Irrigation Research Update

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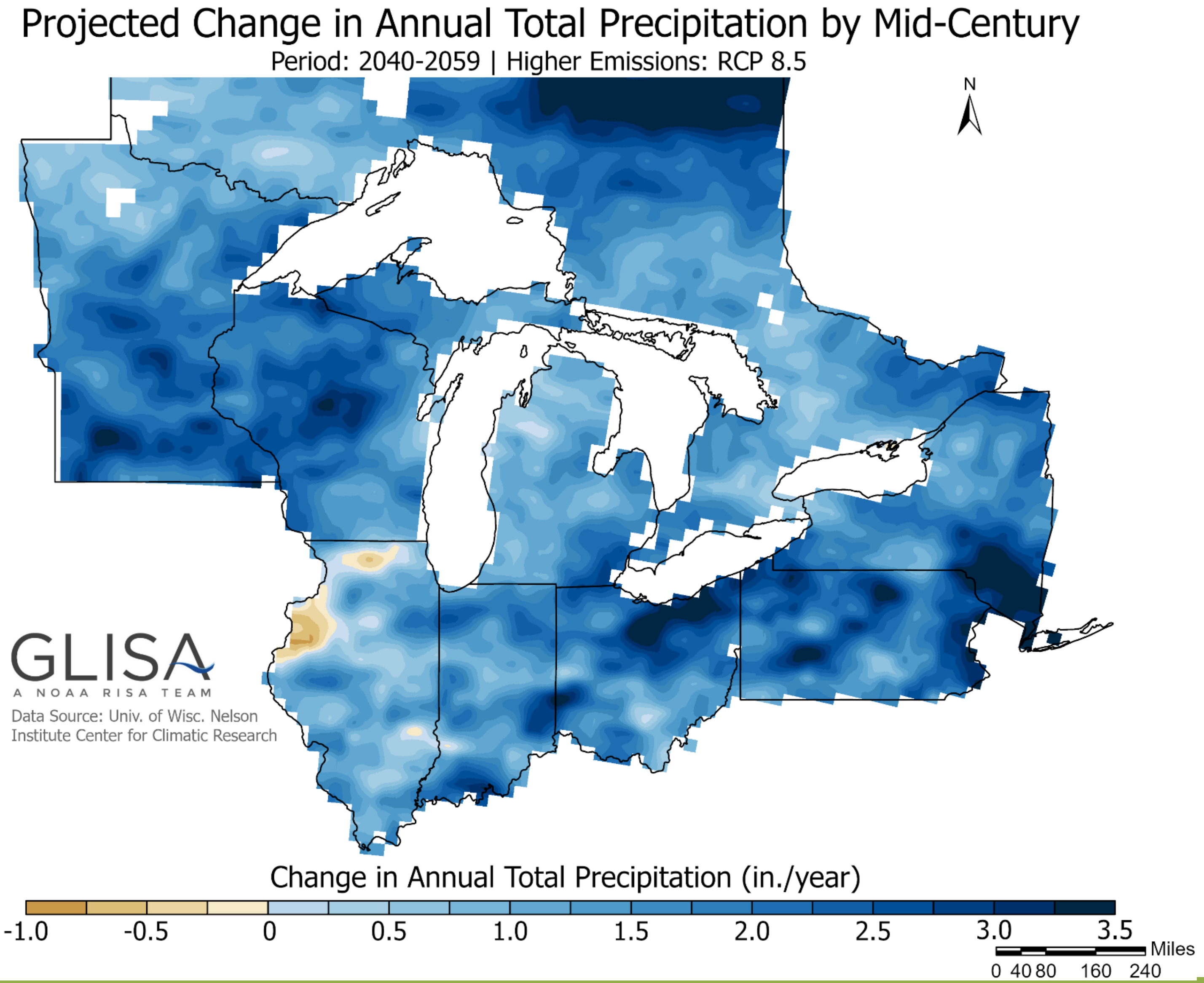
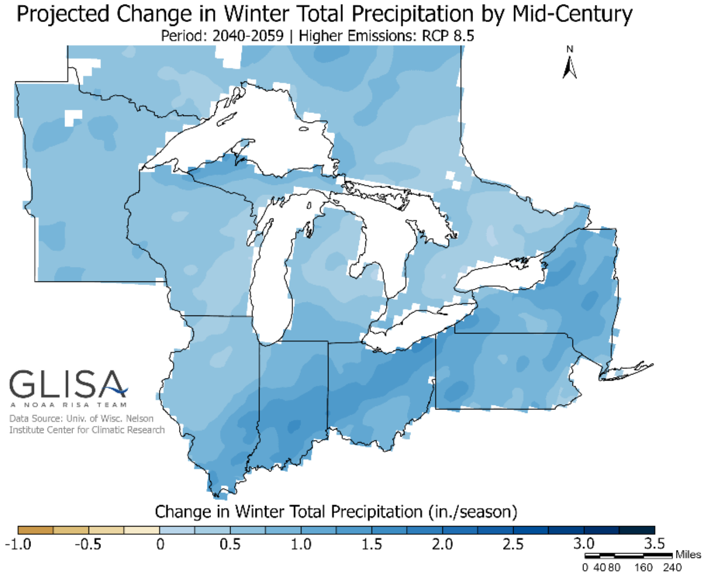
Michigan State University Extension

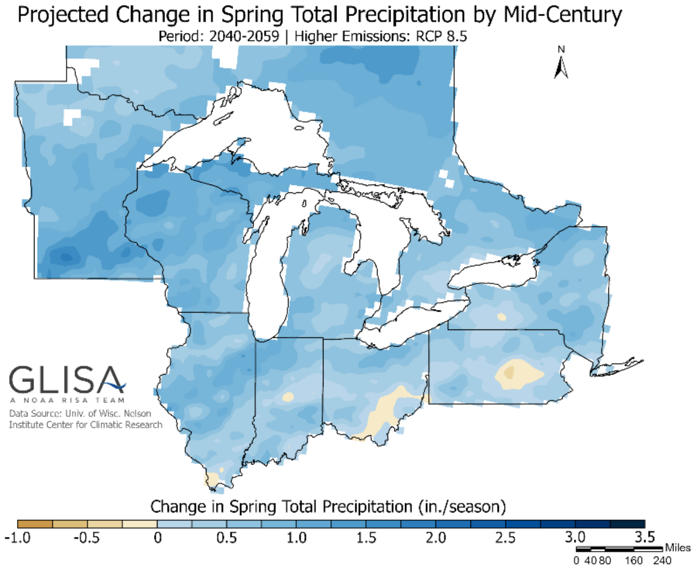
Michiana Irrigated Corn and Soybean Workshop
Feb. 26, 2024

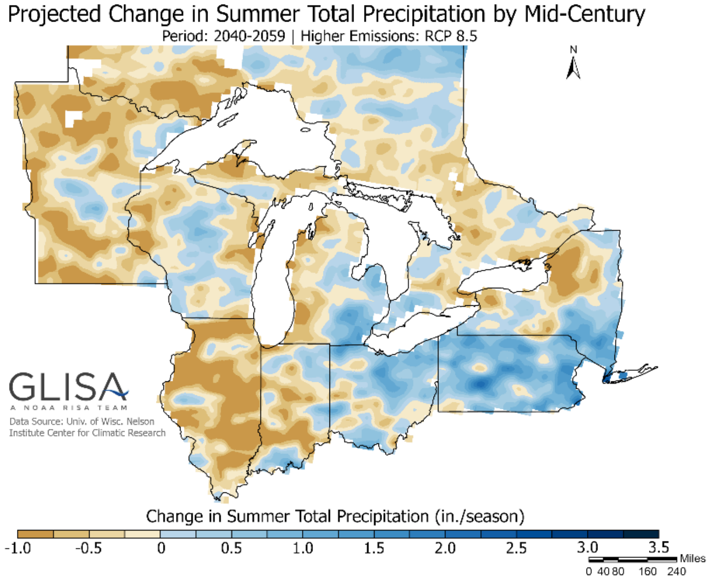
Impacts of Climate Change on Water Management in Agriculture

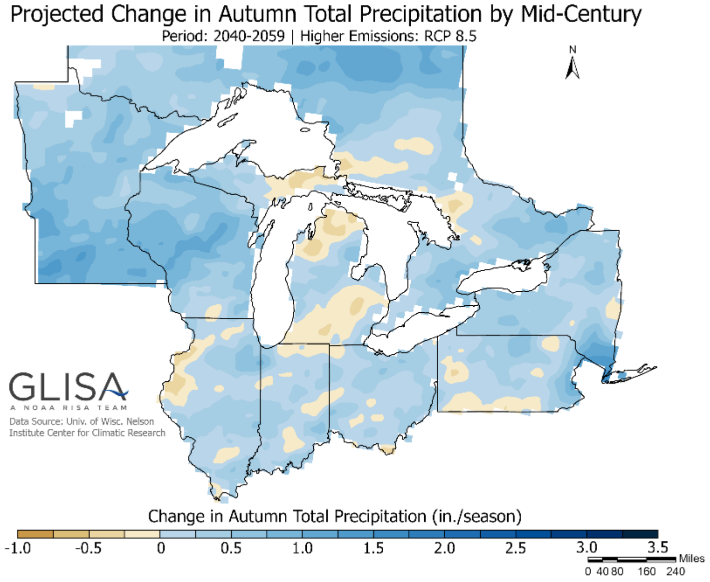


Impacts of Climate Change on Water Management in Agriculture

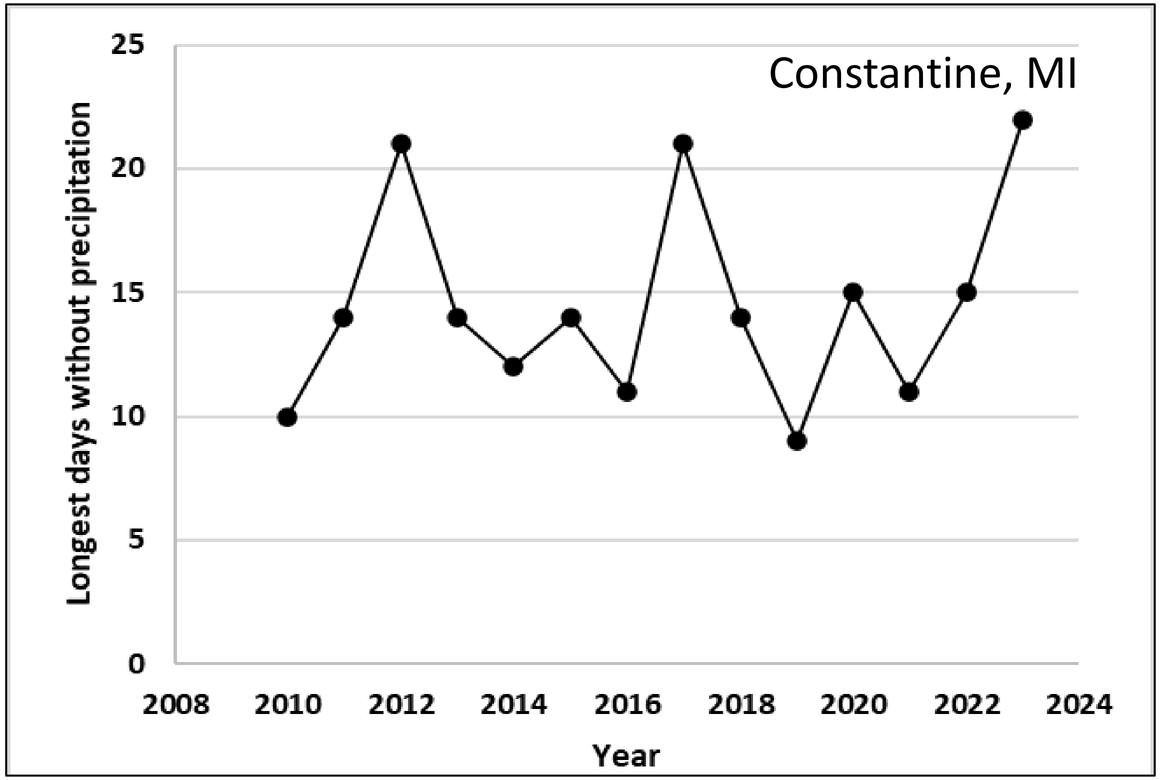


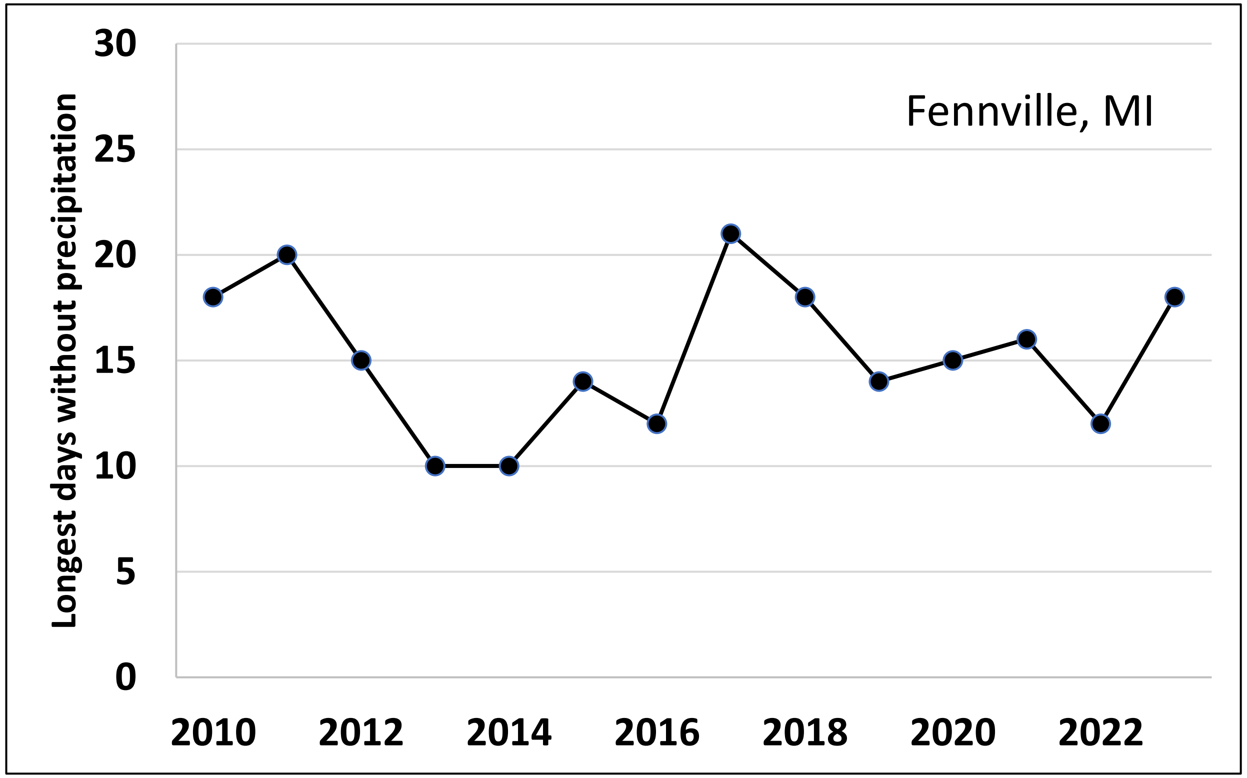






Impacts of Climate Change on Water Management in Agriculture





Longest period without precipitation during the growing season (May - September).
Most seasons require irrigation to prevent yield loss.

