Purdue Extension
Knowledge to Go

MICHIGAN STATE UNIVERSITY EXTENSION

Getting More out of Irrigation

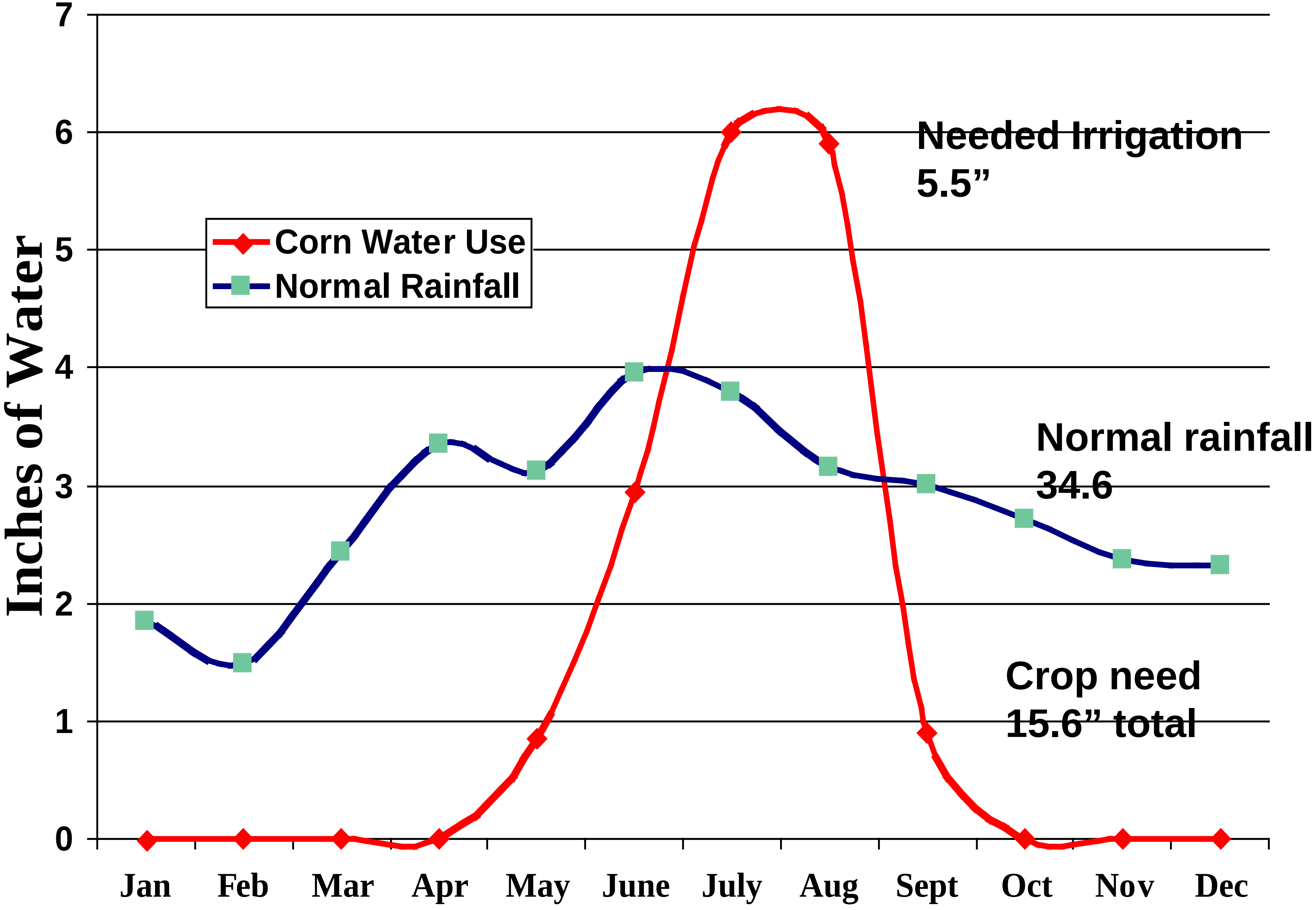
Lyndon Kelley

MSU Extension / Purdue University Irrigation Management Agent

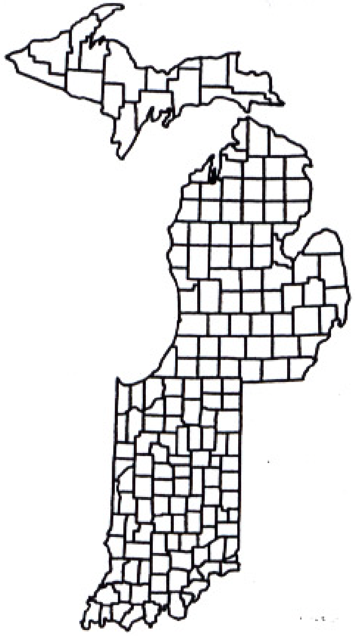
St. Joseph Co. MSU Extension, 612 E. Main St., Centreville, MI 49032

kelleyl@msu.edu, 269-467-5511

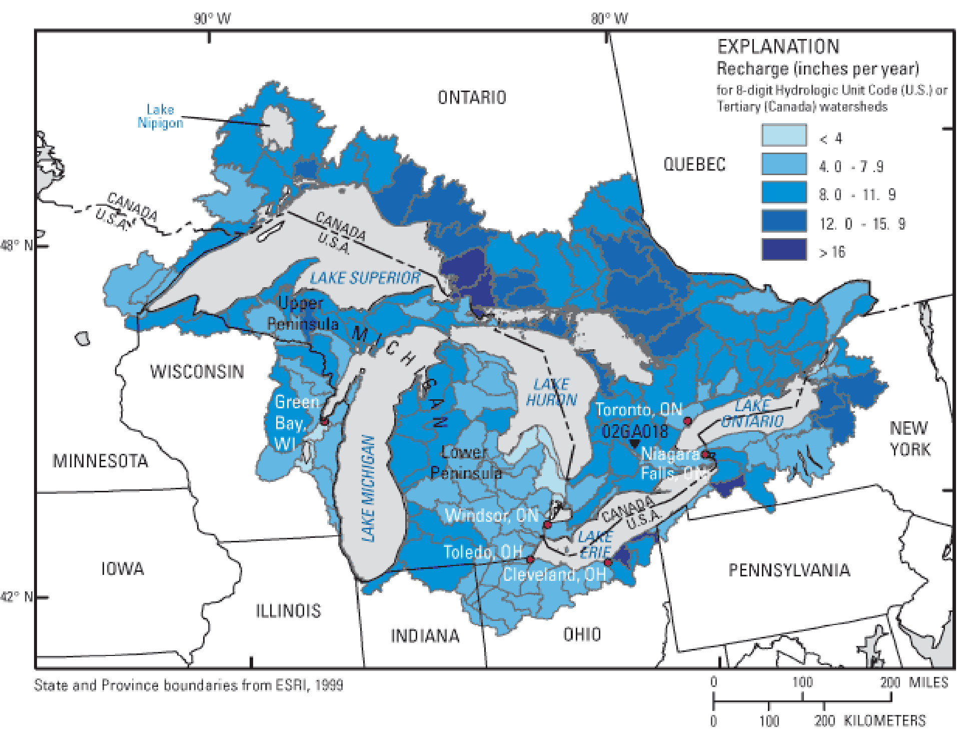
www.msue.msu.edu - find St. Joseph Co.
- then hit the Irrigation button


Inches of Water
7
6
5
4
3
2
1
0
Corn Water Use
Normal Rainfall
Needed Irrigation
5.5”
Normal rainfall
34.6
Crop need
15.6” total
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec

Indiana’s Irrigation is Concentrated in High Groundwater Recharge Areas



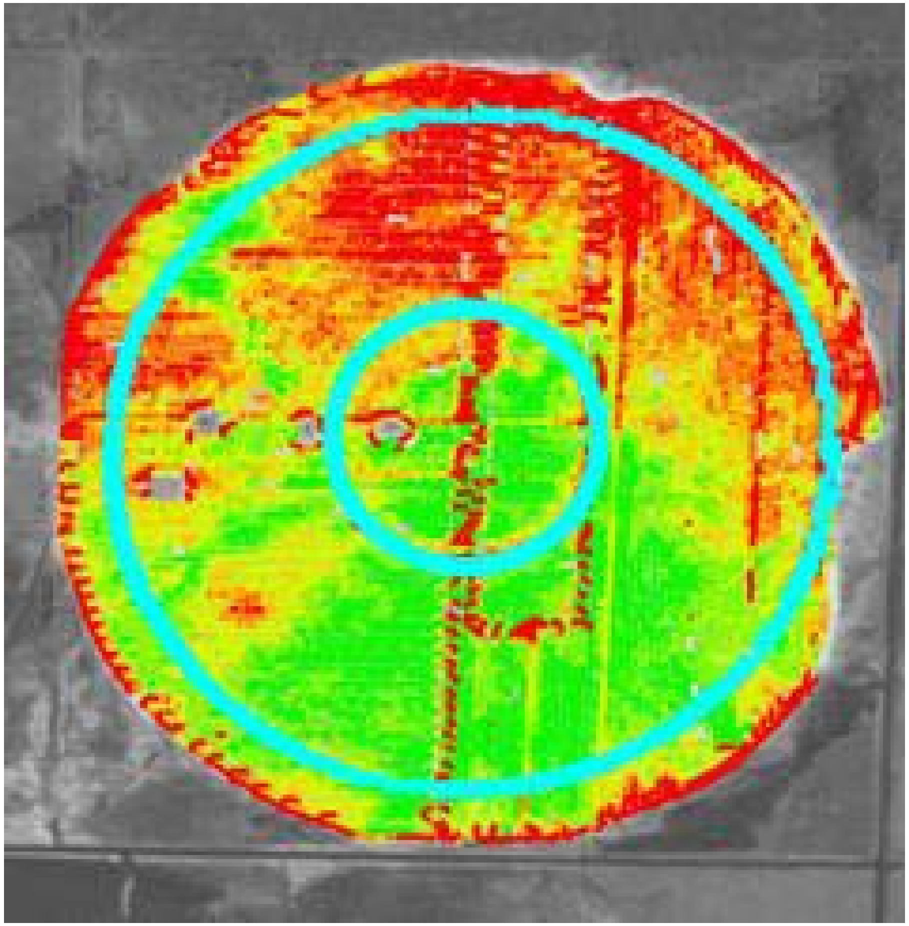
- 58% of Indiana’s irrigated land is located in nine North west and North central counties.
- Groundwater conflicts in these counties are rare since the control of the early 1990’s.
- Over 32” of annual rainfall with over 8” of recharge.

