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Irrigation Water Saving and Related Incentive Programs

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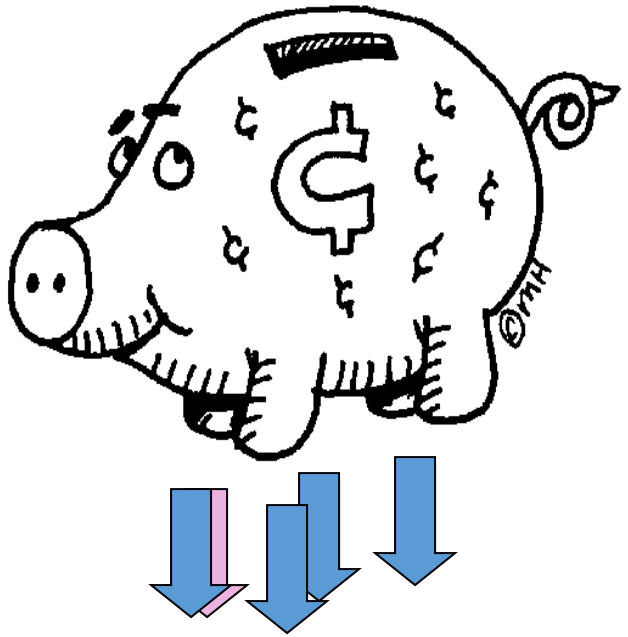
https://www.canr.msu.edu/irrigation/

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 allows 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 its 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.

Make all visual identified repairs… first….

As great as a 20x over application followed by under application to the outer portion of system.

Distribution system repairs:

System specific - Major yield reduction

- 30% less water applied by portion of machine beyond missing sprinkler.

Distribution system repairs:

System specific : example

Next ring out represents 37 acres

x 30% = 11 acres,

11 acres x 7” annual application

= 77 acre inches (7%)

300’ arm + 70’ end gun coverage = 370’

1300’ + 370’ = 1670’

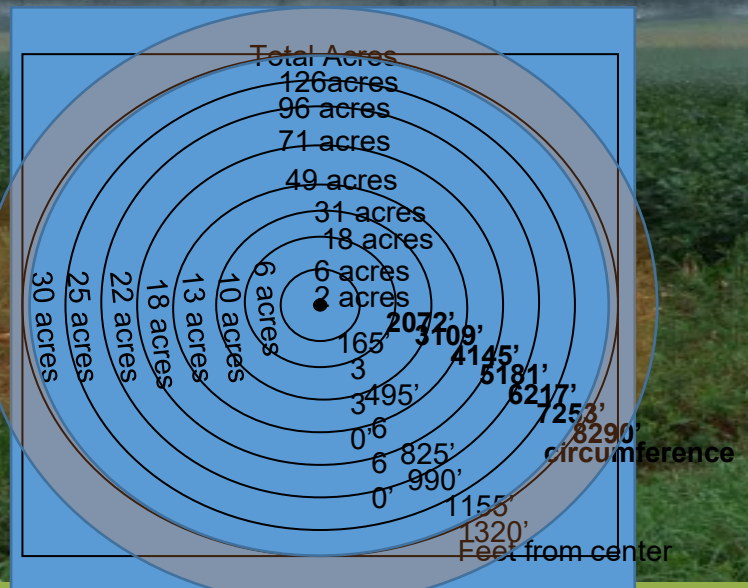
1670’ system = 201 acres

-1300’ system = 122 acres

= 79 acres or 39% of systems water

20’ wide band at 1300’ = 4 acre band

About a 20 x over application



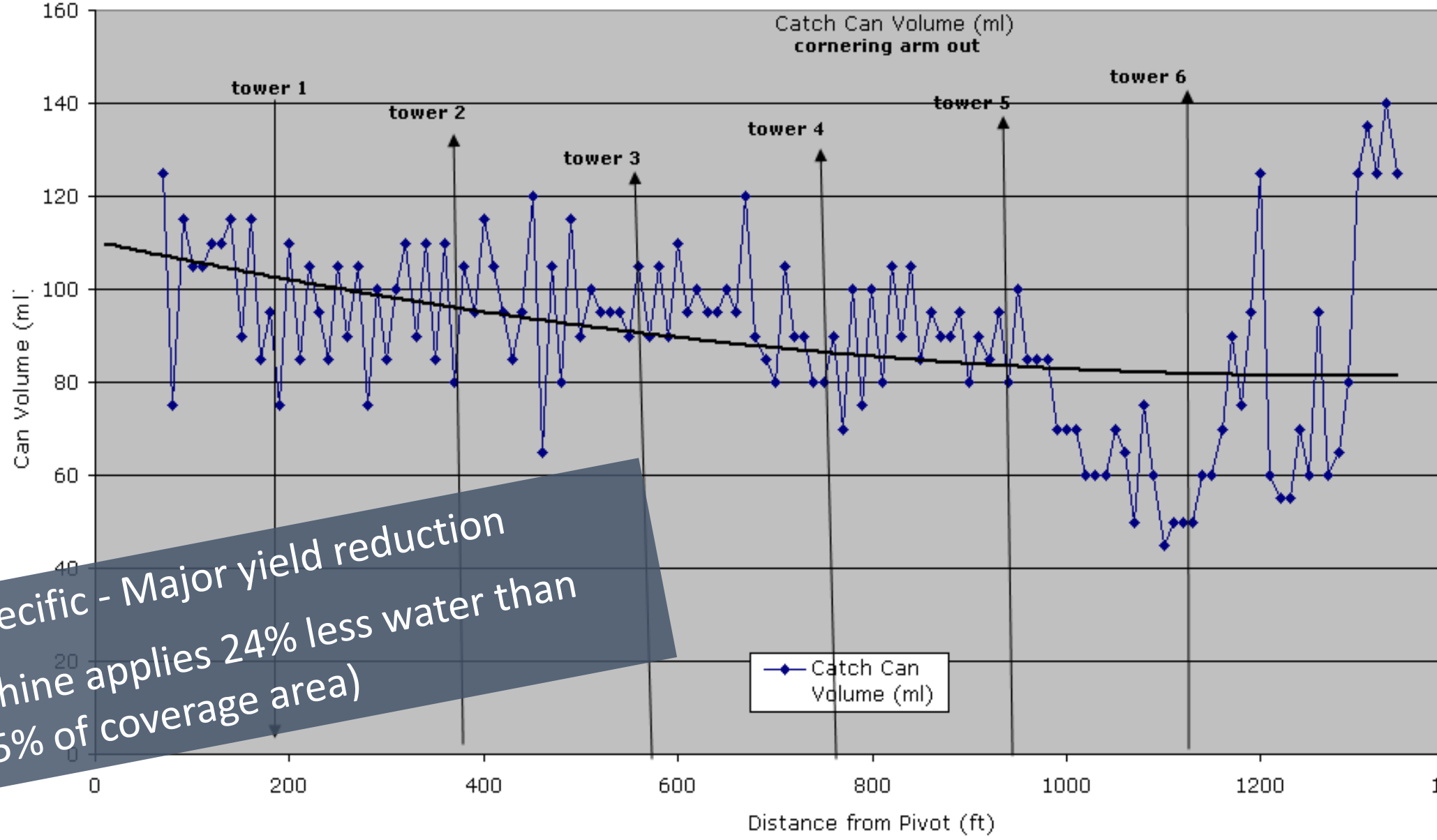
Irrigation System Evaluations for Uniformity