USDA Hydrological Soil Map - Michigan

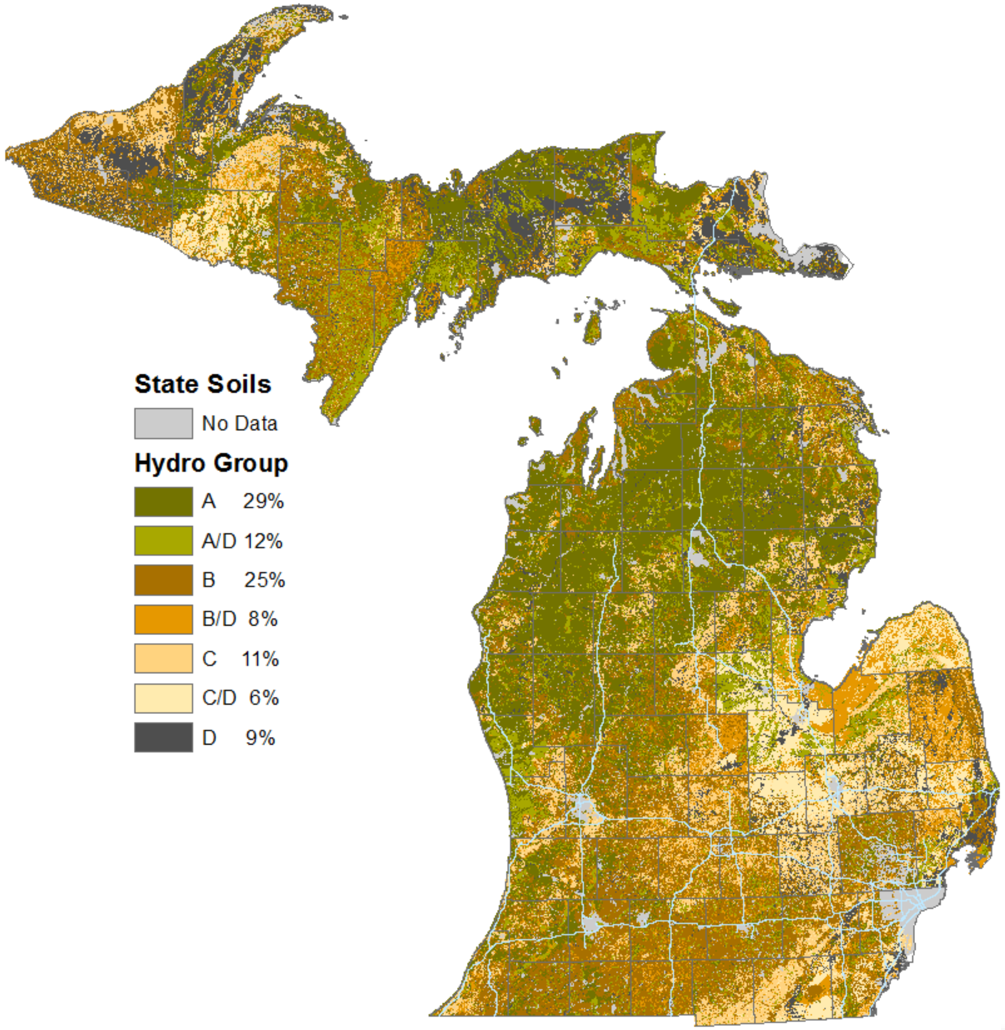
Natural Resources Conservation Service (NRCS) classified soils based on texture and water table depth into Hydrologic Soil Groups.

Example Texture of Each Soil Group

A: Sands or gravel
B: Sandy loam, loam, silt loam, and silt
C: Clay loam
D: Clay

Group A/D, B/D, C/D

Soils classified as A/D, B/D and C/D have a high water table, which means low ability to move the water out of the root zone. If it is drained, it is considered as the first letter.



Hydrological Soil Map - Indiana

Natural Resources Conservation Service (NRCS) classified soils based on texture and water table depth into Hydrologic Soil Groups.

Example Texture of Each Soil Group

A: Sands or gravel

B: Sandy loam, loam, silt loam, and silt

C: Clay loam

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Group A/D, B/D, C/D

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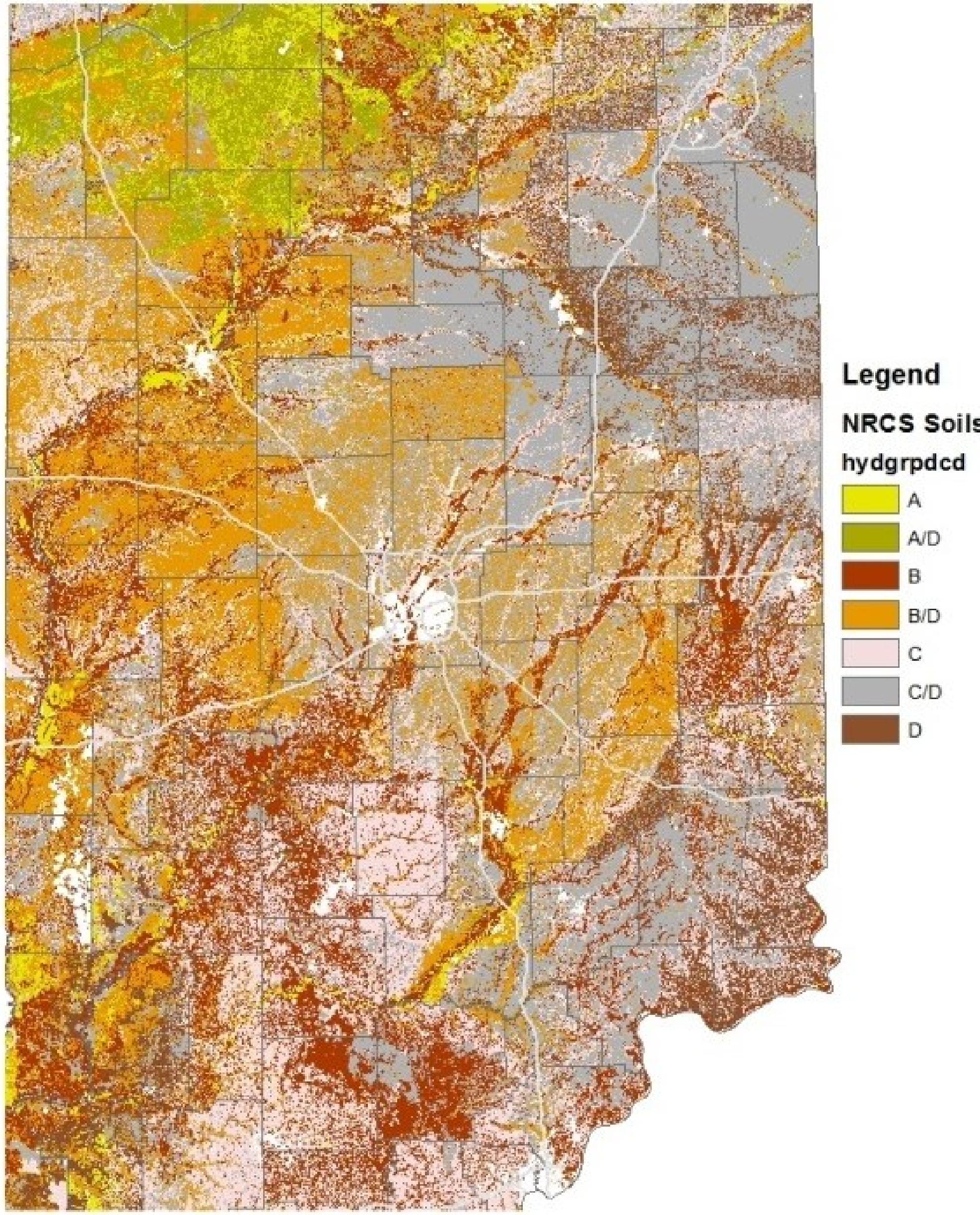
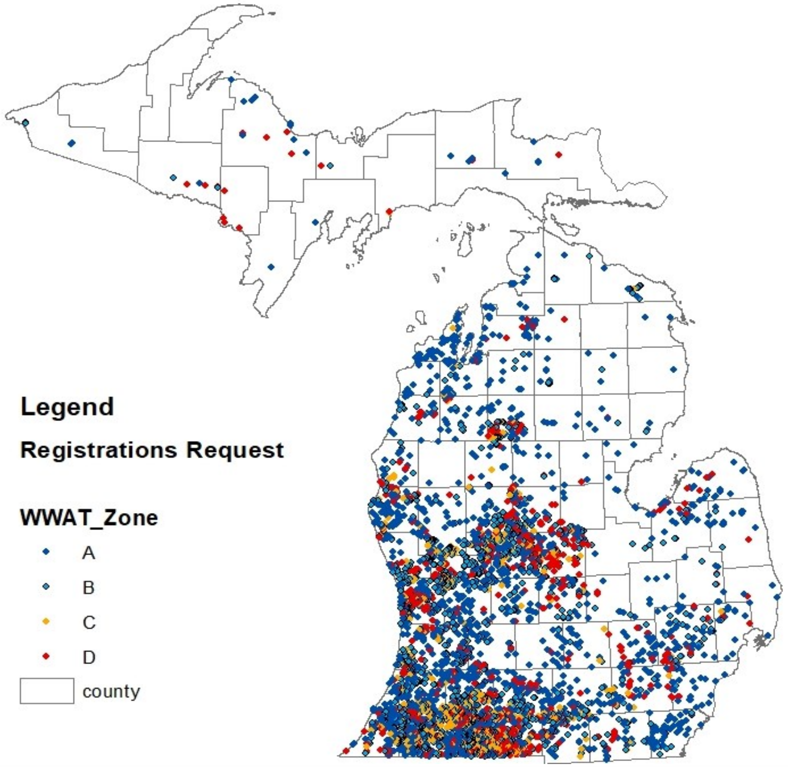