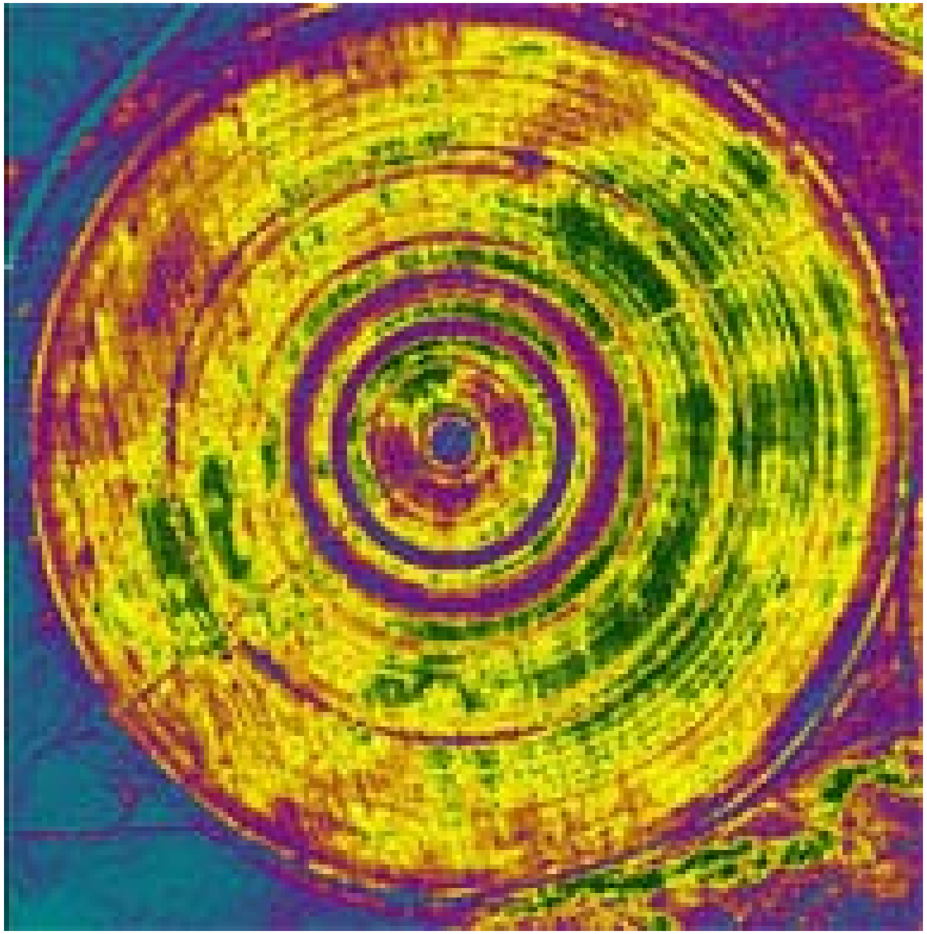


Getting More out of Irrigation

- Uniform application of water
- Preventing Irrigation Runoff
- Water Supply- Quantity
- Water Supply - Quality Factors
- Scheduling – water the crop when it needs it
- Fertigation-Chemigation

Have you seen yield map patterns that match the irrigation system configuration?





Irrigation System Uniformity

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

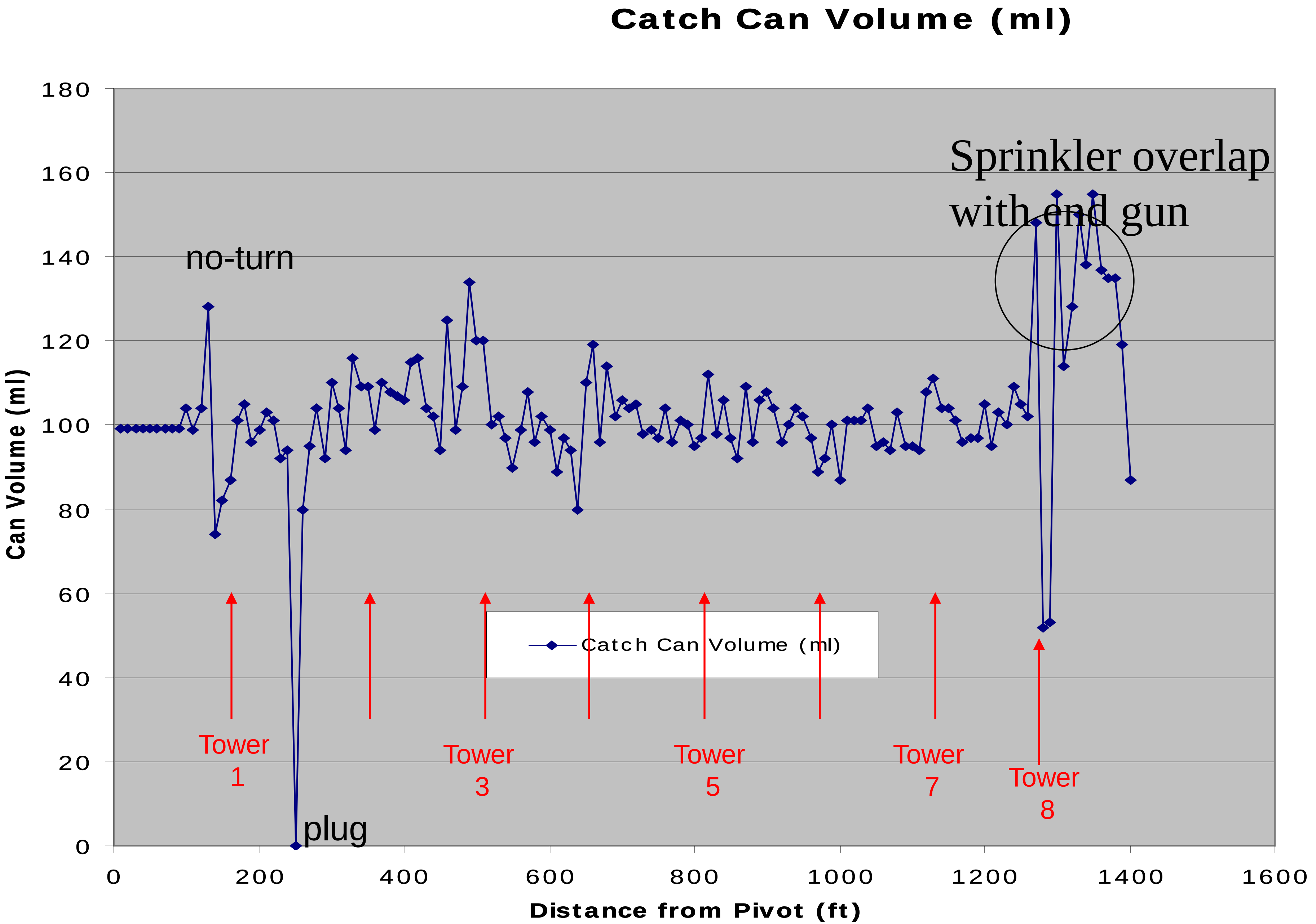
- 10% or less deviation from the average is ideal.
- Over applied area will likely be over applied each application
- Under applied areas will likely be under applied each application

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 -Options

- Irrigator trainings (MSU Ext., MGSP, NRCS)
- Private consultants
- SCD



http://web1.msue.msu.edu/stjoseph/anr/anr.htm

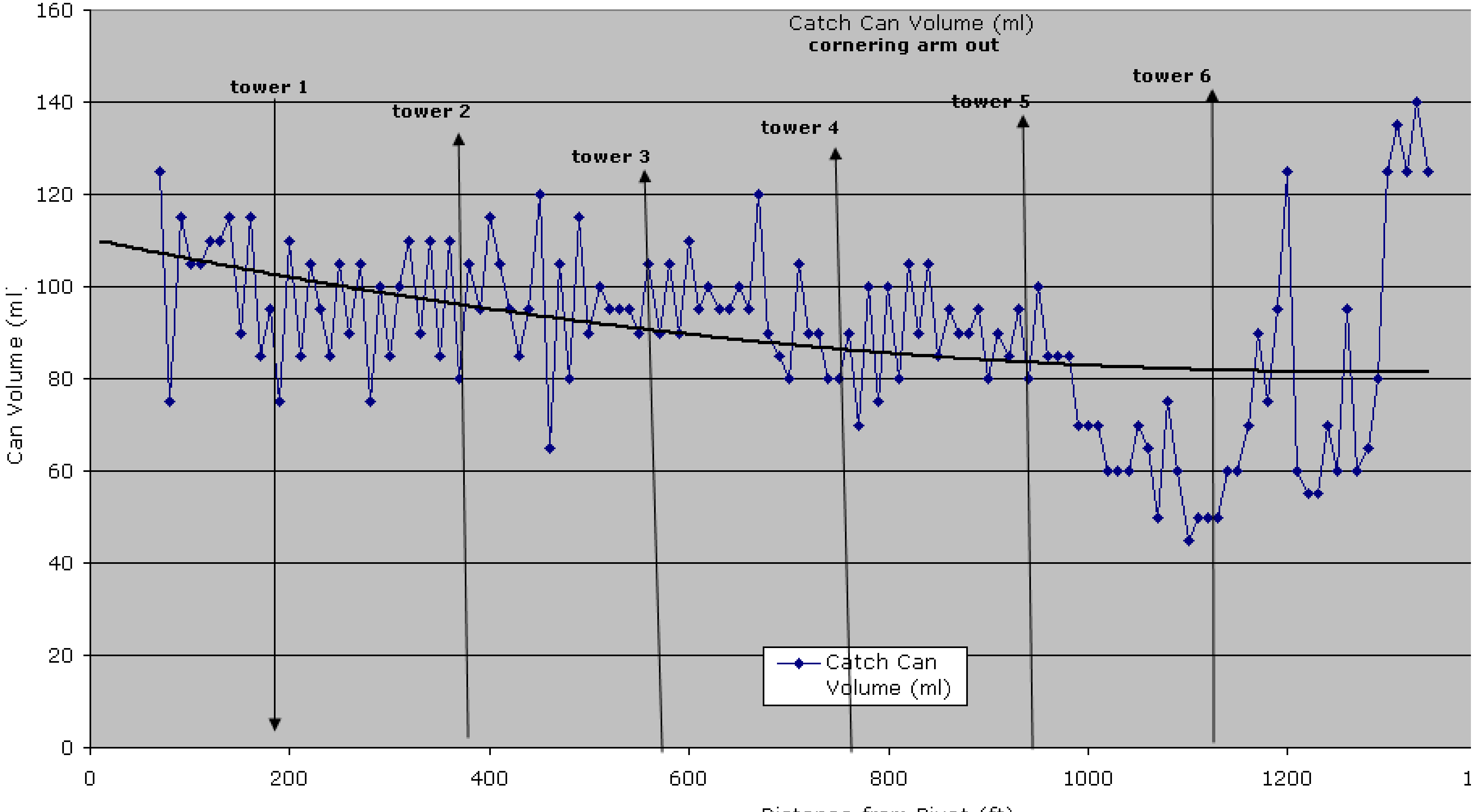
Greatest improvement needed

- End gun stop adjustment
- Water supply over or under design
- End gun orifice, too little or too much
- Wrong sprinkler or tip
- Leaks, plugs and **no turn sprinklers**