Over and under applied areas will likely be over or under applied each application multiplying the negative effect.

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”

A 10% or less deviation from the average is ideal (15% is acceptable).

Uniform Water Application



- System specific - Major yield reduction
- Far ½ of machine applies 24% less water than expected (75% of coverage area)

Greatest Improvement Needed

Pivots

- **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 (Replace sprinkler package when >10% require repair)**

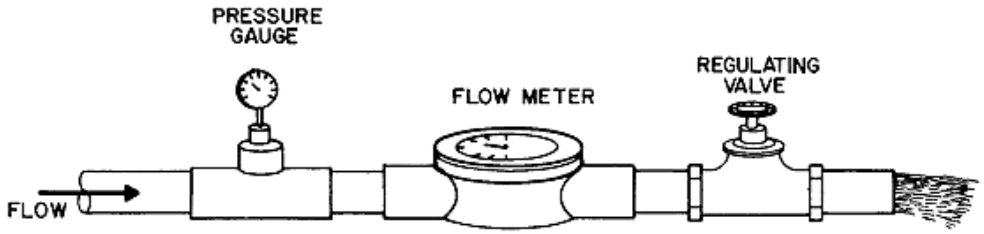
Trickle/Drip

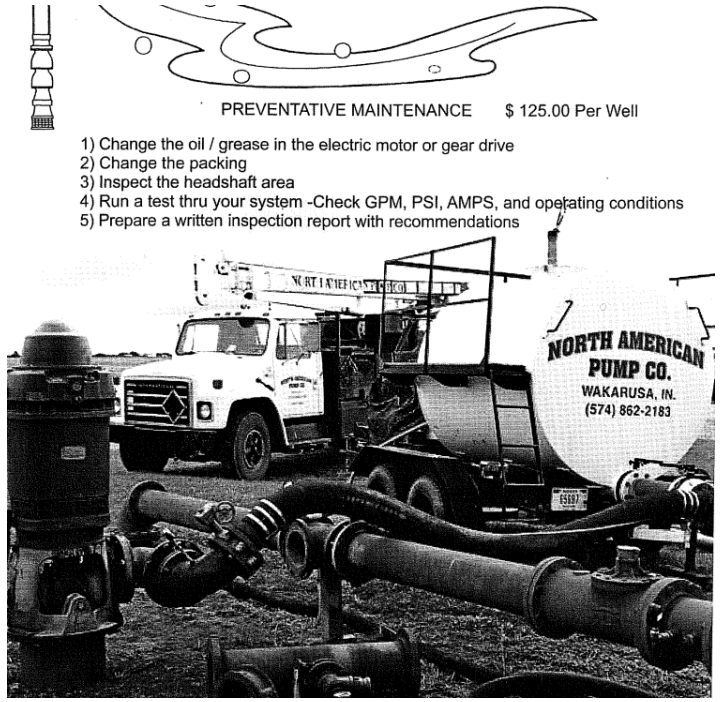
- **Follow a good design**
- **Line length matched to design**
- **Supply pressure issues at manifold**

Big Gun Travelers

- **Traveler lane gap spacing**
- **Water supply over or under design (pressure at gun)**
- **Gun orifice, tip wrong**
- **Wind differences**

Measure flow at desired pressure prior to ordering sprinkler package.





If your pressure is off 10% or more from the sprinkler chart – flow test and correct flow or re-nozzle.

Poor performance?

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

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Minimize overlap
Minimize dry corners
Avoid non-field watering

System specific : example
290 irrigated acre , 36 acre double watered, 7” annual application
= 252 acre inches (12%)

Overlap and dry corners are bad for the environment and your profits.

Choosing the right sprinkler package.

For Michigan/Indiana irrigation systems-

Minimal concern for water loss to air
Big concern for run-off issues
(we are not in Arizona)

Look for:

- greatest wetted area / pressure required
- most uniform (C.U.)
- easy updated nozzle package
- greatest tolerance of pressure change

Walk existing irrigation systems and look for run-off where it most likely to be.