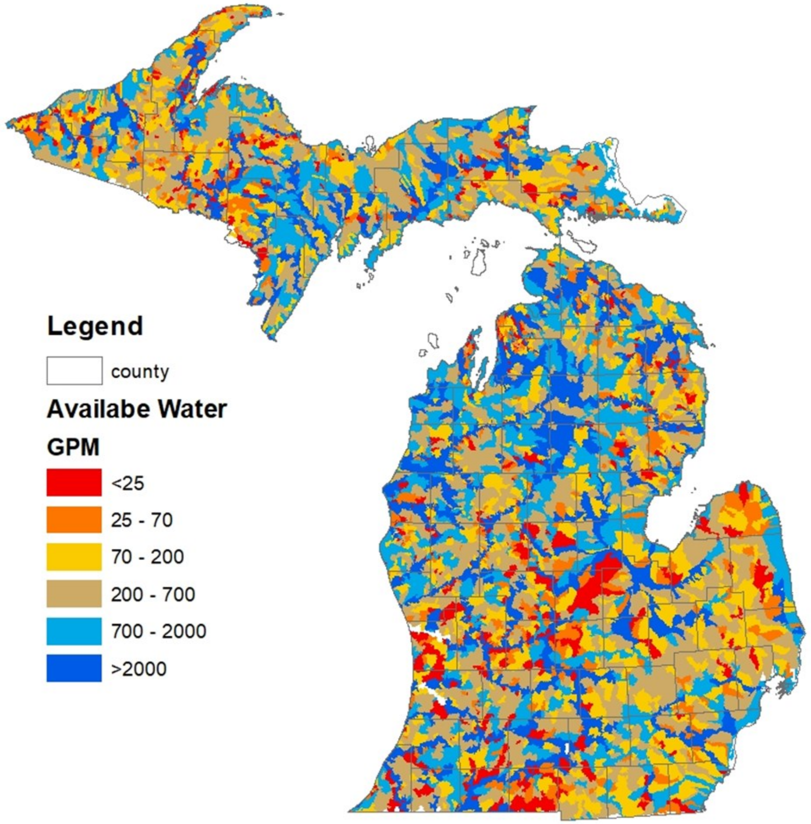

UNCHARTED WATERS

America Is Using Up Its Groundwater Like There's No Tomorrow

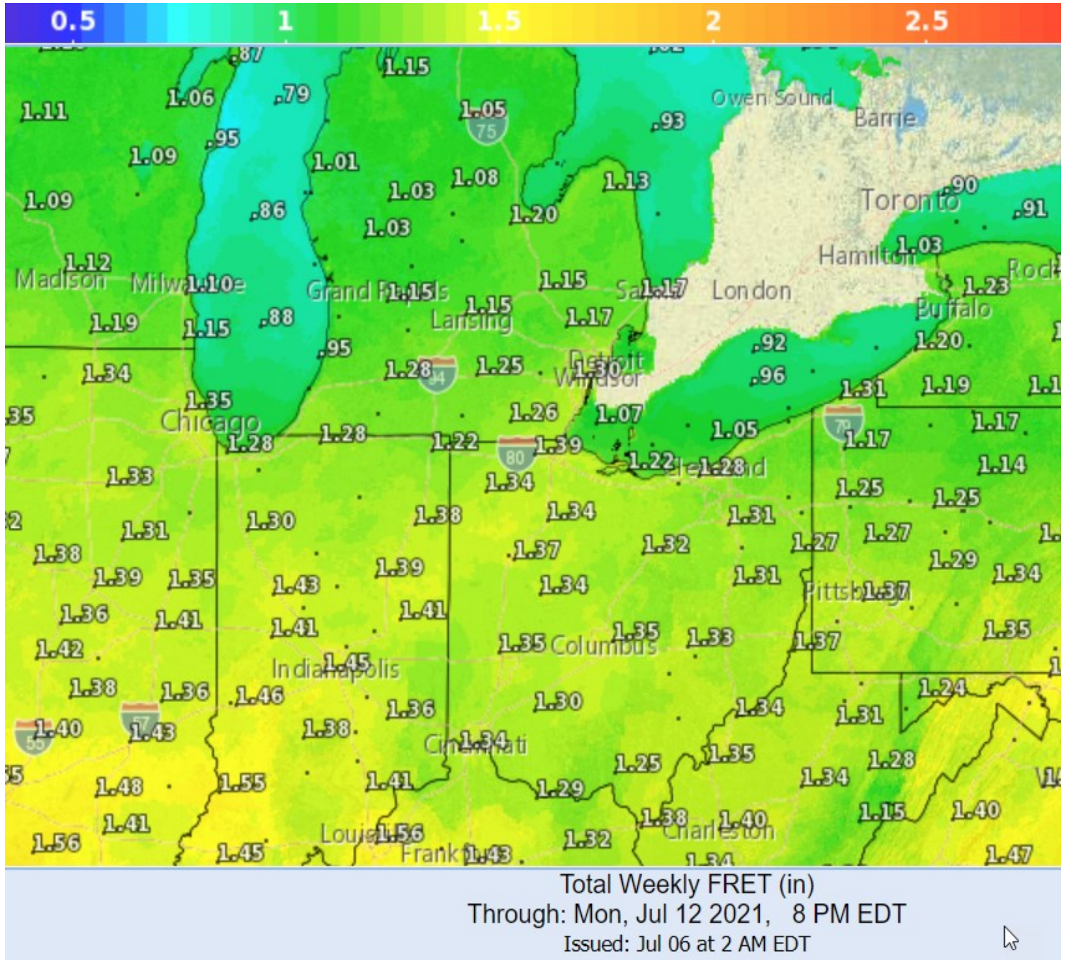
Overuse is draining and damaging aquifers nationwide, a New York Times data investigation revealed.

Registration request (using data Available November 2021)





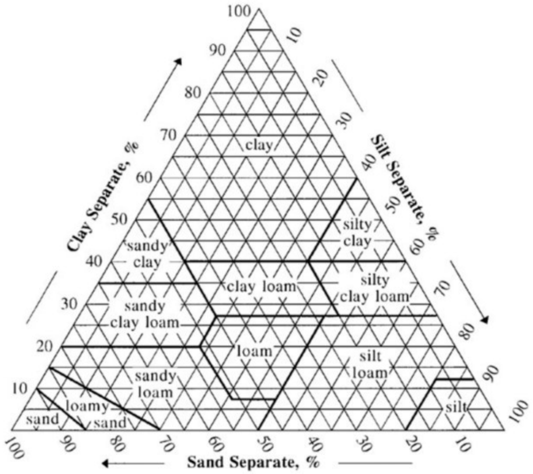
Irrigation Scheduling



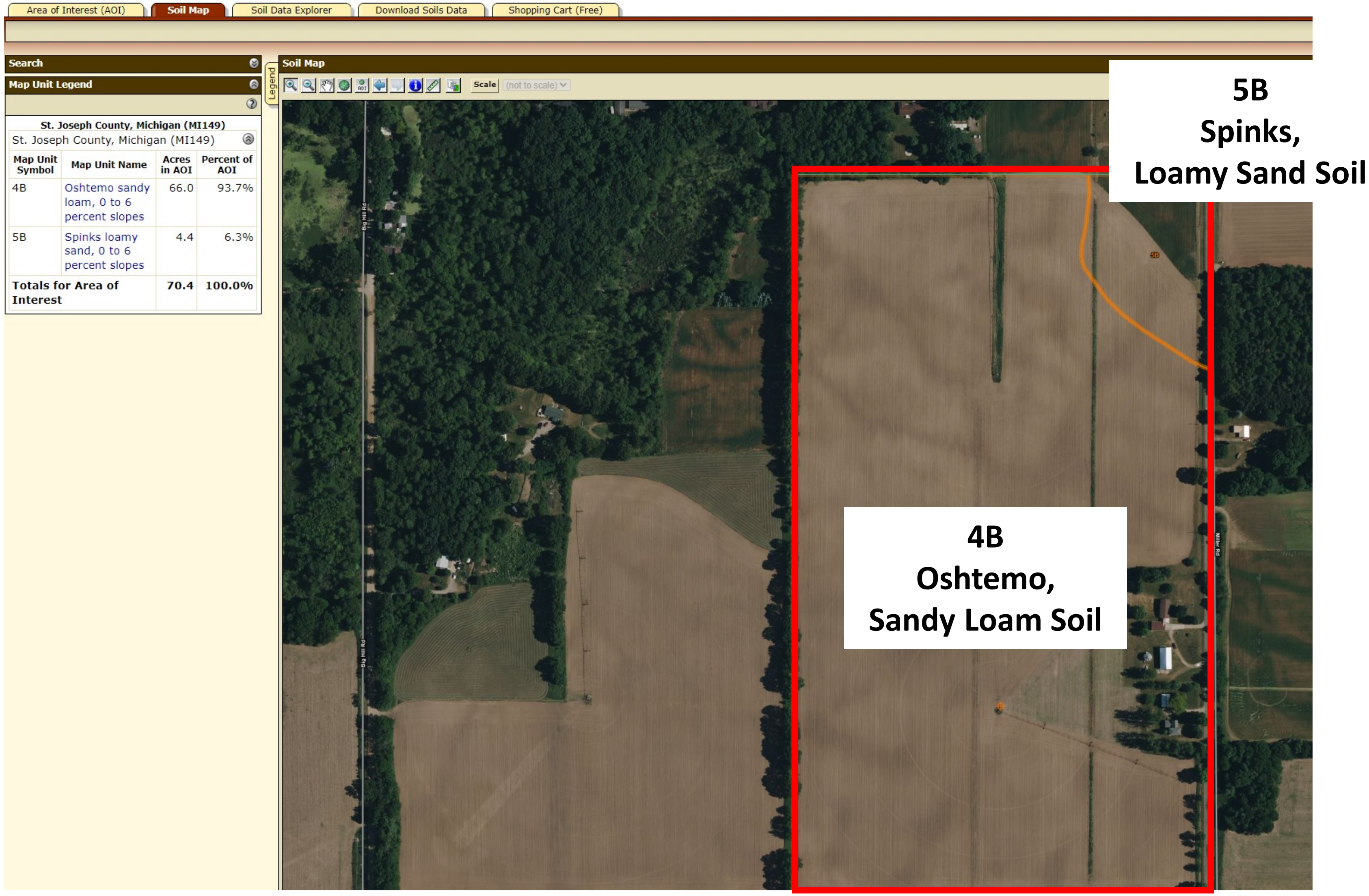
Weather-based Irrigation Scheduling

Sensor-based Irrigation Scheduling

Water Holding Capacity - Soil Sampling

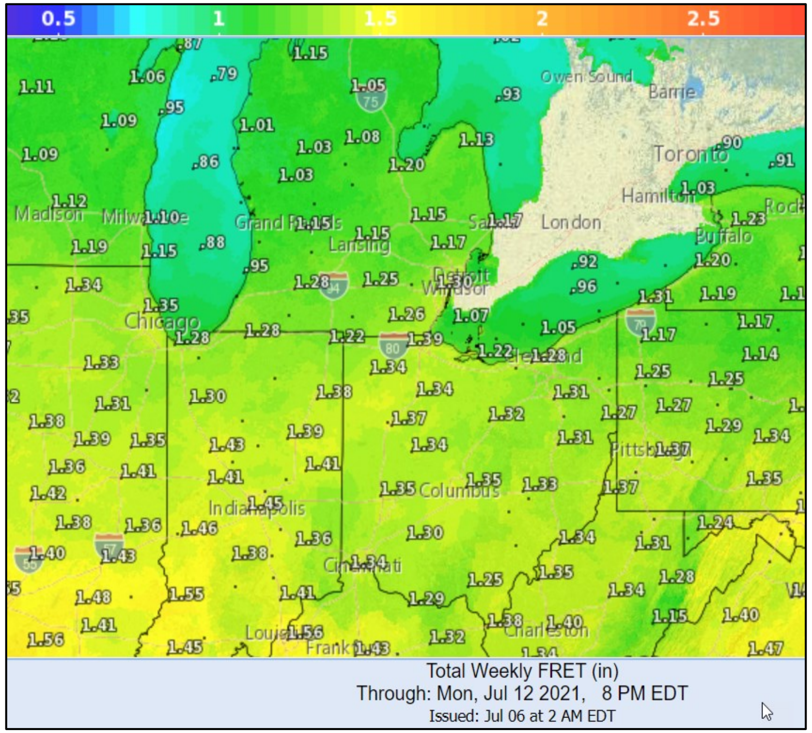


Water Holding Capacity - USDA Web Soil Survey



Current Irrigation Management Practices

Weather-based Irrigation Scheduling



$$ET_C = K_C * rPET$$

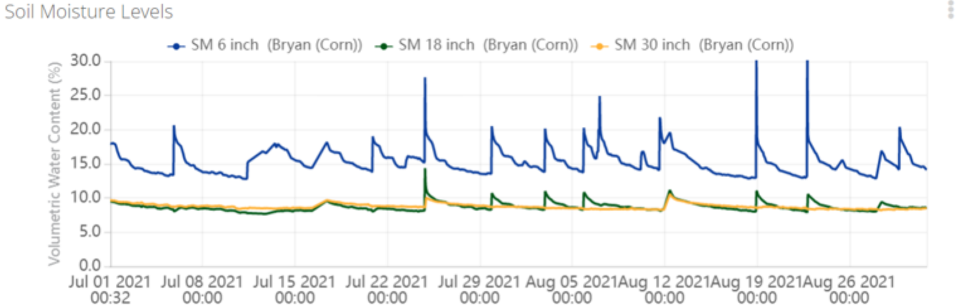
Where,

ET_C = Actual Crop Evapotranspiration (in/day)

K_C = Crop Coefficient (unitless multiplier)

$rPET$ = Reference Potential Evapotranspiration (in/day)

Sensor-based Irrigation Scheduling



Weather-based Irrigation Scheduling - Crop Evapotranspiration

$$ET_C = rPET * K_C$$

Where,

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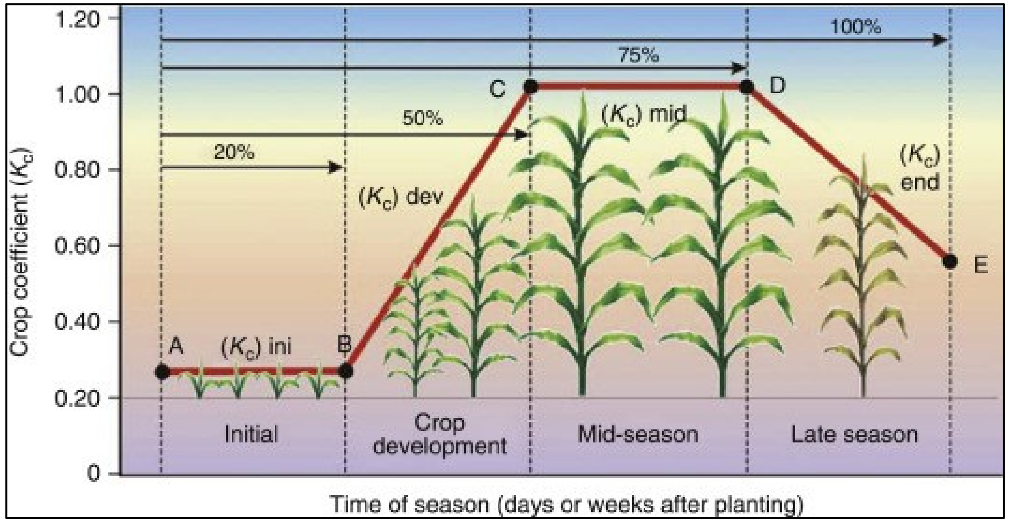
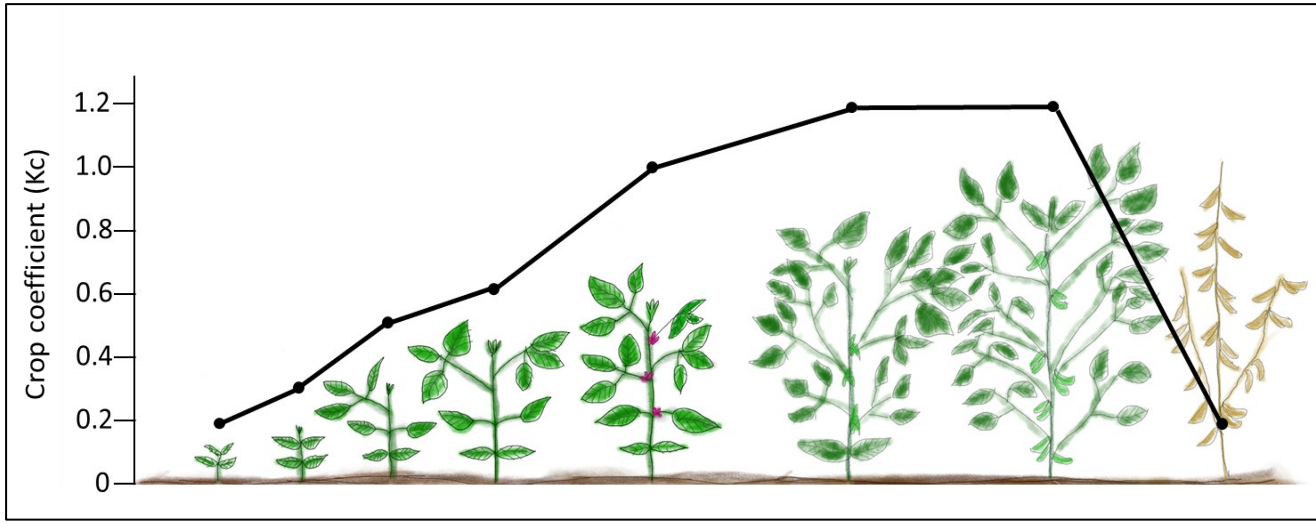
$rPET$ = Reference Potential Evapotranspiration (in/day)