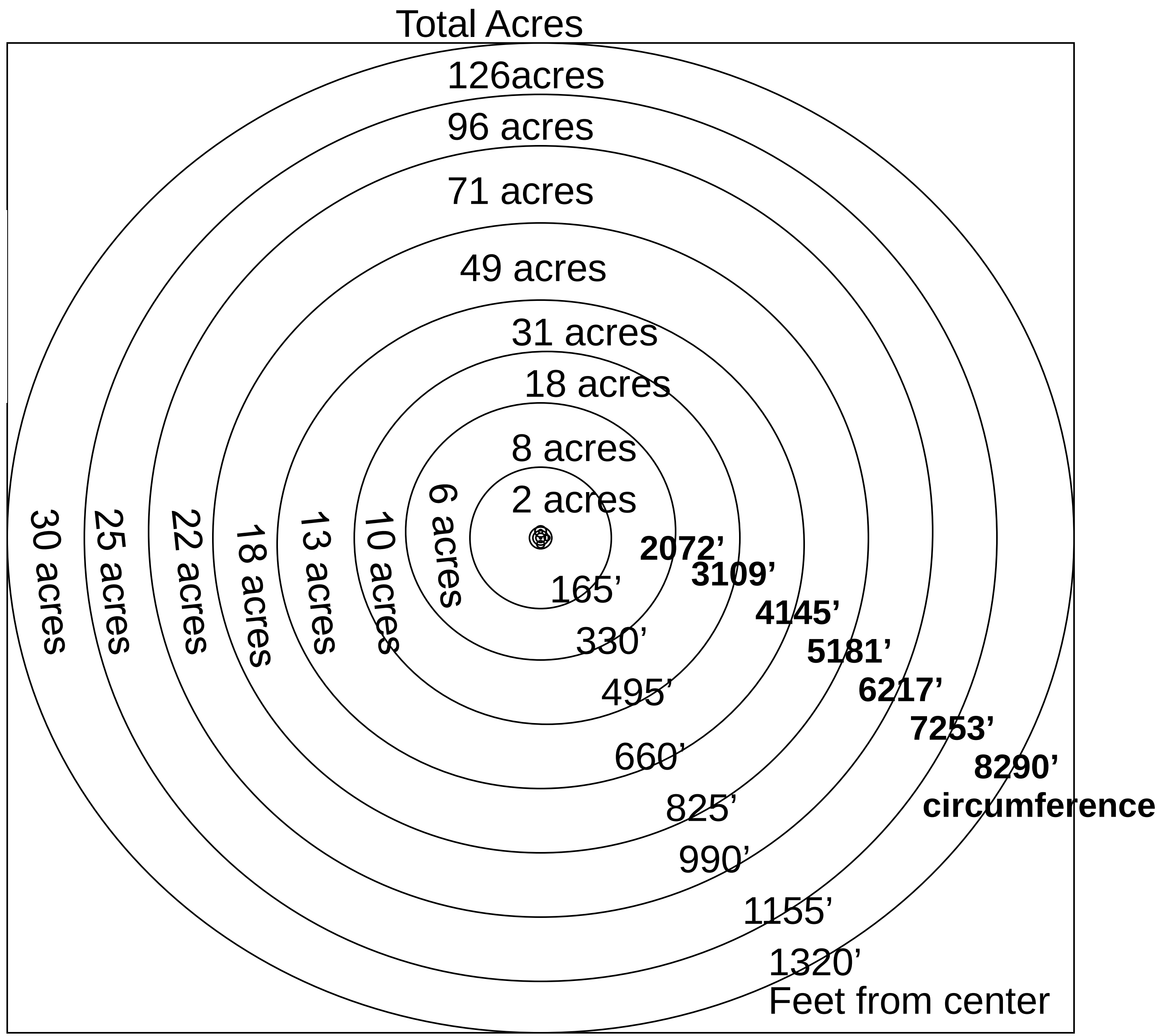
Water supply over or under design

supply over design yield tail up, supply under design yield tail down

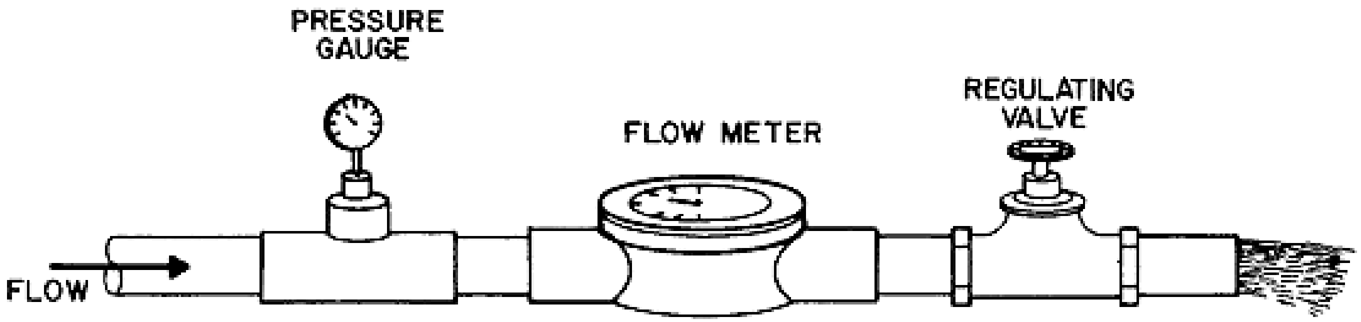
Example of Water supply under volume for sprinkler design



Over and under application issue affect the majority of the application area



Measure flow at desired pressure prior to ordering sprinkler package



Poor performance:

Ask dealer to measure flow at peak water use season and compare to design parameters.

Most system apply within 85% of the expected application

MSU Extension Irrigation System Evaluation Tool, 1-23-07

Farm Name [redacted] Farm

System Uniformity Coefficient = 79

System Identification: Cornering Arm System on [redacted] Farm-Behind House

Cornering Arm Extended

Good System uniformity coefficient are 85 or greater

Deviation from desired application = -0.04

Application is 4 % under expectation

System Settings

Application rate (in)	0.5	Wind speed (mph)	4 mph
Percent timer Setting (%)	19	Wind Condition (variable or steady)	steady
Operating Pressue (psi)			

Rate of application calculator

Time from start to end of application at highest rate section of system (min.)	22	Inches/Hour	1.25
Rate of application for the highest rate section of system (minute /one inch)	48.00		

		Average Application (cm)	1.164
Length of evaluation area (ft)	1340	Average Application (in)	0.46
Catch Can Spacing Distance (ft)	10		
		Average catch, collected only (ml)	88.95
number of cans data collected from	129	*70% average catch can (ml)*	*59.94*
number of cans set	134	Evaluation area, full circle (acres)	122.82
		catch can openning area (sq cm)	76.977
Diameter of catch can (cm)	9.9	catch can openning area (sq in)	11.767

catch can number	Distance from center point	catch volume in ml	Data adjustment	Comments	Water volume (cm)	Water volume (in)	% applied of average	Deviation from average (%)	Area covered per catch can (acres)	Area covered per catch can (% of total)	Weighted Deviation
1	10		88.95		1.156	0.455	99.26%	-0.74%	0.01623	0.01%	0.0001
2	20		88.95		1.156	0.455	99.26%	-0.74%	0.02885	0.02%	0.0002
3	30		88.95		1.156	0.455	99.26%	-0.74%	0.04327	0.04%	0.0003
4	40		88.95		1.156	0.455	99.26%	-0.74%	0.05770	0.05%	0.0005
5	50		88.95		1.156	0.455	99.26%	-0.74%	0.07212	0.06%	0.0006
6	60		88.95		1.156	0.455	99.26%	-0.74%	0.08655	0.07%	0.0007
7	70	125	0.00		1.624	0.639	139.48%	39.48%	0.10097	0.08%	0.0011
8	80	75	0.00		0.974	0.384	83.69%	-16.31%	0.11539	0.09%	0.0008
9	90	115	0.00		1.494	0.588	128.32%	28.32%	0.12982	0.11%	0.0014
10	100	105	0.00		1.364	0.537	117.16%	17.16%	0.14424	0.12%	0.0014

Data Entry / Uniformity Graph

Preventing Irrigation Runoff

(comparing irrigation instantaneous application rate to soil infiltration rate)

Preventing Irrigation Runoff

(comparing irrigation instantaneous application rate to soil infiltration rate)

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

Factors that **<u>increase</u>** runoff :

- Small Wetted area or throw of sprinkler
- Low Pressure
- Larger applications volumes
- Soil compaction
- Heavy soils
- Slope
- Row hilling