(last span, hills, compaction)

Choosing the right sprinkler package

Overhead irrigation systems-

Minimal concern for water loss to air – major concern for run-off issues

(we are not in Arizona)

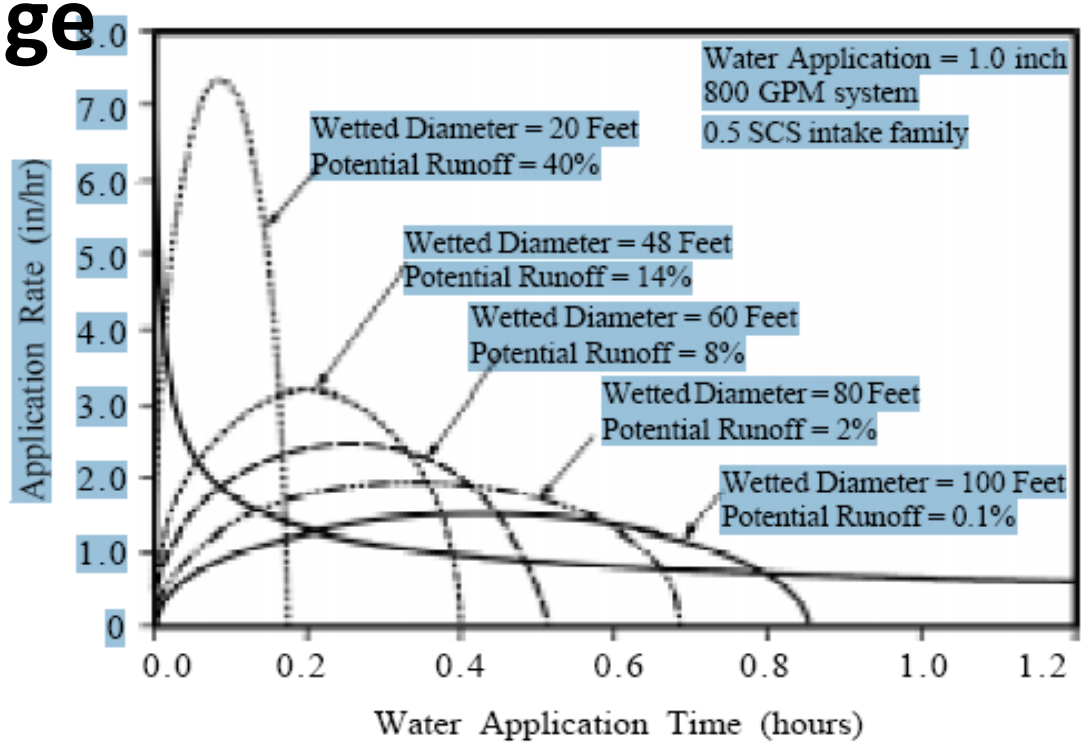


Figure 8. Effect of wetted diameters on the potential for runoff.

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

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

- Sprinkler small wetted area
- Low pressure
- Larger applications volumes

- Soil compaction
- Heavy soils
- Slope
- Row hilling

Instantaneous application rates from 1” per 12 minutes to 1” per 80 minutes

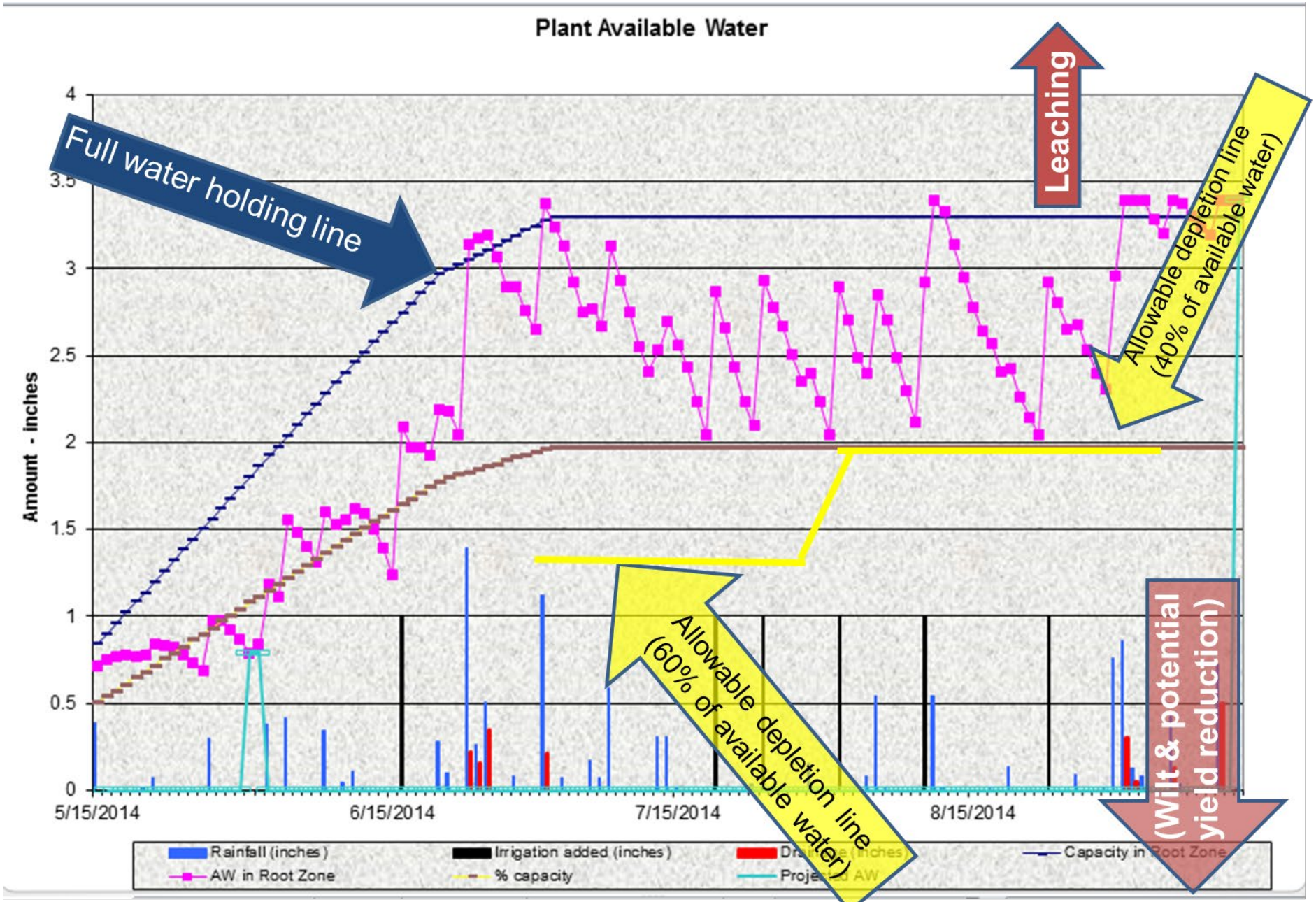
Larger irrigation applications reduce the number of wetting events resulting from irrigation and net more water to plant.