K_C = Crop Coefficient (unitless multiplier)



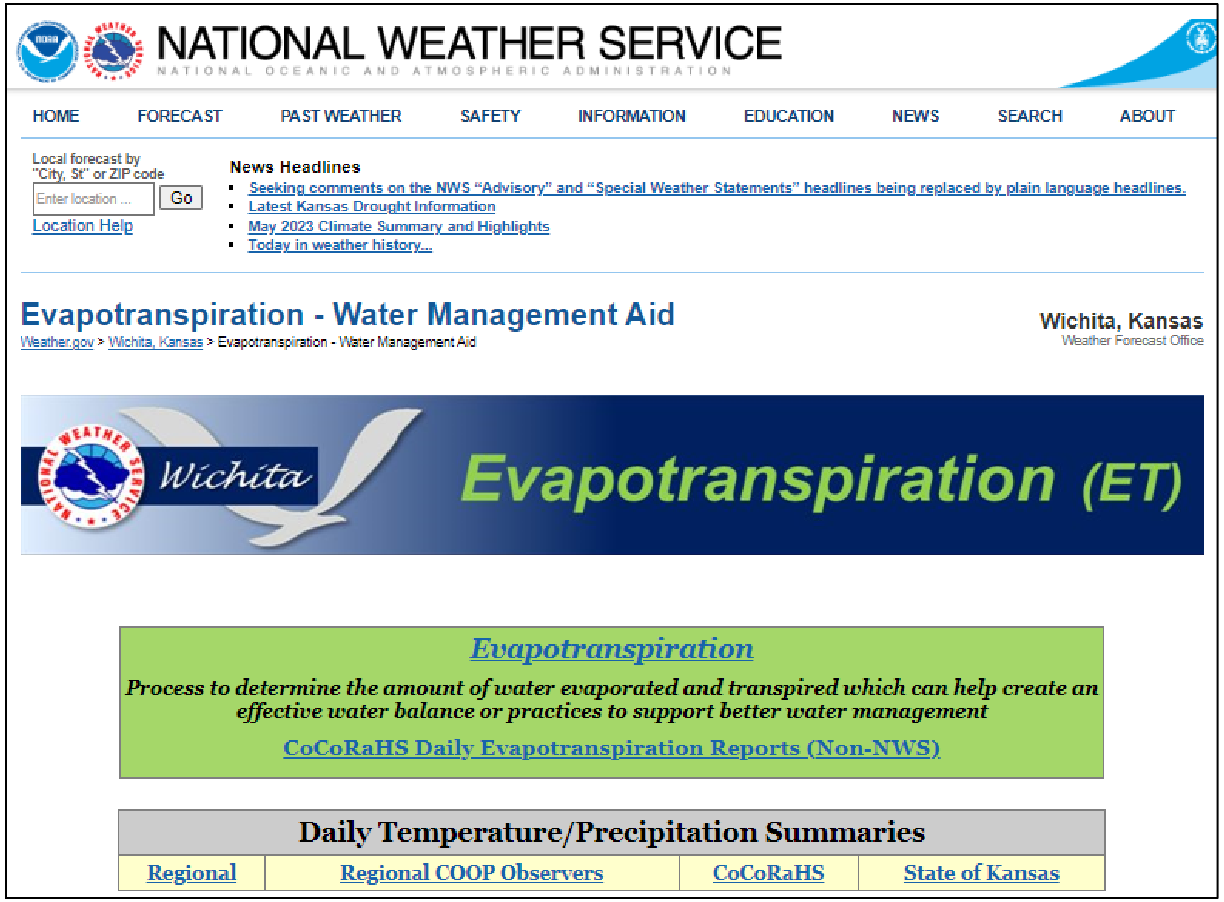
Corn Kc (Pokorny, 2019)

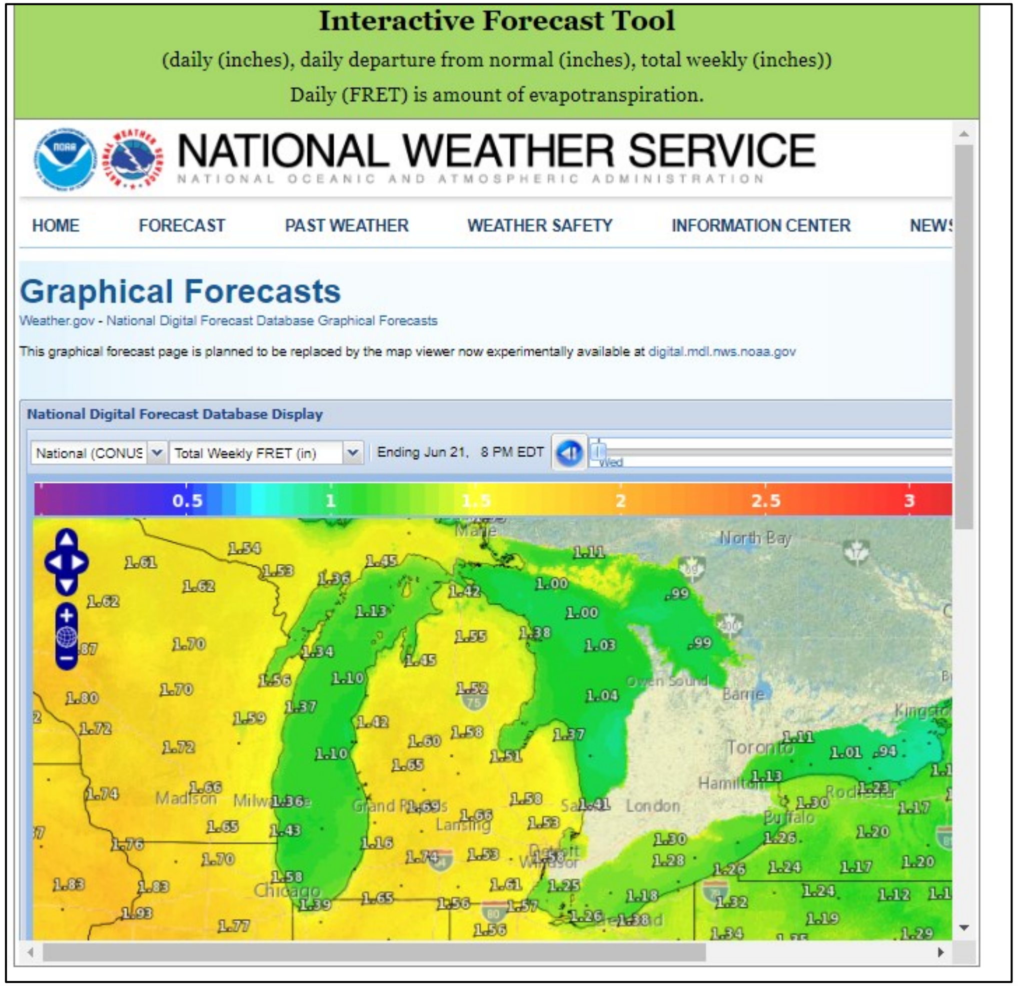


Soybean Kc

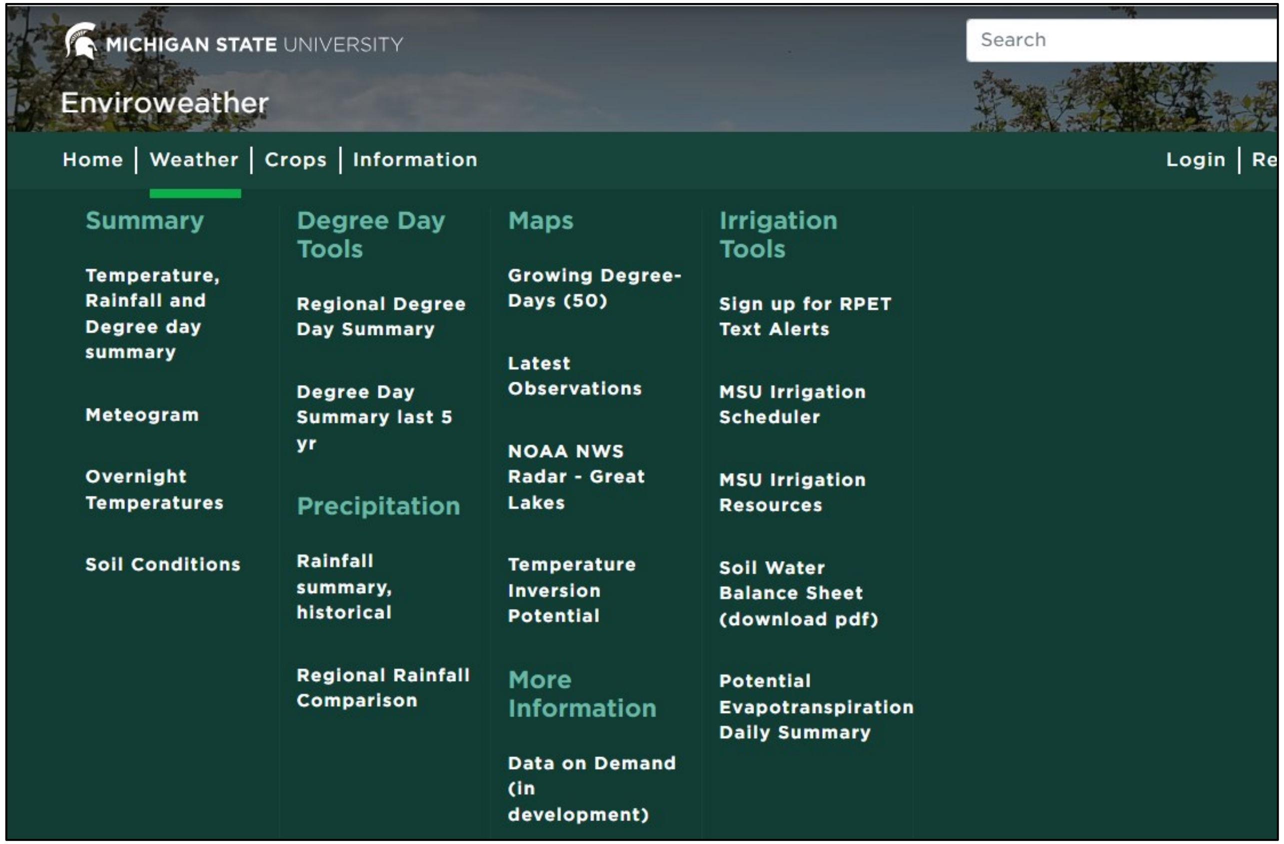
Reference Potential Evapotranspiration

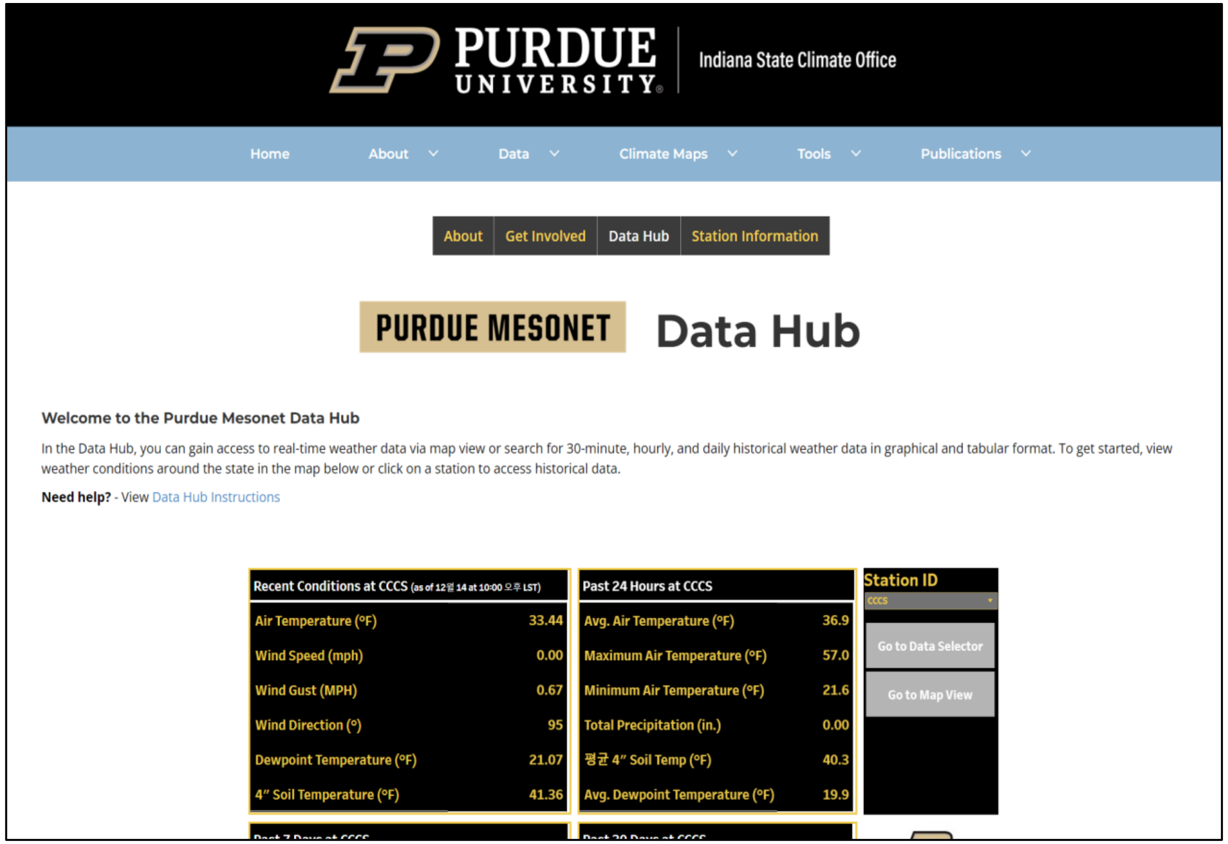
https://www.weather.gov/ict/Evapotranspiration