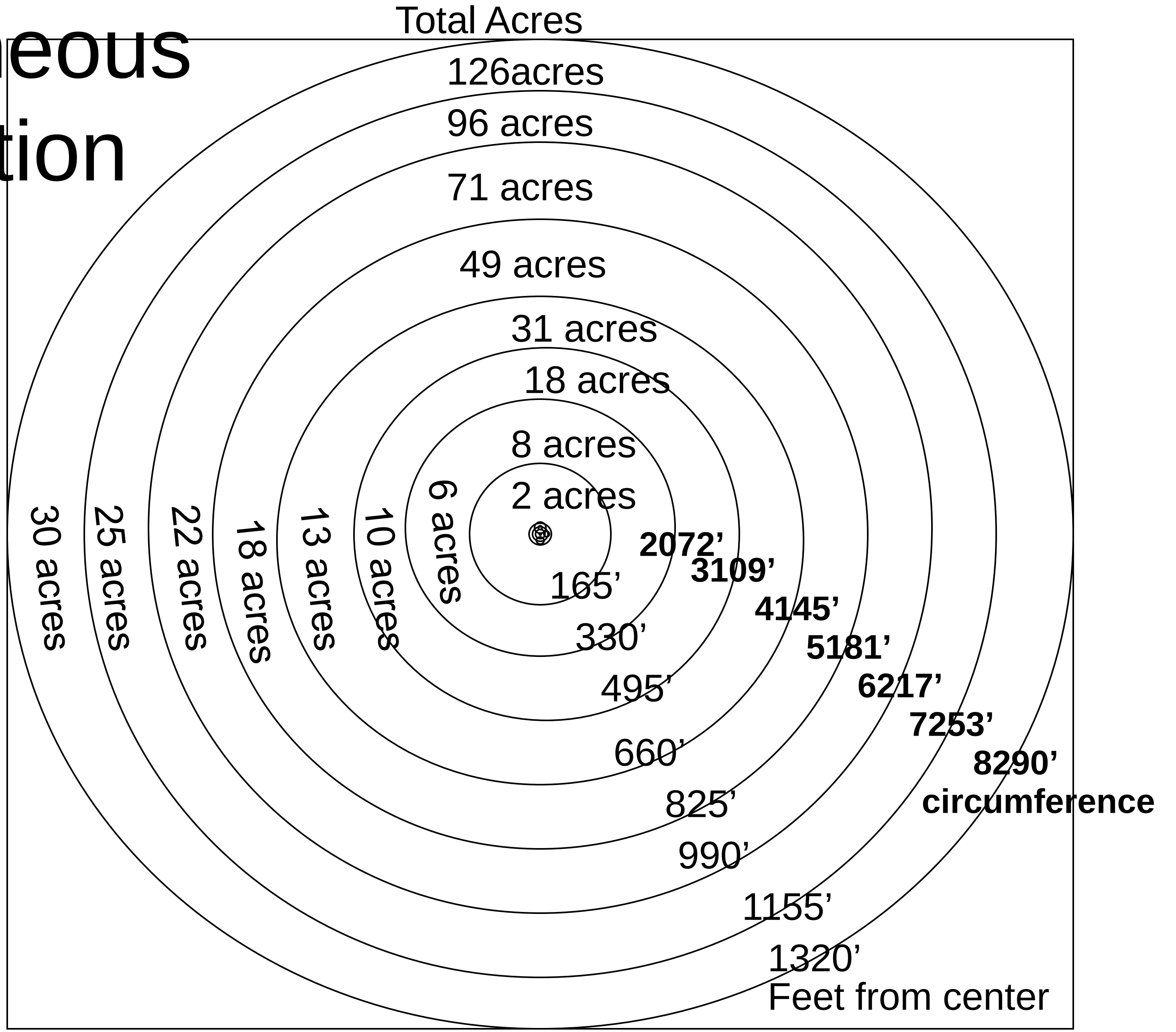
Instantaneous application rate

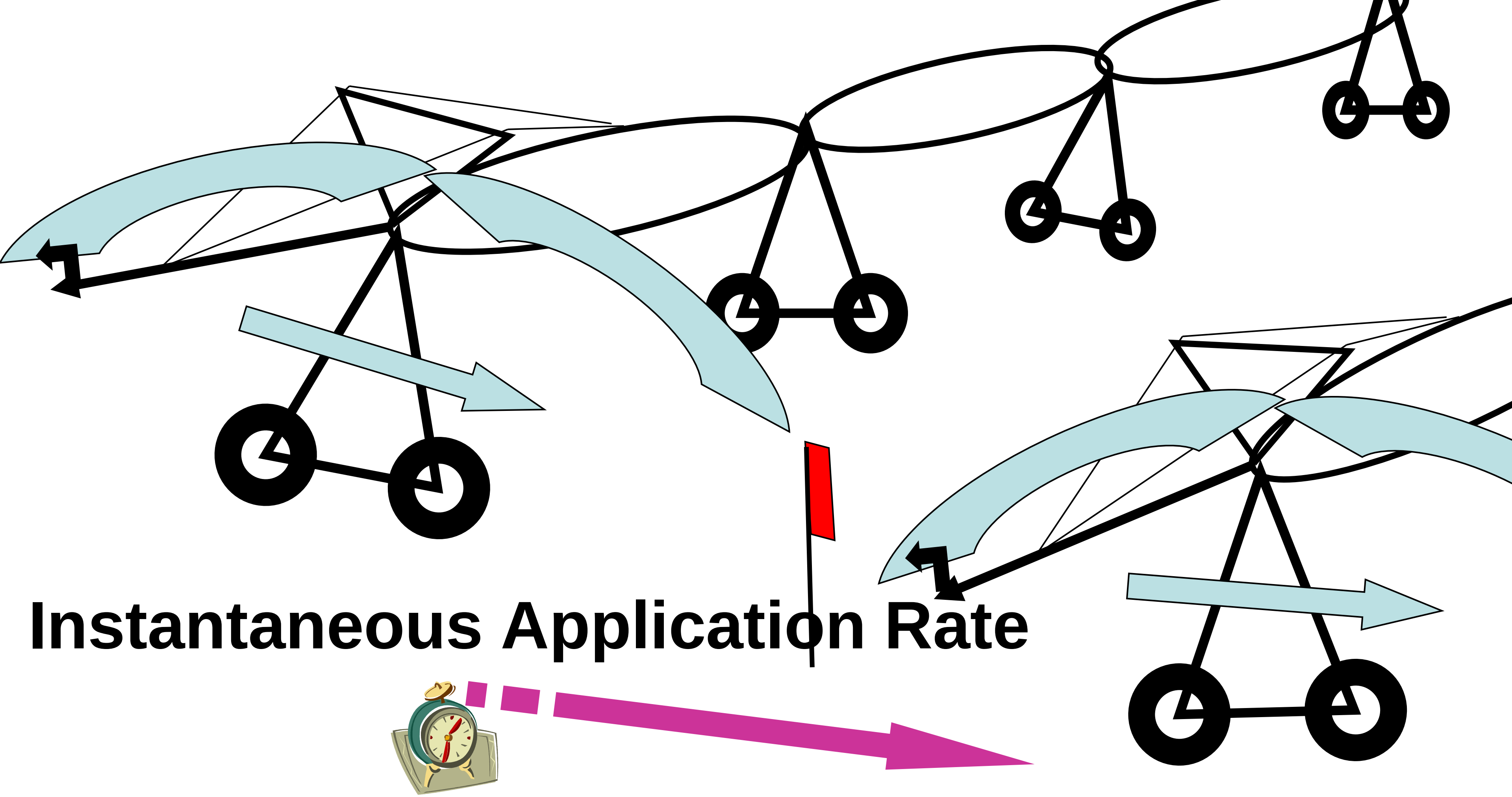
3 days / circle @ 1”
3 days = 4320 min.

8290’ / 4320 min.=
= 1.92’/minute

20’ ft. wetted area=
= 1” / 10.4 Minutes

40’ ft. wetted area=
= 1” / 20.8 Minutes





Instantaneous Application Rate

1. Time it from first drop of irrigation to last
2. Divide by know application rate
3. Convert to minute to provide 1” of irrigation

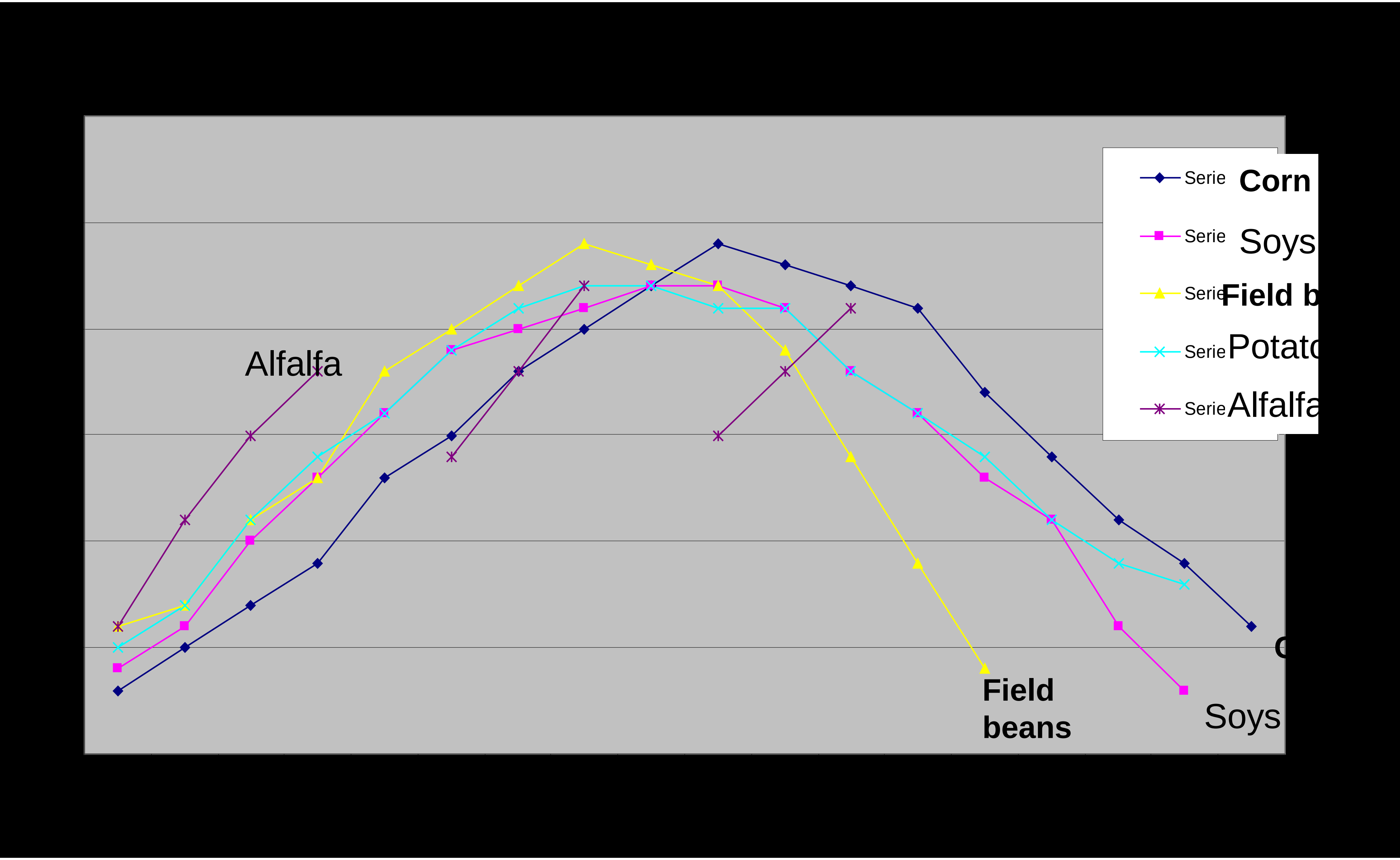
Water Supply

Quality Factors

- Foreign material – clogs pumps, screen and nozzles- sand, algae, aquatic plants and fish/frogs
- Salt – salinity (western problem)
- Calcium – and other elements that deposit in pipes
- Disease agents – manure effluent, waste treatment facilities,
- Warm surface water- major vegetable production limitations
- Aquatic weed treatment-lake algae milfoil treatment

Quantity needed

- Irrigation water replaces the plant water use (removed from soil)
- Water use is directly correlated to light interception
- 50% light interception results in about 50% of the maximum water use
- Maximum water use mid-July early August, full light interception, highest temperatures and brightest days.