- Use big applications, 4-5 days of water needs
- Water needs peak at 0.22” to 0.28” = 1.0” to 1.25” 4-5 days
- If your July crop water need is 7.0” and you get 2.0” of rain your irrigation need is 5.0”

Application	# of Applications (# of wetting events)	Net plant available water
1.25”	4	4.6“
1.00”	5	4.5”
0.71”	7	4.3”
0.50”	10	4.0”
0.33”	15	3.5”
0.25”	20	3.0”

- Avoid applications that result in runoff (Reducing and Evaluating Irrigation Runoff, Irrigation Factsheet #13)

Estimate and replace crop water use



Rain gauges and data

- Basic unit – 2 inch opening
- Cost less than $10
- One rain gauge for each 80 acres.
- Recording rain gauge cost $50 - $100

Michigan is a supplemental irrigation area – Well over half of or crop water needs come from rainfall.

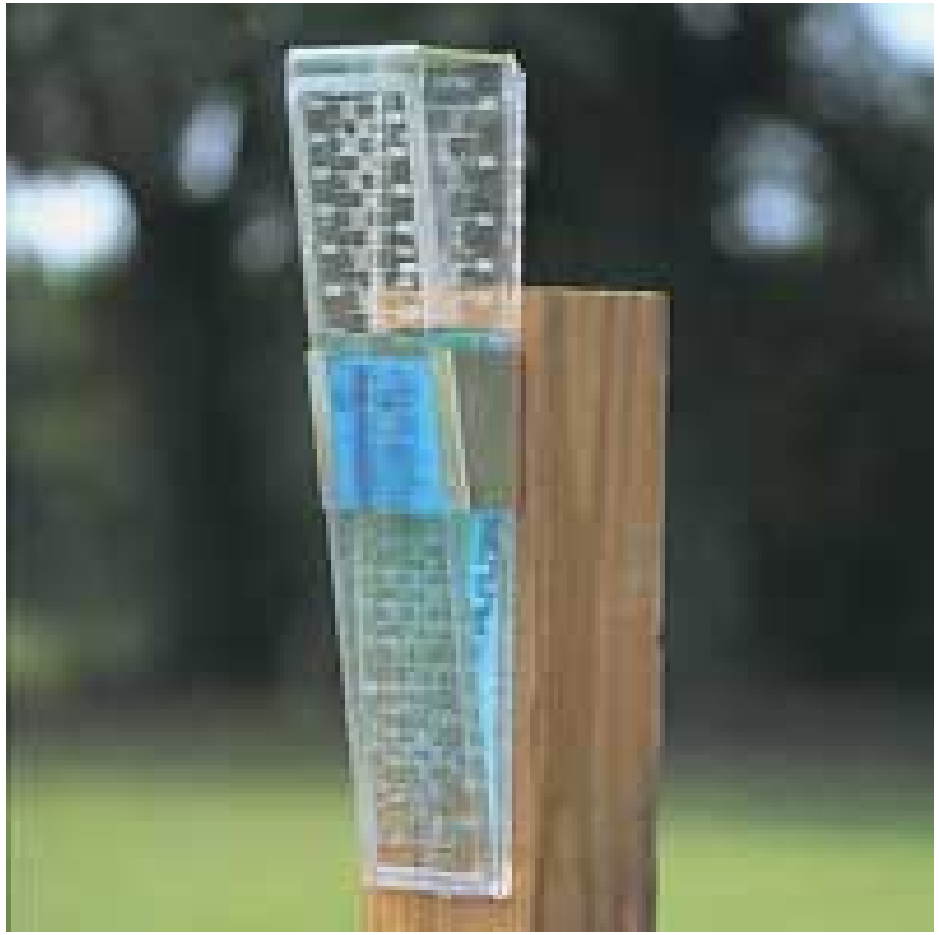


Table 5. Average water use for POTATOES in inches/day

Temperature F	Week after emergence																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
50-59	.02	.03	.04	.06	.07	.08	.08	.09	.09	.09	.09	.07	.07	.06	.05	.04	.04
60-69	.03	.05	.06	.08	.10	.12	.12	.13	.13	.13	.13	.11	.10	.09	.07	.05	.05
70-79	.04	.06	.09	.11	.13	.16	.18	.18	.18	.17	.17	.14	.13	.11	.09	.07	.07
80-89	.05	.07	.11	.14	.16	.19	.21	.22	.22	.21	.21	.18	.16	.14	.11	.09	.08
90-99	.06	.09	.13	.16	.19	.23	.24	.26	.26	.25	.25	.21	.19	.17	.13	.11	.10
Potato growth stages			↑ 7 in.	↑ budding		↑ full cover											