Reference Potential Evapotranspiration

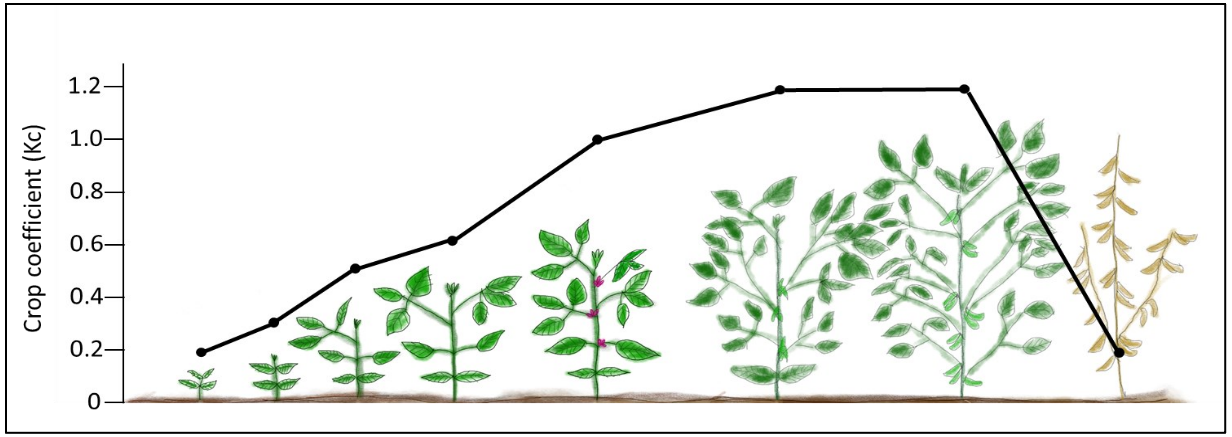




MSU Enviroweather Program

$$ET_C = K_C * rPET$$

$$ET_C = \boxed{1.1} * \boxed{0.83\ in} = 0.91\ in$$



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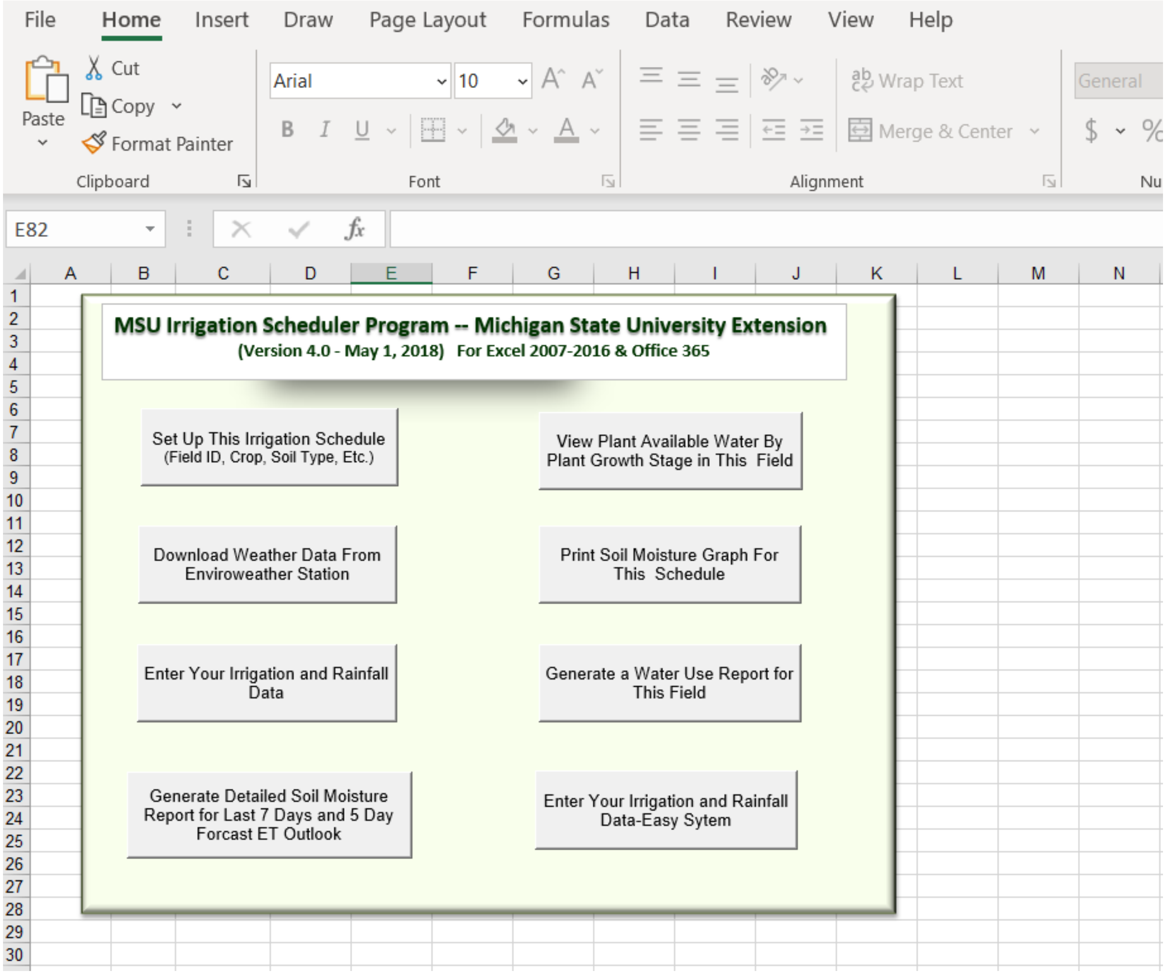
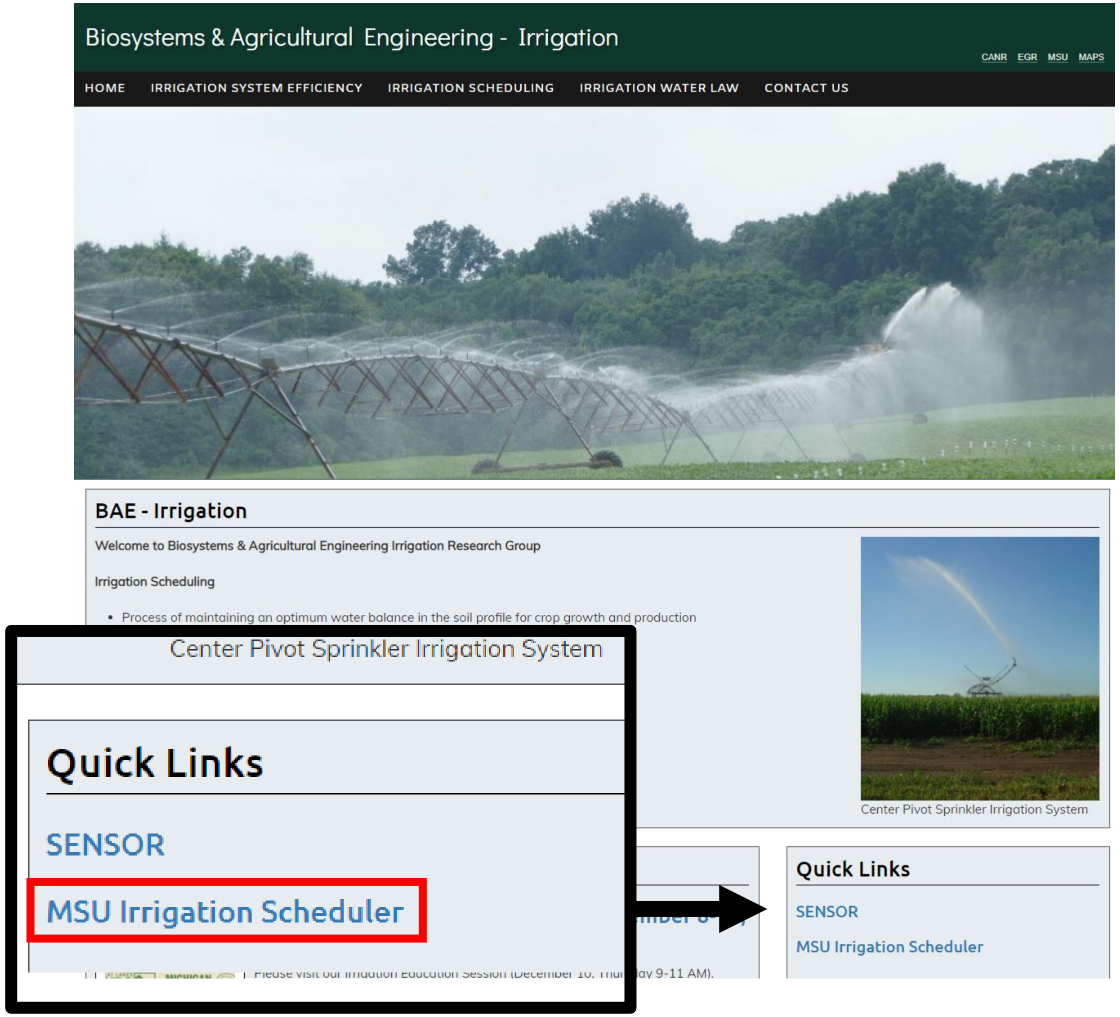
https://www.egr.msu.edu/bae/water/irrigation/

MSU Irrigation Scheduler Program

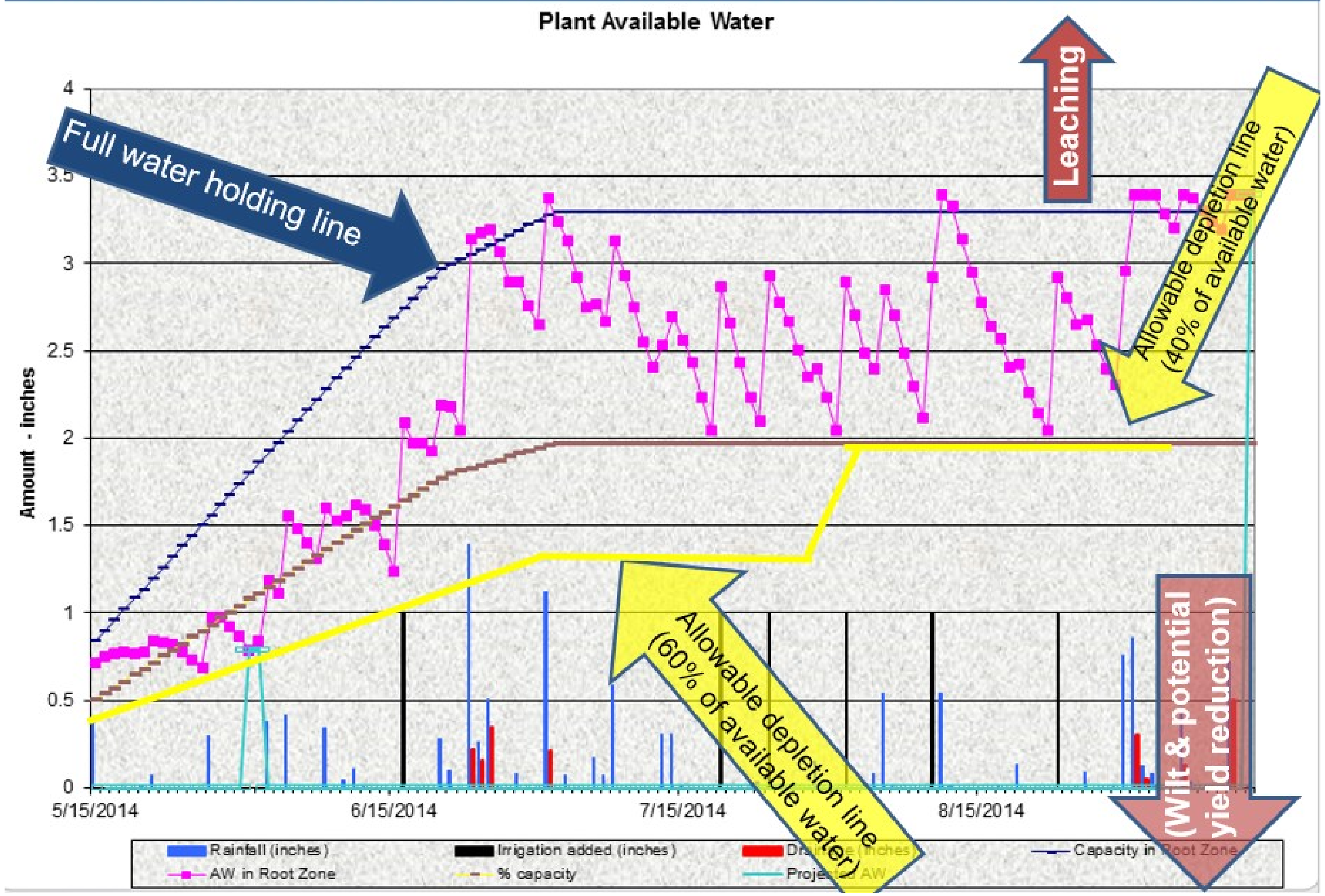




www.egr.msu.edu/bae/water/irrigation

MSU Irrigation Scheduler Program

MSU Excel Irrigation Schedule Checkbook Method - Mendon 2014

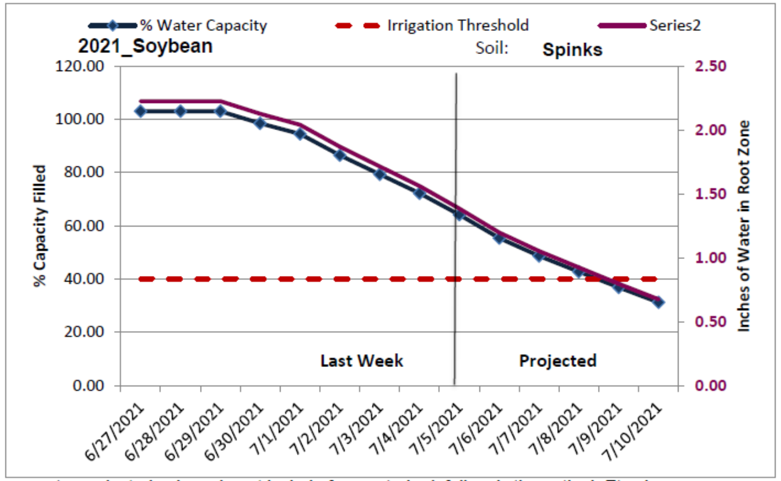


St. Joseph County Soil and Water Conservation District Irrigation Scheduling Service
Weekly Water Balance Report and Et Outlook for Next 5 Days