From Minnesota Extension bulletin “Irrigation Scheduling”, assuming temperature 80-89

Quantity Needed

- Maximum water use for most crops is .27 - .32 in./day
- 3 gal/minute/acre pump capacity = 1”/week
- 5 gal/minute/acre pump capacity = .25 in./day
- 7 gal/minute/acre pump capacity =.33 in./day, 1”every 3 days
- 500 gal/minute pump can provide 1” every 4 days on 100 acres

Quantity Needed

In a hot 1st week of August John's corn crop ET. was .30 in./day

John's field has a AWC of **3.0 in.** (Available water capacity)

He started irrigating when the AWC was **1.0 in.** down

John's irrigation system can apply .20 in./day.

By the end of the week how far behind is John? (.30 -.20)x7 **=.70 in.**

During 2nd week of August, ET. remains .30 in./day, John shuts down 2 days for repair. By week end how far behind is John? (.5 +.6)= **1.1in.** **2.80 in. total deficit**

3rd. Week, no rain, John's corn field is hurting.

Calculating drought capacity

- Crop ET. was 0.30 in./day
- Available water capacity of **0<u>3.0 in.</u>** (AWCI
- Irrigation system can apply 0.20 in./day.
- Started irrigating when the AWC was **<u>1.0 in.</u>** down
- <u>3.0 in.</u> (AWC) - <u>1.0 in.</u> = 2.0 in. available capacity
- 2.0 in. available capacity / 0.10 daily deficit = 20 days
- 20 days of drought capacity- Not Considering down time

Limited water supply Irrigation Management

- Diversify the crops sharing the water supply between high and low water use.
- Stager planting date to stager peak water need times.
- Plant part of irrigated area to a sacrifice crop to neglect during extended drought.

- Start irrigating early to bank water ahead.
- Stager forage crop cutting dates to avoid simultaneous peak use.


Segment: 0.29 MILES
20 acres
30 acres
20 acres
30 acres
Unknown
Witt Lake Rd
0
0.21mi

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

Potential ET measured by weighing lysimeter

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).**

Meteorologically, ET depends on…

Evapotranspiration (ET) = fn (net radiation) +

fn (temperature) +

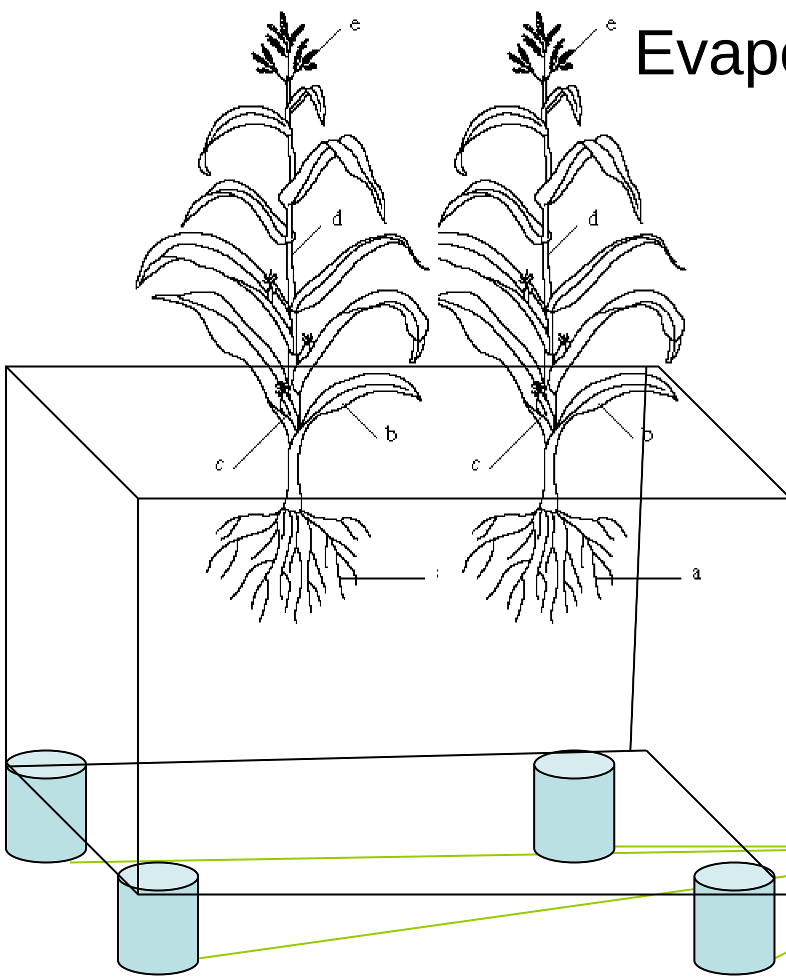
fn (wind speed) +

fn (air humidity)

Weighing Lysimeter

Rain and Irrigation increase weight

Evapotransporation decrease weight

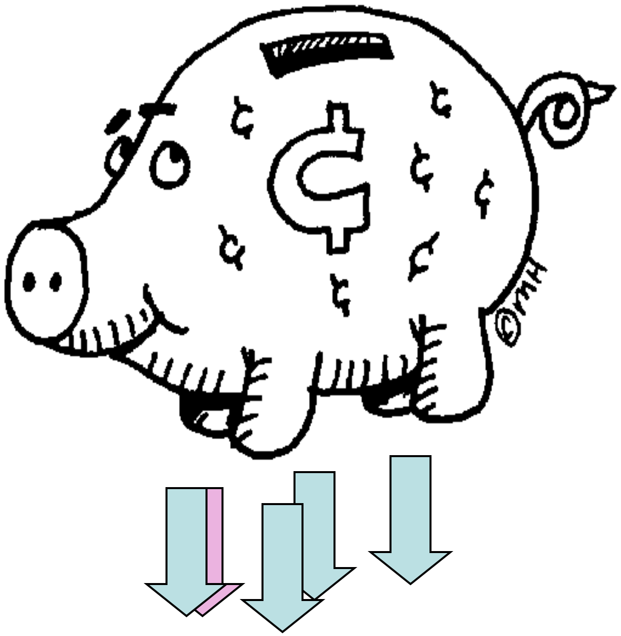


Think of your soil as a bank

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

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

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

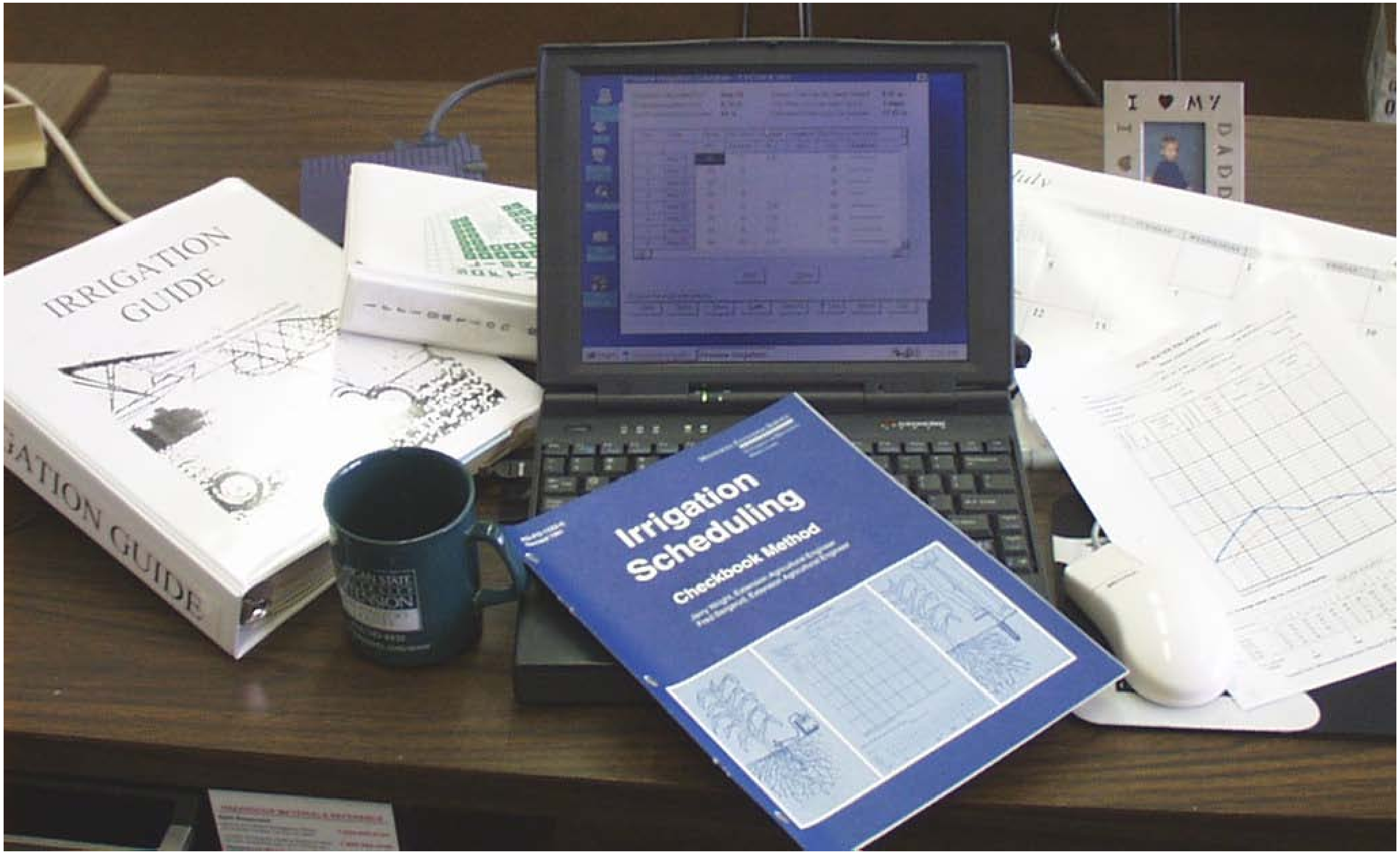


Rooting depth:
The plant can only get water to the depth of it's roots.

Deletion:
Plants 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.