SOIL WATER BALANCE SHEET

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Field:_____ Crop:_____ Emergence date:_____

Pumping capacity:_____ gpm per acre = _____ net application inches per day

Available Water Capacity:_____ inches in root zone of _____ inches

Growth Stage:	Vegetative	Critical Growth	Maturing
Allowable Soil Water Deficit:	_____ % _____ inches	_____ % _____ inches	_____ % _____ inches

Starting Soil Water Deficit		SWD - CWU + Rainfall + Net Irr = New SWD					
Date	**Kc**	**Potential ET (PET)**	**Crop Water Use (CWU)= PET*Kc**	**Rainfall**	**Net Irrigation (Net Irr)**	**Soil water deficit (SWD)**	**Notes**
7-1-21			**0.16**	**0**		**1.80**	**Full cover**
7-2-21			**0.16**	**0**		**1.64**	
7-3-21			**0.19**	**0**		**1.45**	
7-4-21			**0.19**	**0**		**1.26**	
7-5-21			**0.16**	**0**	**0.70**	**1.80**	**Full cover**
			0.16	**0**		**1.64**	

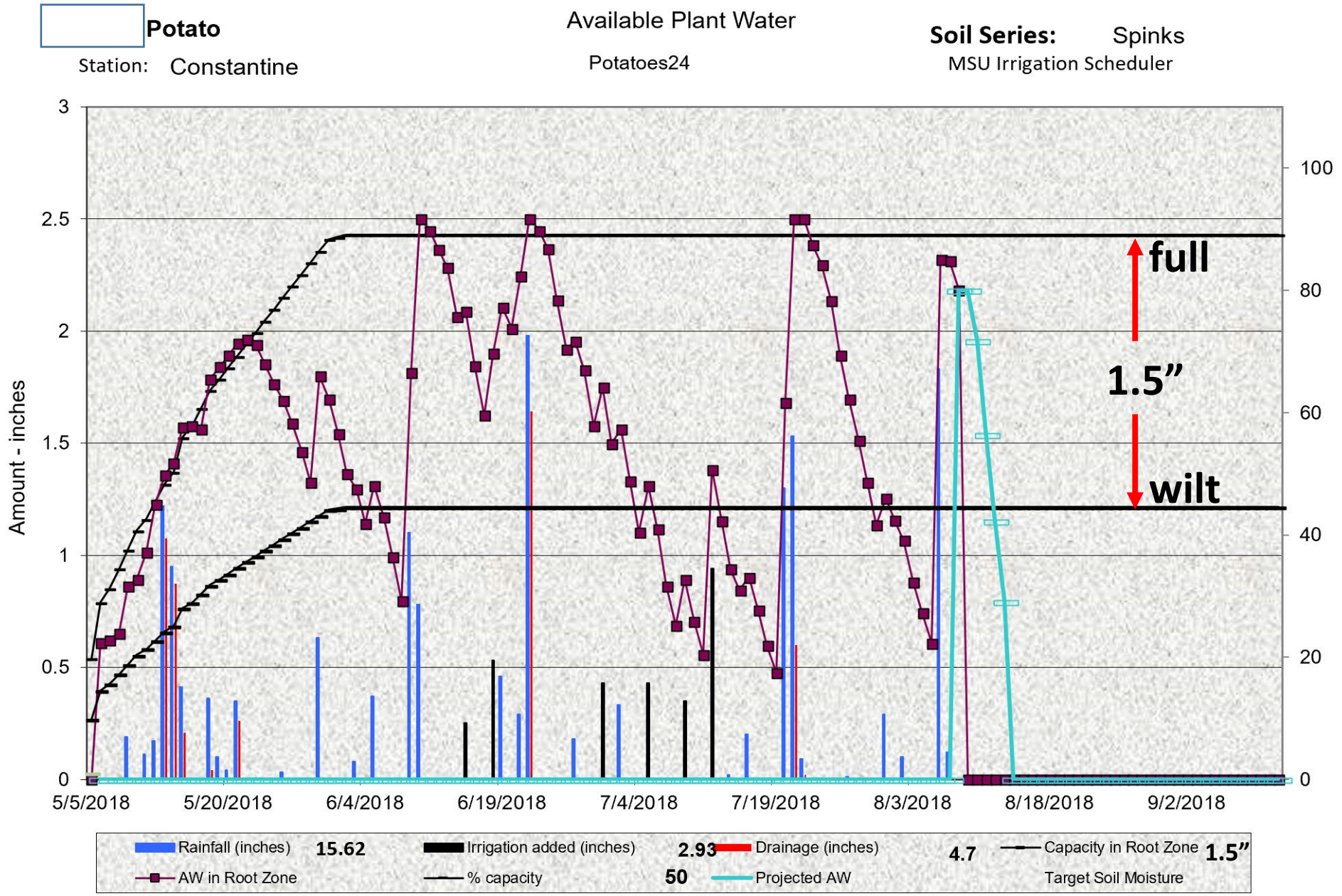
	A	B	C	D	E	F	G	H	I	J	K	L	N	O
18	Date	Root Depth (inches)	Rainfall (inches)	Irrigation added (inches)	Potential ET (inches)	% Canopy Cover (Kc)	ET modified for crop (inches)	Capacity of root zone (inches)	Available Water in root zone (inches)	% capacity filled	Drainage (inches)	Additional capacity of root zone (inches)	Proj ETO	Proj ET
111	1-Aug	24.0	0		0.17	0.96	0.16	3.15	2.62	83	0.00	**0.53**		0.00
112	2-Aug	24.0	0.4		0.08	0.97	0.08	3.15	2.94	93	0.00	**0.21**		0.00
113	3-Aug	24.0	0		0.18	0.98	0.18	3.15	2.76	88	0.00	**0.39**		0.00
114	4-Aug	24.0	0		0.17	0.99	0.17	3.15	2.59	82	0.00	**0.56**		0.00
115	5-Aug	24.0	0		0.08	1.00	0.08	3.15	2.51	80	0.00	**0.64**		0.00
116	6-Aug	24.0	0.3		0.1	1.01	0.10	3.15	2.71	86	0.00	**0.44**		0.00
117	7-Aug	24.0	0		0.09	1.02	0.09	3.15	2.62	83	0.00	**0.53**		0.00
118	8-Aug	24.0	0		0.14	1.01	0.14	3.15	2.48	79	0.00	**0.67**		0.00
119	9-Aug	24.0	0		0.16	1.00	0.16	3.15	2.32	74	0.00	**0.83**		0.00
120	10-Aug	24.0	0		0.16	1.00	0.16	3.15	2.16	68	0.00	**0.99**		0.00
121	11-Aug	24.0	0		0.15	0.99	0.15	3.15	2.01	64	0.00	**1.14**		0.00
122	12-Aug	24.0	0.8		0.09	0.98	0.09	3.15	2.72	86	0.00	**0.43**		0.00
123	13-Aug	24.0	0		0.13	0.97	0.13	3.15	2.59	82	0.00	**0.56**		0.00
124	14-Aug	24.0	0		0.14	0.97	0.14	3.15	2.46	78	0.00	**0.69**		0.00
125	15-Aug	24.0	0		0.12	0.96	0.12	3.15	2.34	74	0.00	**0.81**		0.00
126	16-Aug	24.0	0		0.16	0.95	0.15	3.15	2.19	70	0.00	**0.96**		0.00
127	17-Aug	24.0	0		0.16	0.94	0.15	3.15	2.04	65	0.00	**1.11**		0.00
128	18-Aug	24.0	0		0.14	0.94	0.13	3.15	1.91	61	0.00	**1.24**		0.00
129	19-Aug	24.0	0		0.16	0.93	0.15	3.15	1.76	56	0.00	**1.39**		0.00
130	20-Aug	24.0	0	1	0.16	0.92	0.15	3.15	2.61	83	0.00	**0.54**		0.20
131	21-Aug	24.0	0		0.16	0.91	0.15	3.15	2.47	78	0.00	**0.68**		0.30
132	22-Aug	24.0	0.2		0.07	0.90	0.06	3.15	2.61	83	0.00	**0.54**		0.15
133	23-Aug	24.0	0		0.17	0.89	0.15	3.15	2.46	78	0.00	**0.69**		0.05
134	24-Aug	24.0	0		0.17	0.87	0.15	3.15	2.31	73	0.00	**0.84**		0.00
135	25-Aug	24.0	3.5		0.16	0.86	0.14	3.15	3.24	103	2.52	**0.00**		0.00
136	26-Aug	24.0	0.5		0.13	0.85	0.11	3.15	3.63	115	-2.03	**0.00**		0.00