Generated: 07/06/21 MSU Irrigation Scheduler

Field Name: 2021_Soybean
Crop: Soybeans24
Emergence Date: 5/16/2021

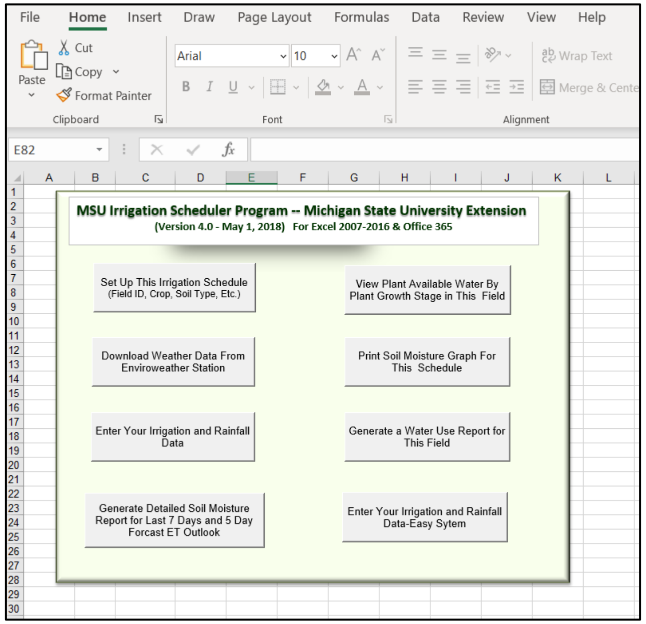
Date	Rainfall	Irrigation	Crop Et	Forecasted Et	Drainage	AW Above Threshold	Additional Capacity
6/27/2021	0.16		0.06		0.02	1.30	0.00
6/28/2021	0.32		0.11		0.21	1.30	0.00
6/29/2021	1.18		0.11		1.07	1.30	0.00
6/30/2021	0.02		0.12		0.00	1.26	0.03
7/1/2021	0		0.09		0.00	1.18	0.12
7/2/2021	0		0.17		0.00	1.00	0.29
7/3/2021	0		0.15		0.00	0.85	0.45
7/4/2021	0		0.15		0.00	0.70	0.60
7/5/2021	0		0.18		0.00	0.52	0.77
7/6/2021			0.1888		0.00	0.33	0.96
7/7/2021				0.15	0.00	0.19	1.11
7/8/2021				0.13	0.00	0.06	1.24
7/9/2021				0.13	0.00	-0.07	1.36
7/10/2021				0.12	0.00	-0.19	1.49
Totals	1.68	0	1.14	0.52	1.30		



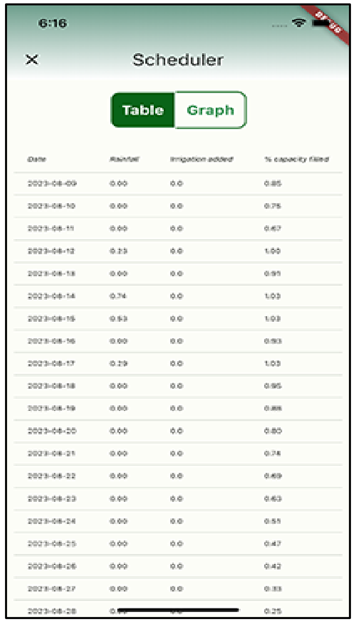
Please note: projected values do not include forecasted rainfall, only the outlook Et values.
Irrigation Threshold: Dropping below this level may cause yield loss. To avoid, initiate irrigation.
Enviroweather Station Selected: Constantine

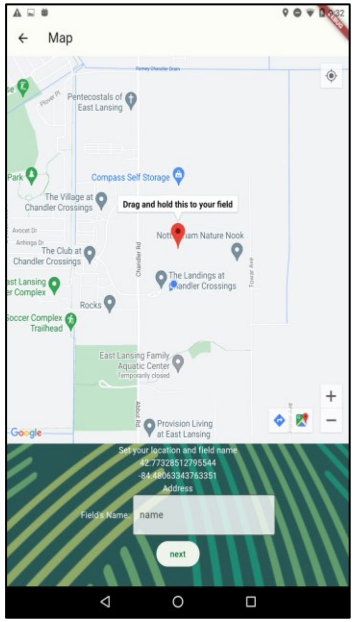
Updating MSU Irrigation Scheduler – (In-progress)

Excel-based MSU Irrigation Scheduler

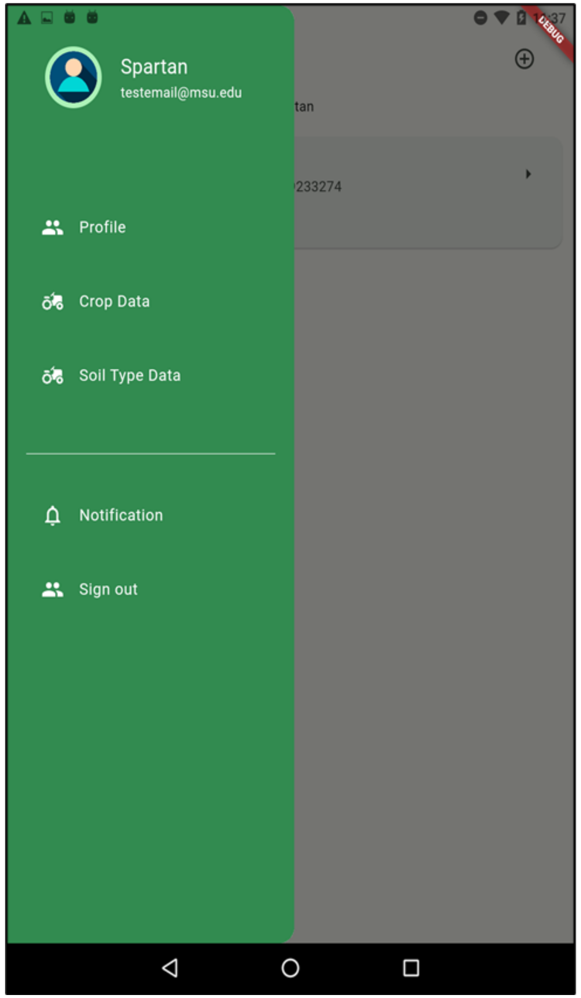


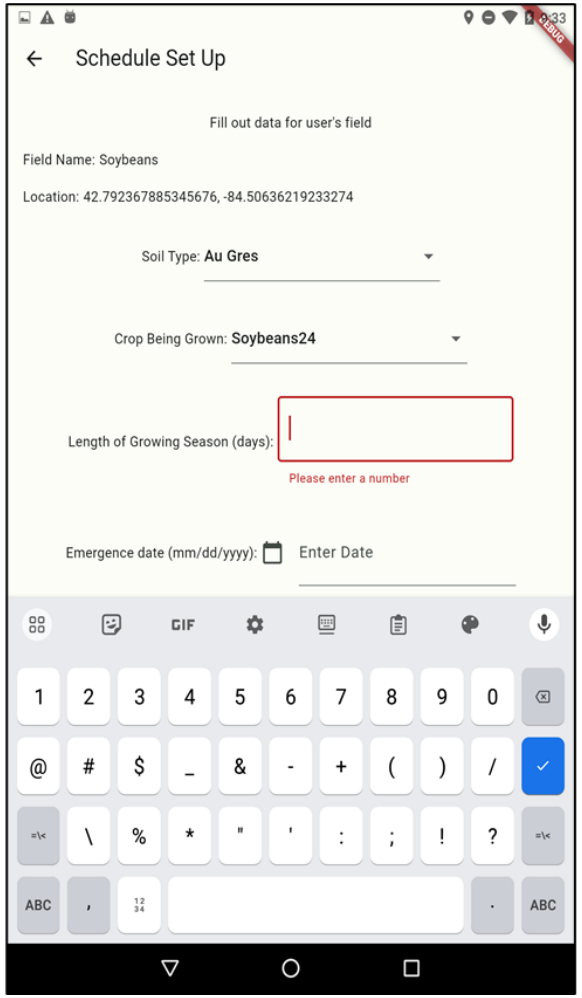
Mobile App-based MSU Irrigation Scheduler

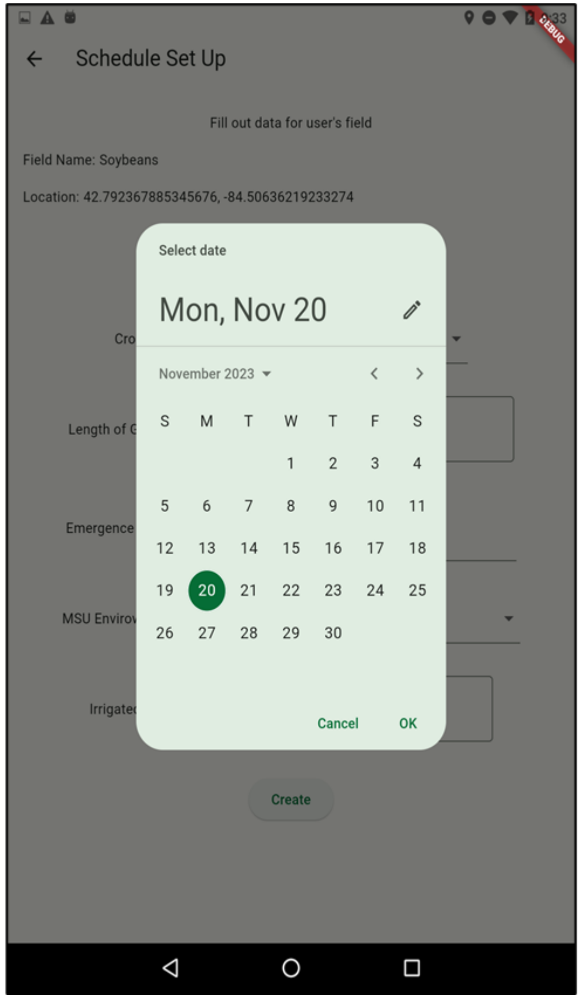


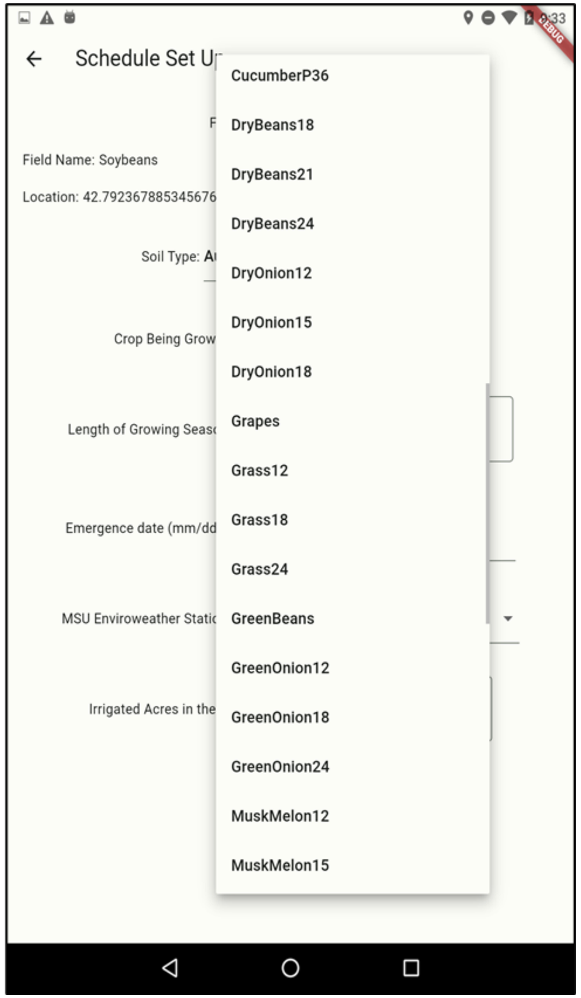


MSU Irrigation Scheduling Mobile App (In-progress)





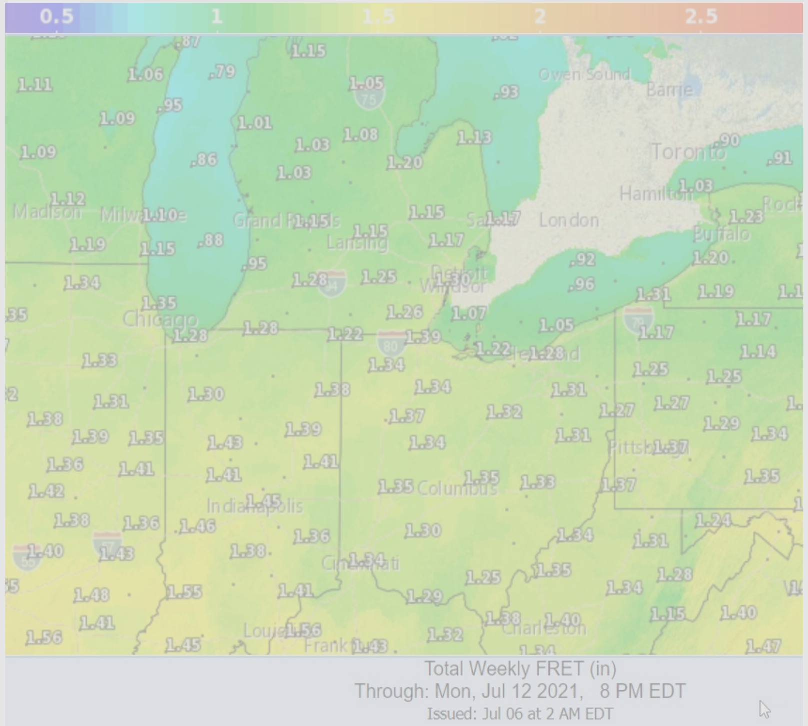




If you are interested in trying Beta version, please leave a note it in the survey.