Irrigation Scheduling
Checkbook Method



Soil Survey of Scott County, Indiana

Calculating Water Holding Capacity

Soil Name	Depth Inches	Available water holding capacity	Average Available water holding capacity	Ave. Available water holding capacity (24 in.)	Ave. Available water holding capacity (36 in.)
Oshtemo	**0 - 14** **14 – 35** **35 - 60**	**0.10 – 0.15** **0.12 – 0.19** **0.06 – 0.10**	**0.125** **0.155** **0.08**	**14” x 0.125=1.75** **10” x 0.155=1.55** **-----------------------** **= 3.3**	**14” x 0.125= 1.75** **21” x 0.155= 3.26** **1” x 0.08 = 0.08** **-----------------------** **= 5.09**
Spinks	**0 – 10** **10 – 26** **26 - 60**	**0.08 – 0.10** **0.08 – 0.10** **0.04 – 0.08**	**0.09** **0.09** **0.06**	**10” x 0.09= 0.9** **14” x 0.09= 1.26** **-----------------------** **= 2.16**	**10” x 0.09= 0.9** **16” x 0.09= 1.26** **8” x 0.06= 0.48** **-----------------------** **= 2.64**

Rain Gauges

- Basic unit – 2 inch opening
- Cost less than $10
- One rain gauge for each 40 acres.
- Recording rain gauge cost $50 - $100

Irrigation Scheduling Checkbook Method –University of Minnesota

- Items to Conduct Checkbook Irrigation Scheduling
  - o Two or more rain gauges
  - o Max-Min thermometer or access to local temperature reports
  - o Soil probe or in field moisture sensors
  - o Daily crop water use table or local ET hotline or website report
  - o Soil water balance worksheets
  - o Estimate of soil moisture holding capacity

SOIL WATER BALANCE SHEET

(Make copies as needed)

Field SW 1/4 Crop corn Emergence date 6-1-08

Pumping Capacity ______ gpm per acre= ______ net application inches per day

Available Water Capacity 3.0 inches in root zone of 36” inches

Growth Stage	Vegetative	Critical Growth	Maturing
Allowable	50 %	____ %	____ %
Soil Water Deficit	1.5 inches	____ inches	____ inches

Week after emergence	Date	Soil water field reading A	Soil water field reading B	Maximum temperature	Add: Crop water use	Subtract: Rainfall	Subtract: Net irrigation	Available Soil water 2.00 A	Available Soil water B
	Jun 21			75	.15	-0-		1.85	
	Jun 22			75	.15	-0-		1.70	
	Jun 23			85	.18	-0-		1.52	
	Jun 24			85	.18	-0-		1.34	
	Jun 25			75	.15	-0-	0.75	1.94	
	Jun 26			75	.15	-0-		1.79	

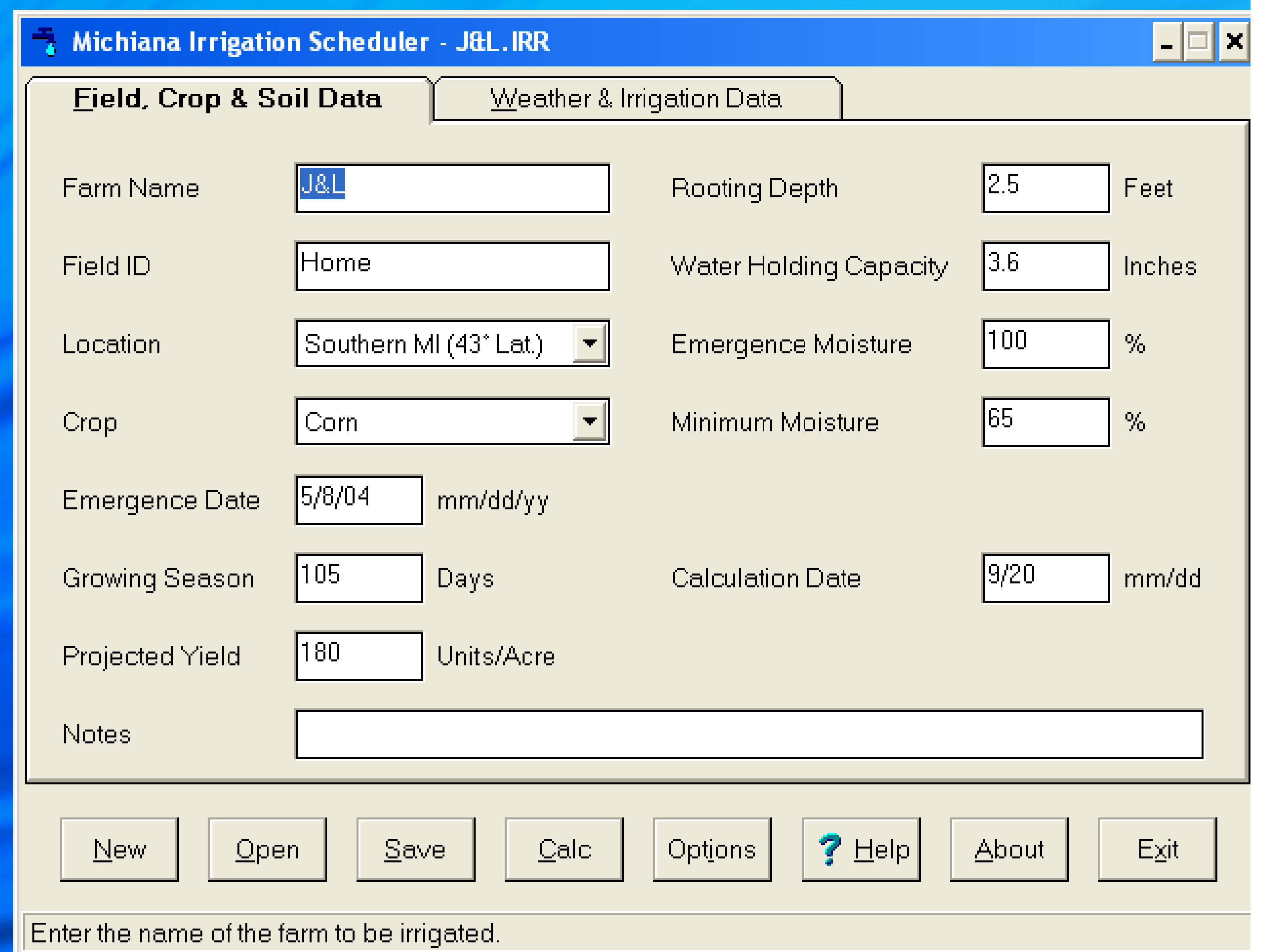
Temperature F	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Week after emergence																	
50-59	.01	.02	.03	.04	.05	.06	.08	.09	.09	.10	.10	.10	.09	.07	.06	.05	.04	.03
60-69	.02	.03	.04	.06	.08	.09	.11	.12	.13	.15	.14	.14	.13	.11	.09	.07	.06	.04
70-79	.03	.04	.05	.07	.10	.12	.15	.16	.17	.19	.19	.18	.17	.14	.11	.09	.07	.05
80-89	.03	.05	.07	.09	.13	.15	.18	.20	.22	.24	.23	.22	.21	.17	.14	.11	.09	.06
90-99	.04	.06	.08	.11	.15	.18	.21	.24	.26	.28	.27	.26	.25	.20	.17	.13	.11	.07
Corn growth stages		↑ 3 leaf			↑ 8 leaf			↑ 1st tassel	↑ silk		↑ blister kernel			↑ early dent	↑ dent			

Michiana Irrigation Scheduler

- Max and min temperatures
- Rainfall/Irrigation

Purdue Agronomy web site – Michiana Irrigation Scheduler: Est. From High/Low temp. & date

www.agry.purdue.edu/irrigation/IrrDown.htm



Michiana Irrigation Scheduler - J&L.IRR
Field, Crop & Soil Data
Weather & Irrigation Data
Farm Name
J&L
Field ID
Home
Location
Southern MI (43° Lat.)
Crop
Corn
Emergence Date
5/8/04
mm/dd/yy
Growing Season
105
Days
Projected Yield
180
Units/Acre
Notes
Rooting Depth
2.5
Feet
Water Holding Capacity
3.6
Inches
Emergence Moisture
100
%
Minimum Moisture
65
%
Calculation Date
9/20
mm/dd
New
Open
Save
Calc
Options
Help
About
Exit
Enter the name of the farm to be irrigated.

Michiana Irrigation Scheduler - J&L.IRR

Field, Crop & Soil Data | **Weather & Irrigation Data**

Day	Date	Normal Temp.	High Temp.	Low Temp.	Rainfall (in.)	Irrigation (in.)
39	Jun 15	67	80	61		
40	Jun 16	67	83	67		
41	Jun 17	68	78	63		
42	Jun 18	68	69	61		
43	Jun 19	68	72	51		.8
44	Jun 20	68	73	45		
45	Jun 21	68	69	53	.1	
46	Jun 22	69	80	54		
47	Jun 23	69	70	49		
48	Jun 24	69	72	51		.8

Get Temps

New | Open | Save | Calc | Options | ? Help | About | Exit

Enter the field's daily temperature, rainfall and irrigation data.

Preview Irrigation Schedule - J&L.IRR

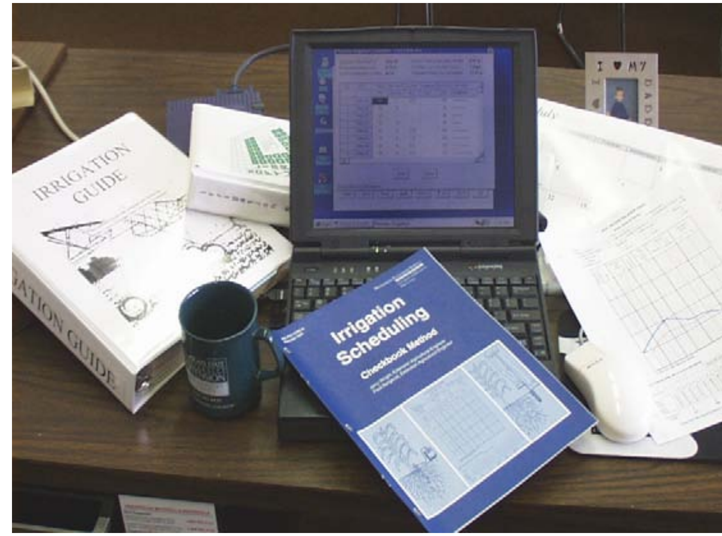
Schedule Calculated For	**Sep 20**	Amount That Can Be Safely Added	**0.01 in.**
Evapotranspiration Rate	**0.00 in.**	If No Rain, You Can Add 1 Inch In	**354 days**
Soil Profile Moisture Content	**100 %**	Estimated Water Loss For Season	**17.39 in.**

Day	Date	Temp. (°F)	Dev. from Normal	Rainfall (in.)	Irrigation (in.)	Soil Mois. (%)	Soil Mois. (relative)
1	May 08	66	+14			100	+++++++
2	May 09	70	+17	0.70		105	++++++++
3	May 10	70	+17	0.10		113	++++++++++
4	May 11	73	+19	0.10		105	++++++++
5	May 12	68	+13			100	+++++++
6	May 13	70	+15	1.00		105	++++++++
7	May 14	54	-2	0.70		103	++++++++
8	May 15	57	+1			100	+++++++

Print   Close

Browse the daily calculations.

