule developed for current crop year. Schedule and irrigation application records submitted to NRCS. MSU Bulletin E2342 may be used for application record keeping.
- Inspection/maintenance records for pump, irrigation system, delivery component, and static water level are to be kept.
- Water user will obtain all necessary permits and comply with all laws and regulations pertaining to IWM.

DOCUMENTATION REQUIRED FOR COMPLETION OF IRRIGATION WATER MANAGEMENT

Date of completion or documentation received	
	IWM Plan filled out
	Maps
	Scheduling Documentation
	Potential Irrigation Runoff Evaluation Documentation
	Uniformity Determination
	Irrigation System Inspection/Maintenance Records

SIGNATURES

Participant_____ Date _____

Planner _____ Date _____

Certification By NRCS Representative_____Date_____
Engineering Job Class _____