Help | **Calculations** | Soil Moisture | Cumulative data | Table1 | Caluations | Crop & Soil Tables

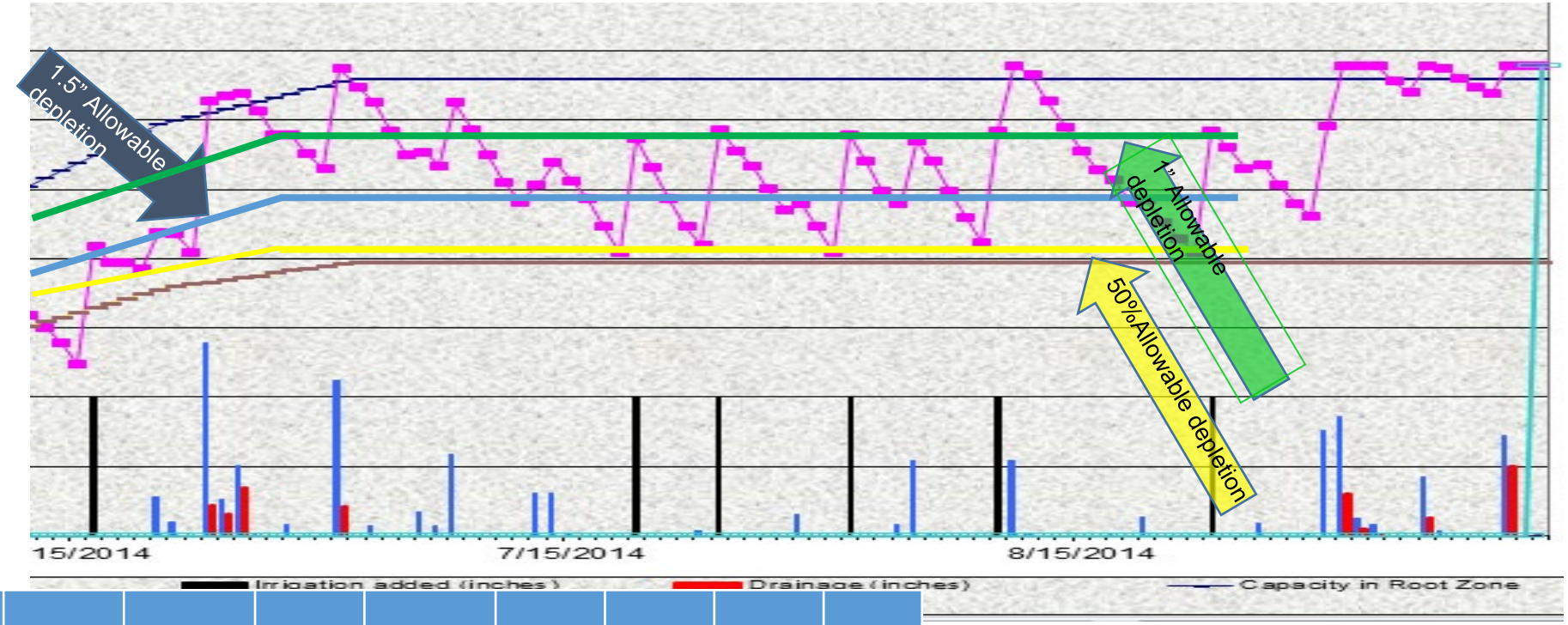
http://www.agweather.geo.msu.edu/mawn/irrigation/