Irrigation Scheduling Checkbook Challenges



Errors will accumulate over time -Weekly ground truthing needed

Rainfall variability is more than often considered

Only "effective" rainfall and irrigation should be considered - Only water entering root zone uniformly is "effective"

Corn crop mature in program by calendar, not heat

?? Soil Moisture ??

Pesticide and Nitrogen issues - Cons of Irrigation

- Irrigation is most common on light/sandy soil that often have high poorly protected aquifers.
- Irrigated soil will often be maintained with higher soil moisture than non-irrigated, increasing the potential of leaching pesticides and nitrogen.

Pesticide and Nitrogen issues - Pros of Irrigation

- Lack of water accounts for 45% yield variation on light/sandy soil.
- Irrigation allows higher pesticides and nitrogen use efficiency, using nutrients that may be lost post harvest.
- The greatest potential of leaching pesticides and nitrogen happens early in season, often prior to irrigation application season.

Assure the best plant stand possible

- Irrigate, if necessary, to make sure to get maximum germination and uniform emergence.
- ½ inch in most irrigated soil within five days of planting.
- Maintain a moist surface,0.10” to 0.20” applications, till spike.
- Are you ready to irrigate the day you plant?

Using irrigation to get the most from pesticides and nutrients

Timely application of irrigation water:

- Improves incorporation of herbicides.
- Improves activation of herbicides.
- Improves activation/reactivation of insecticides.

- Reduces nitrogen volatilization.
- Maximizes yield to utilize the resources.

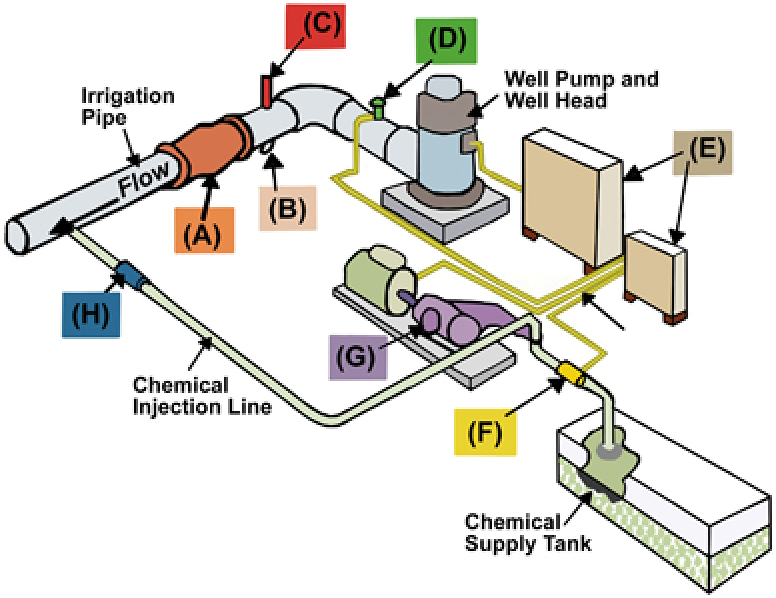
"Dry weather following an application of Dual II Magnum or a tank mixture may reduce effectiveness. Cultivate if weeds develop."

- Do not apply this product through any type of irrigation system.

- If available, sprinkler irrigate within 2 days after application. Apply ½" -1" of water. Use lower water volumes (½") on coarse-textured soils, higher volumes heavier soils (1") on fine-textured soils.

Chemigation – Application of pesticide via irrigation water.

Fertigation – Application of fertilizer via irrigation water.



Split or Multiple Applications

- Try to match N uptake curve of the crop.
- Application of some N must occur by the sixth week after planting.
- Most of the N requirement should be applied by the tenth week after planting.
- Research data suggests that a well timed sidedress application can be as effective as multiple applications in irrigated corn production on loam or heavier soils.
- A combination of sidedress applications and N additions in irrigation water may be needed to maximize corn yields on some sandy soils.
- Preplant applications of greater than one-third of the total N requirement, with the remainder applied later, are not as effective as sidedress applications on irrigated sandy soils.

Chemigation Label

- Chemigation labels provide specific mixing application and safety precautions for irrigation applications.

- EPA requires products applied through irrigation systems to have a chemigation label.

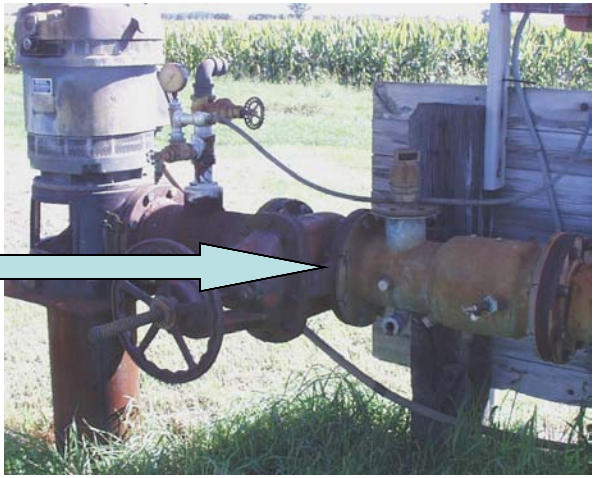
Chemigation Valve Requirements

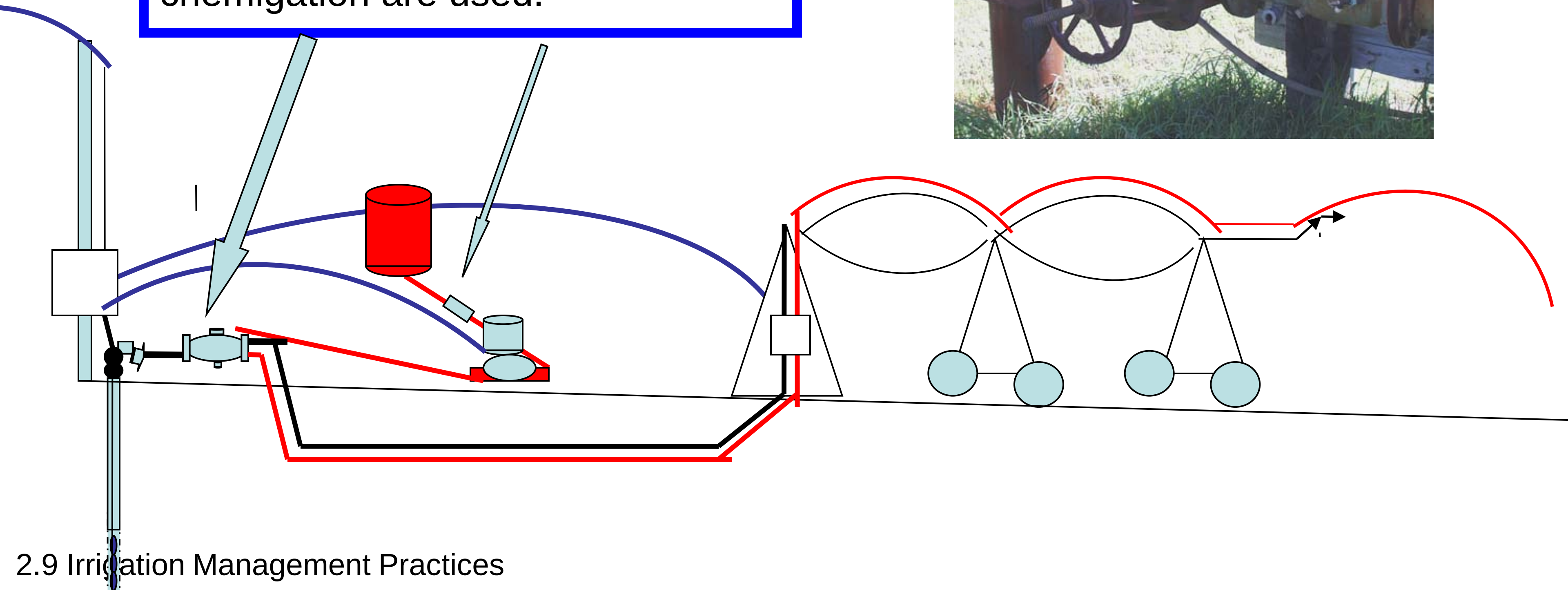
Indiana and Michigan have specific chemigation valve requirements for public water supply connections but not for private water supplies.

Both States require adequate protection of water supply in law or well code.