Current Irrigation Management Practices

Weather-based Irrigation Scheduling



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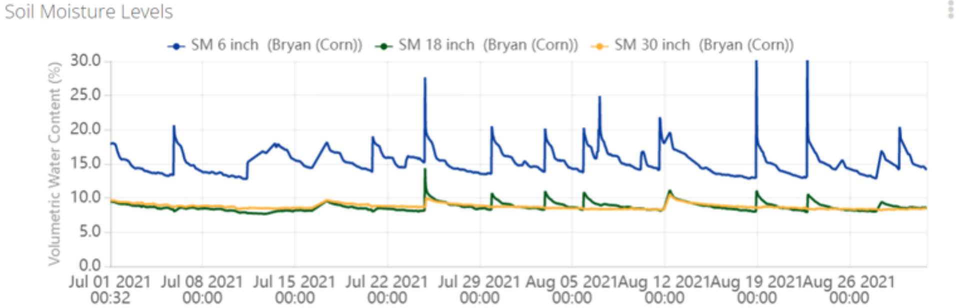
Sensor-based Irrigation Scheduling



Soil Moisture Sensor-based Irrigation Scheduling Method


EC-5


Soil Watch 10


SoilVUE10

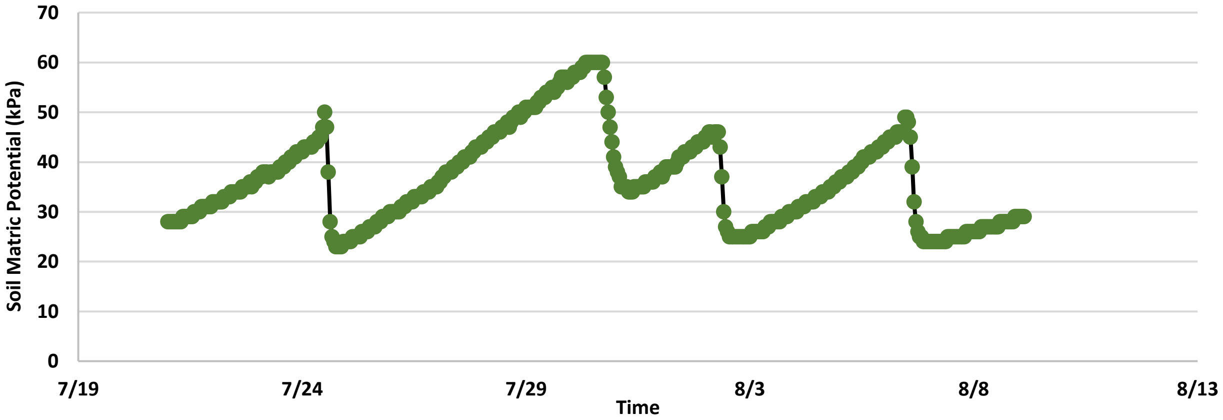

10HS


Teros 12


WATERMARK

Soil Tension – WATERMARK Sensor

Measures the actual soil water tension, which indicates the effort required by root system to extract water from the soil.



Soil Matric Potential for 30%, 50%, and 70% of soil water depletion for different soil types (Irmak et al., 2014)

Soil texture	Depletion in water holding capacity (kPa)		
	30%	50%	70%
Sand	20	30	60
Loamy sand	25	40	67
Sandy loam	28	50	80
Silt loam	80	150	250

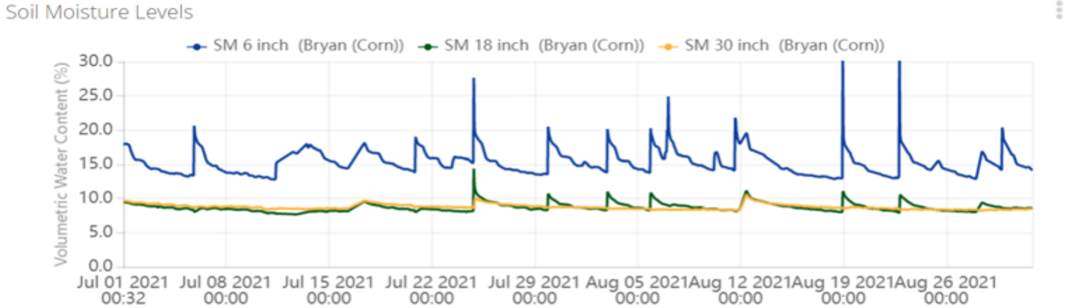
Frequency Domain Reflectometry – Volumetric Water Content

Frequency Domain Reflectometry (FDR) sensors measure soil water content using the dielectric properties of soil which are highly dependent on moisture content.

Material	Dielectric permittivity
Air	1
Soil Minearls	3~7
Organic Matter	2~5
Ice	5
Water	80

Recommended irrigation trigger point for different soil types

Soil Texture	Trigger Point Range (Irrigate when VWC falls below these values)
Sand	7 - 8 %
Loamy Sand	8 -10 %
Sandy Loam	12 - 15 %
Loam	20 - 26 %



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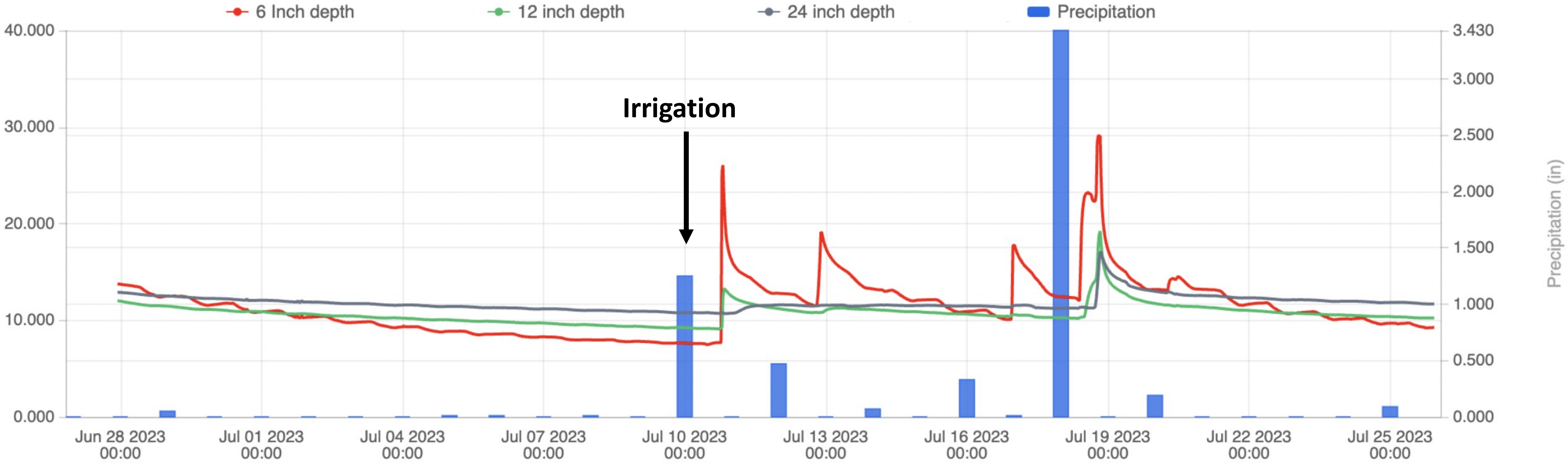
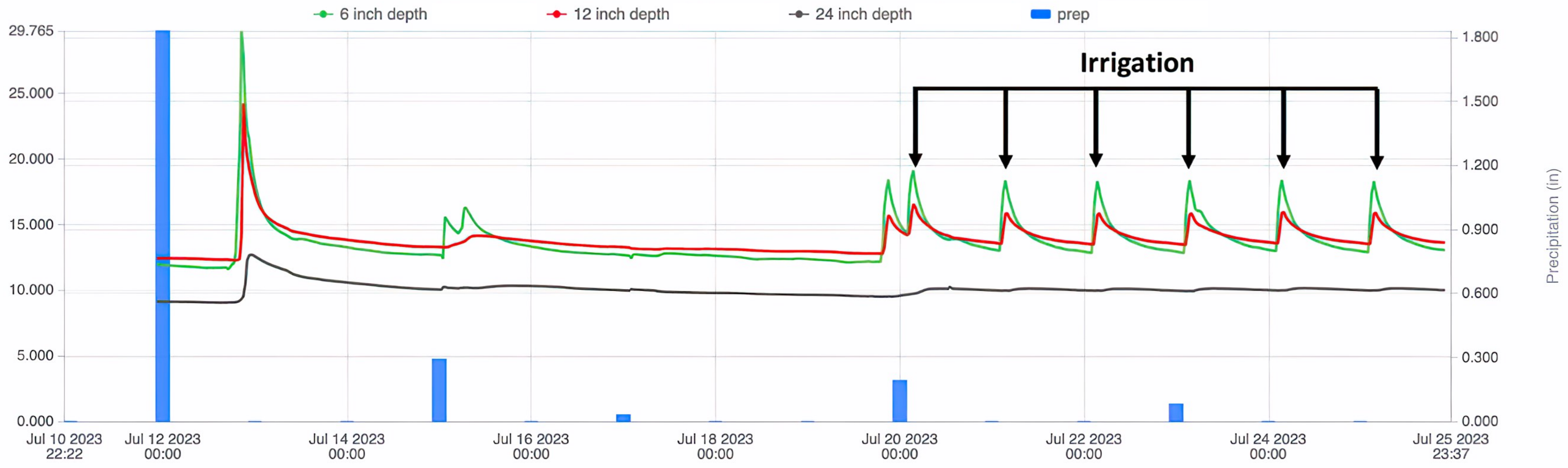
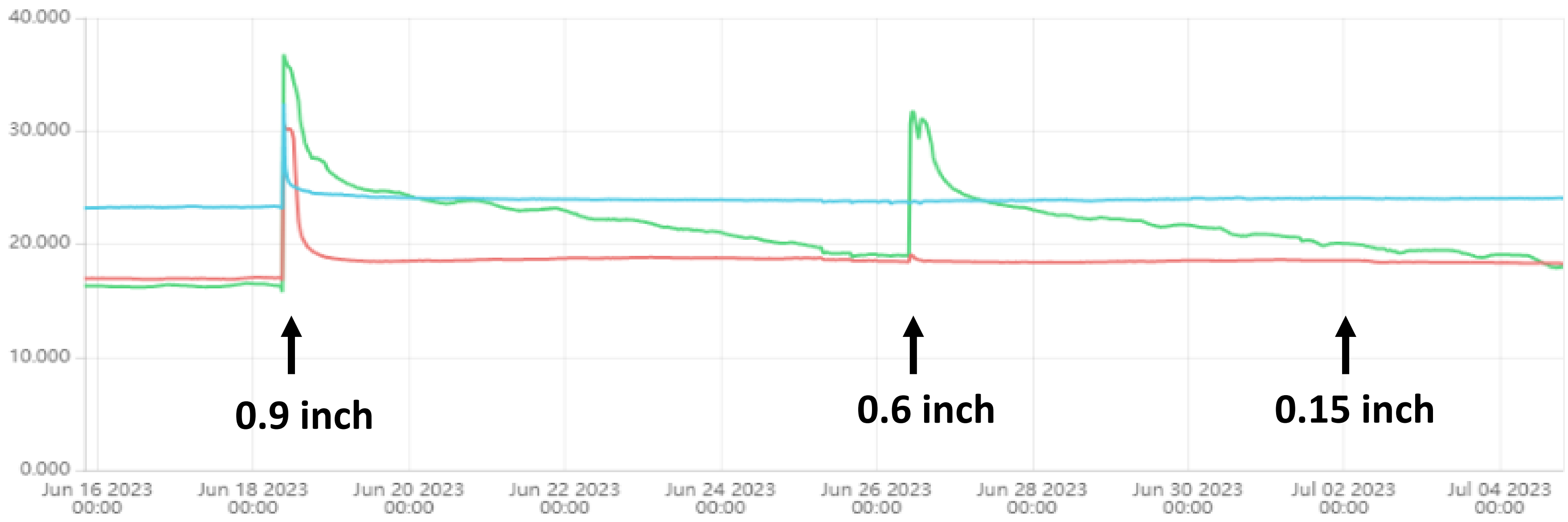
Center Pivot Irrigation - 2023



Drip Irrigation - 2023



Tekonsha, MI



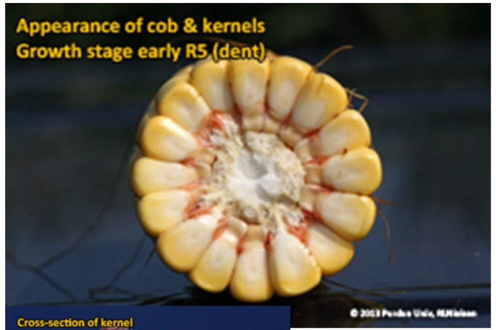
Green – 1 FT.
Blue – 2 FT.
Red – 3 FT.