Checkbook Irrigation Scheduling

http://www.agweather.geo.msu.edu/mawn/irrigation/



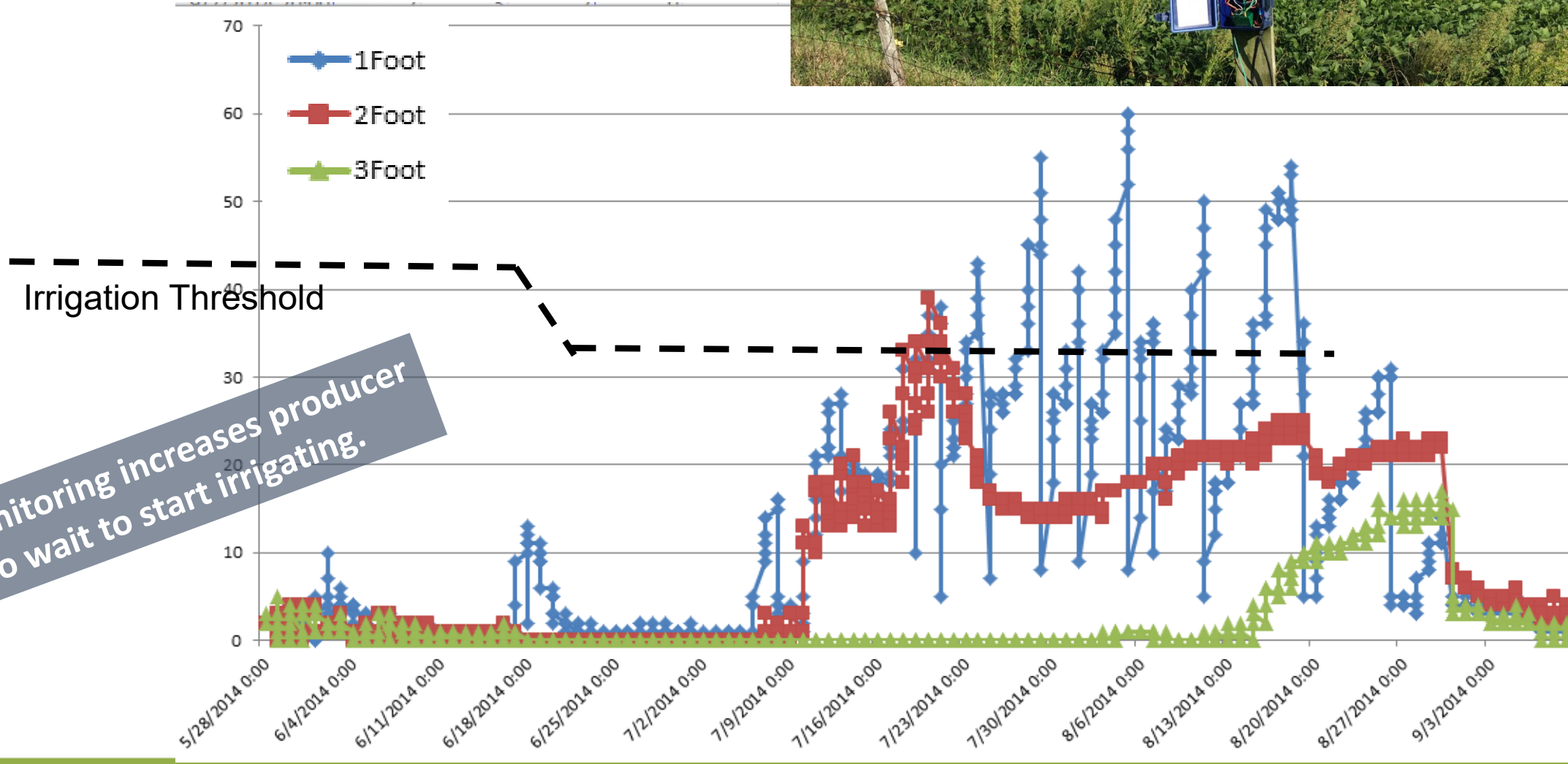
Plant available water 2016 Mendon Corn



	Soil	Kalamazoo	Kalamazoo	Kalamazoo	Oshtemo	Oshtemo	Oshtemo	Spinks	Spinks	Spinks
Year	Practice	50%	1.5"	1"	50%	1.5"	1"	50%	1.5"	1"
2005		1.0	3.0	4.5	1.0	3.0	4.5	3.5	3.5	5.0
2006		0.0	3.0	3.5	0.0	3.0	4.5	2.5	2.5	5.5
2012		10.0	11.5	12.0	10.5	11.5	12.0	12.0	12.0	12.5
2013		6.0	7.5	8.5	6.5	7.0	8.0	8.0	8.0	10.0
2014		1.0	3.0	3.5	2.0	3.0	3.5	3.5	3.5	5.0
2015		2.0	4.5	6.0	4.0	4.5	6.0	4.5	4.5	6.0
2016		5.0	7.0	7.5	6.0	7.0	8.5	7.5	7.5	8.5
Sum	inches	40.0	59.0	68.0	47.0	58.5	69.5	64.5	64.5	78.5
Average	inches	3.64	5.36	6.18	4.27	5.32	6.32	5.86	5.86	7.14

Potential annual water savings = 2”

Watermark Soil Moisture, 2014 Soybean, Constantine, MI



Soil moisture monitoring increases producer confidence to wait to start irrigating.