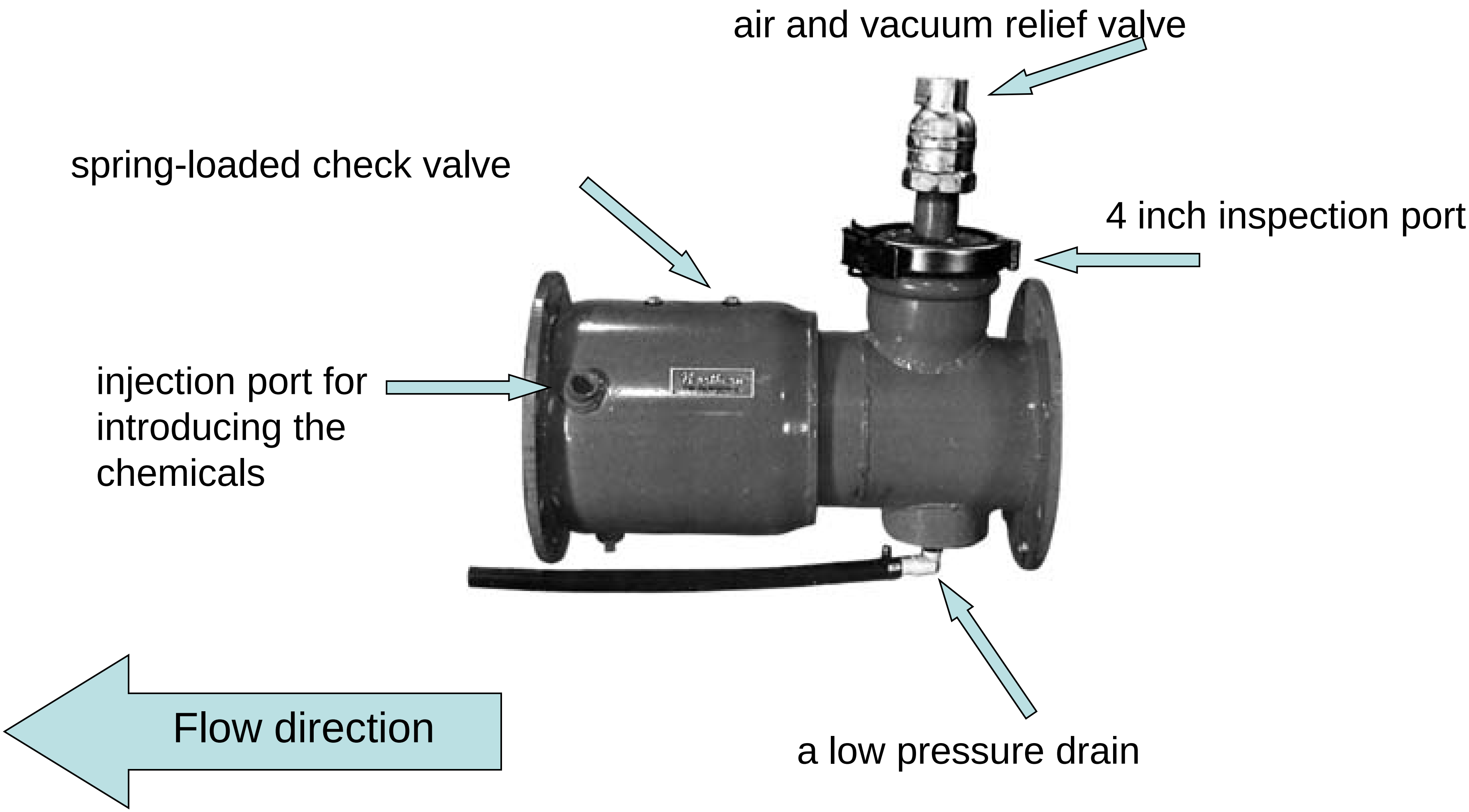
Are appropriate backflow prevention devices in place and properly maintained if fertigation or chemigation is used?

Backflow prevention safety devices are used and properly maintained if fertigation or chemigation are used.

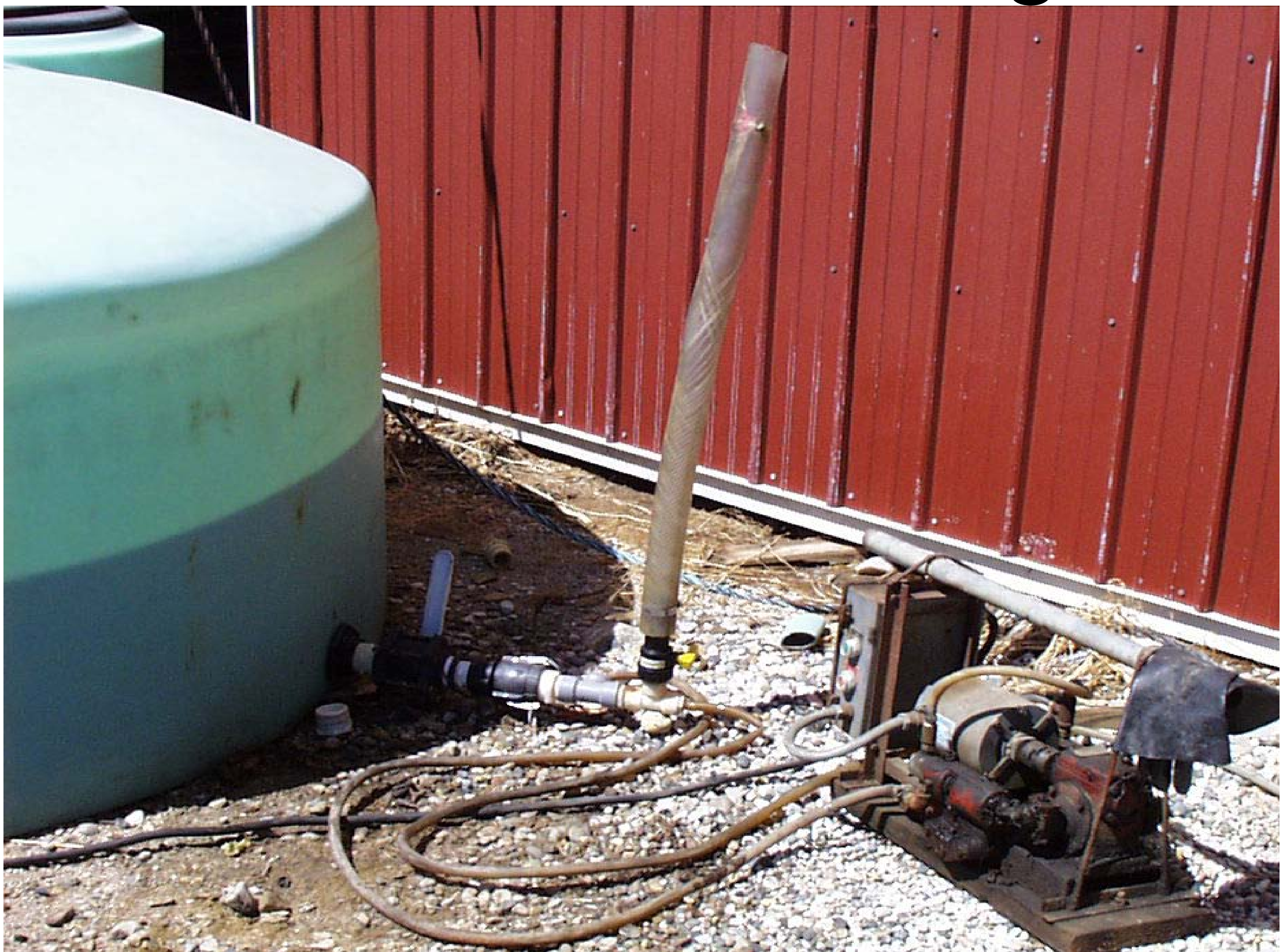




Most chemigation valves consist of:



Calibrating a Center Pivot for Chemigation



Irrigation management to Protect Groundwater

- Backflow protection with Air gap and vacuum relief

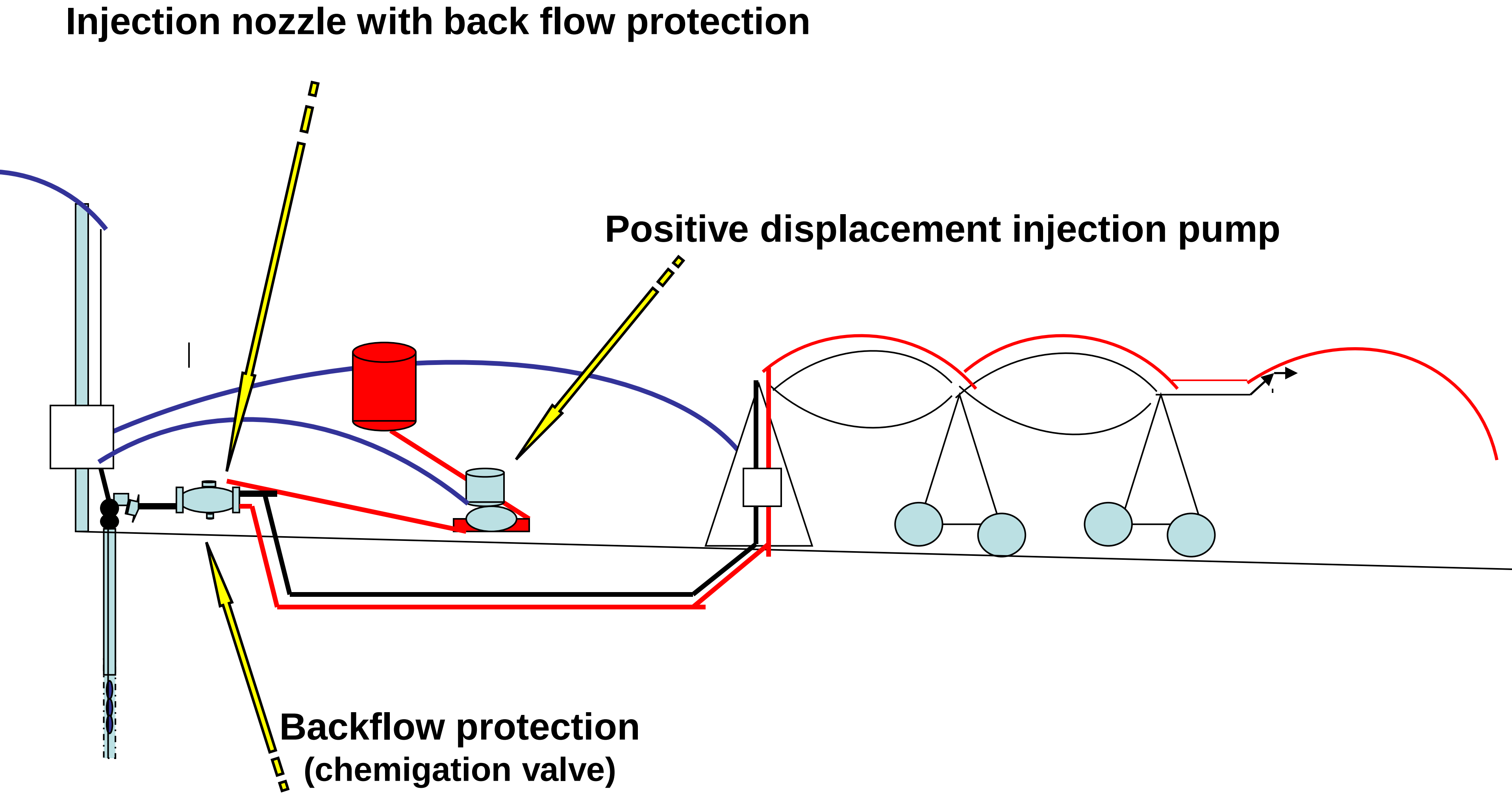
-required for chemigation and fertigation

- good idea for all systems.

-Interlocks between nitrogen pump and irrigation pump.

-Backflow protection between injection point and supply tank.

Chemigation / Fertigation Systems Safety Interlock –Shut down entire system if any component stops



Well Backflow situation – What do I do?

Pump, Pump, Pump as soon as possible.

Nebraska study showed majority of contaminant recovered in the first hour when pumping started immediately.

- Increased recovery of contaminant out to three days of pumping. Majority in day one.
- Reduced total recovery if pumping start 24 hour later.