Soil Moisture Sensors

Soil moisture sensors are tools that indirectly measures the soil moisture content, based either on the force required to pull water out of the soil (tension) or the electrical properties of the soil.

EC-5

Soil Watch 10

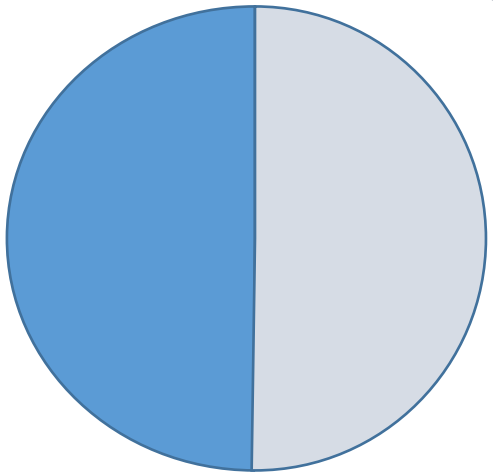
WATERMARK

Teros 12

Variable Rate Irrigation

- **Two different soils with a wide difference in water holding capacity**
- **Two different crops with a difference in E.T.**
- **Pivot speed could speed up to allow a lower application.**

Potential savings of 2” water each time the profile is refilled by rain.



2” x 2 refill rain events x 142 acres / 2 = 284 acre inches

Available water holding capacity

Soil Type / depth	Bronson	Spinks
0”to 6” 0”to 6”	.84” .84”	.54” .54”
6”to 12” 0”to 12”	.86” 1.70”	.54” 1.08”
12’ to 18” 0”to 18”	.90” 2.60”	.54” 1.62”
18” to 24” 0” to 24”	.90” 3.50”	.54” 2.16”
24” to 30” 0” to 30”	.58” 4.08”	.42” 2.58”
30” to 36” 0”to 36”	.34” 5.42”	.36” 2.94”

Irrigation Conservation Practices
(adapted from Steve Davis & Josh Crandel)

- Irrigation System – Sprinkler (442)
  - *Physical system*
- Irrigation Water Management (449)
  - *Management of system*

Note Basic eligibility requirement for any EQIP irrigation financial assistance:

Land under contract must have been irrigated at least 2 out of the last 5 years.

Adapted from Josh Crandel, NRCS Irrigation Specialist

Scope of NRCS irrigation related Equip

- In 2021 NRCS had 4800 acres planned in contracts for 442 and 449 combined state wide. With practices ranging from less than an acre to 100+ acre fields.

- In 2021 NRCS had $40 million of applications submitted and funded about $18.5 million.

Adapted from Josh Crandel, NRCS Irrigation Specialist

Irrigation System – Sprinkler (442)

Replace sprinkler packages and install pressure regulators on existing Center Pivot irrigation system or existing Linear-Move irrigation system.

5-6$ / linear feet of lateral pipe (pipe where nozzles are attached)

Scenario 1 – Conditions

- Coefficient of Uniformity (CU) for retrofitted system must be greater than or equal to 85%.
- Only eligible for existing Center Pivot or existing Linear-Move system with **CU less than 85% OR nozzles that are at least 8 years old**. (Existing CU documented by in-field system evaluation.)
- Flow measurement with flow meter required for retrofit design.
- Post-retrofit CU ≥ 85% documented by in-field system evaluation, Center Pivot Evaluation and Design (CPED), or manufacturer computer model.
- Only eligible with Irrigation Water Management (contract or conservation plan).

Adapted from Josh Crandel, NRCS Irrigation Specialist

Irrigation Water Management (449)

Payment Rate determined by level of management and size of field.

Can be used with any type of irrigation system

Checkbook Irrigation Scheduling

Basic (19$ +- / acre)

Checkbook Method Irrigation Scheduling

Record rainfall, irrigation amounts, and soil moisture

Intermediate (23$ +- / acre)

Basic + using a computer irrigation scheduler

Advanced (39$ +- / acre)

Computer Scheduler with automatic sensors etc.

Soil Moisture Monitor

- Soil Moisture Monitoring system, $1500-3000 in first of three years

Adapted from Josh Crandle, NRCS Irrigation Specialist

•Farm Energy Implementation Funding:

Rural Energy for America Program (REAP) Renewable Energy Systems & Energy Efficiency Improvement Guaranteed Loans & Grants in Michigan. - –

https://www.youtube.com/watch?v=9fPGRj6h8xk&list=PL7q-KXKNksL-o5ayQ5NArDstzIrspJH5&index=3

- **USDA-Rural Development (9006) Program**

  Rick Vandebeek, Renewable Energy Coordinator
  Rural Development-Rural Business/Cooperative Service rick.vanderbeek@mi.usda.gov
  U.S. Dept. of Agriculture, Suite 200 (517) 3245218
  3001 Coolidge, Suite 200
  East Lansing, MI 48823

- **USDA-Conservation Security Program (CSP)**

  Kim Wieber, CSP Coordinator
  Natural Resources Conservation Service kim.wieber@mi.usda.gov
  U.S. Dept. of Agriculture, Suite 250 (517) 3245276
  3001 Coolidge Road
  East Lansing, MI 48823-6349

Energy Efficiency

- Michigan Department of Environment, Great Lakes, and Energy (EGLE)
  Jacob Wilkinson
  Email: Wilkinsonj8@michigan.gov
  Phone: 517-290-7995

- Michigan Utilities (Consumers Energy, DTE, Electric Coops, Municipal Utilities)
  Provide energy efficiency (Waste Reduction) rebates. Consumers and DTE have an agricultural program to work with farmers.

Energy Audit on Your Farm? - https://www.youtube.com/watch?v=yp3apNcdi-I