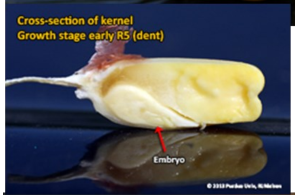
Crop type: Commercial Corn
Stage (7/4/23): V5
Soil: Oshtemo Sandy Loam Soil

Recommended Irrigation Management - *Corn*

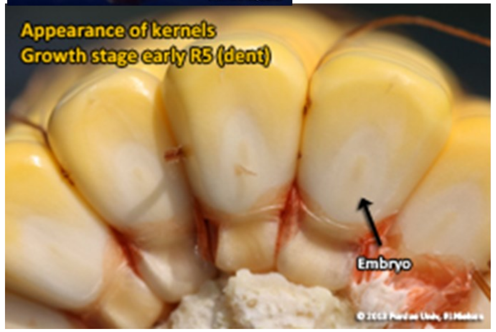
Most critical time for Corn plants to have adequate water is from ***VT*** *until* ***R6****.*

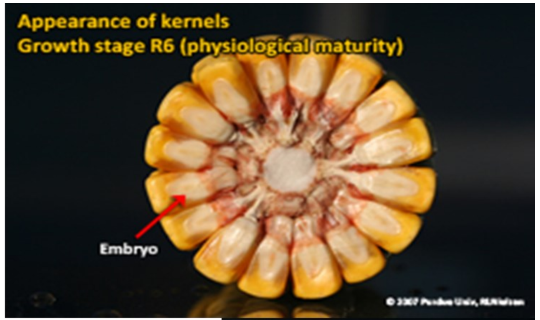
VT



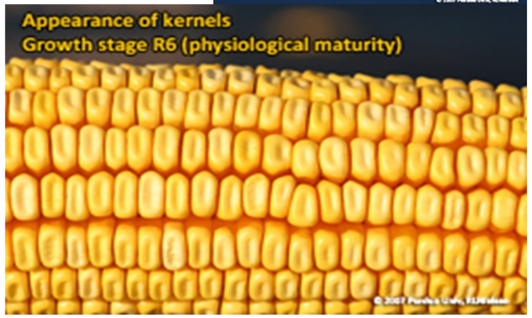


Dent stage- Maintain soil moisture > 50%



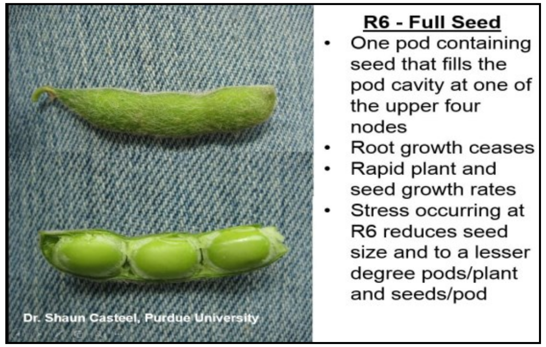


Black layer- No benefit from additional irrigation



Recommended Irrigation Management - *Soybean*

- *Most critical times for Soybean plants to have adequate water are during* ***pod development (R3 - R4) and seed fill (R5 - R6).***
- Not enough moisture during the critical stages (R3-R6) in sandy soil field can reduce yield up to 28 bu/acre.



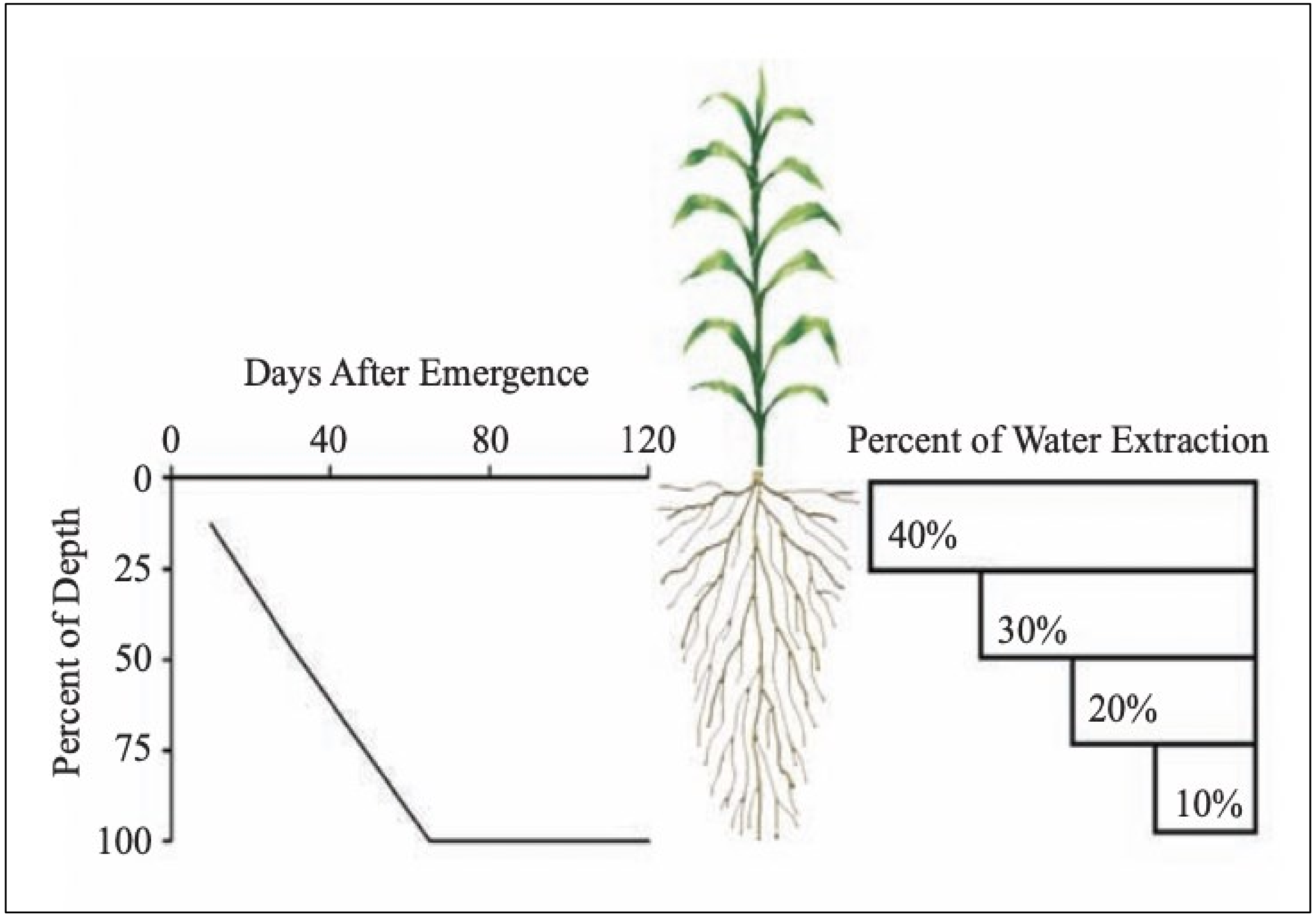
Source: Shaun Casteel, Purdue University.

Stages	Average numbers of days	Range in number of days
Planning to VE	10	5 to 15
VE to VC	5	3 to 10
VC to V1	5	3 to 10
V1 to V2	5	3 to 10
V2 to V3	5	3 to 10
V3 to V4	5	3 to 8
V4 to V5	5	3 to 8
Beyond V5	3	2 to 5
R1 to R2	3	0 to 7
R2 to R3	10	5 to 15
R3 to R4	9	5 to 15
R4 to R5	9	4 to 26
R5 to R6	15	11 to 20
R6 to R7	18	9 to 30
R7 to R8	9	7 to 18

Source: University of Minnesota

Sensor Installation Considerations

- Root depth.
- Representative area.
  - Soil type
  - Slope
  - Crop type
- Installation technique (No air gap)



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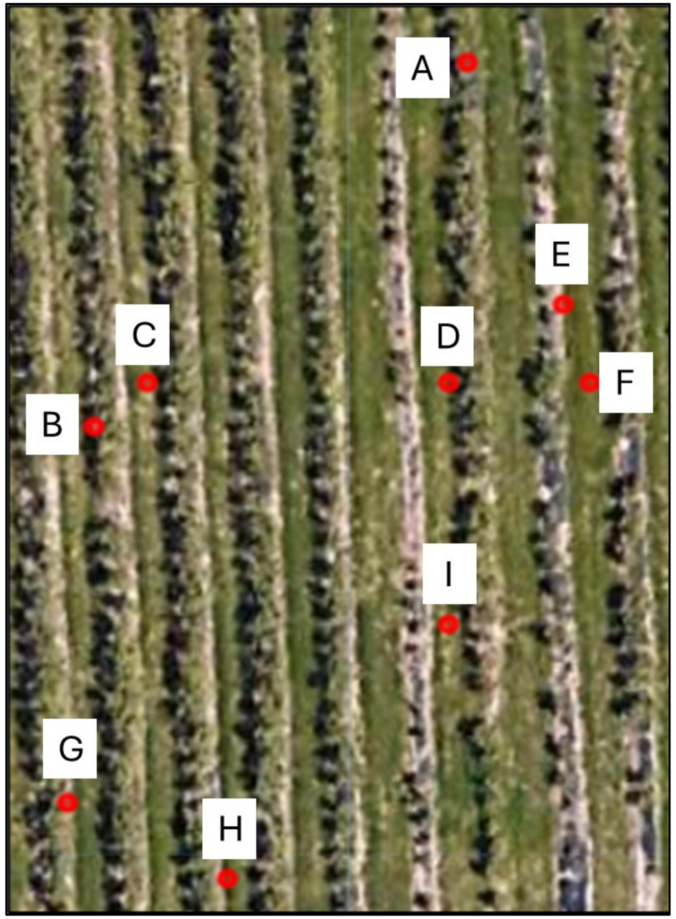
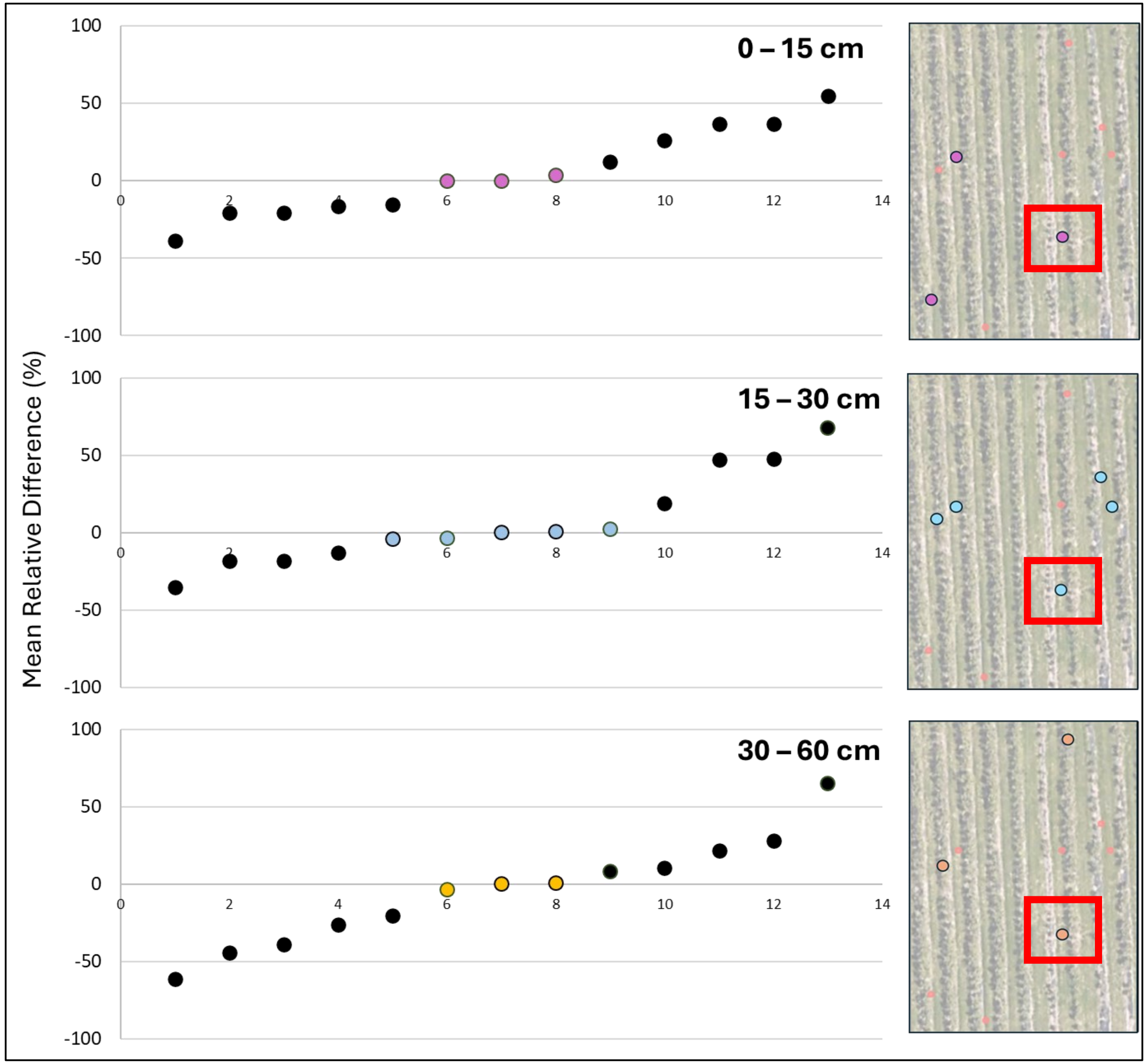
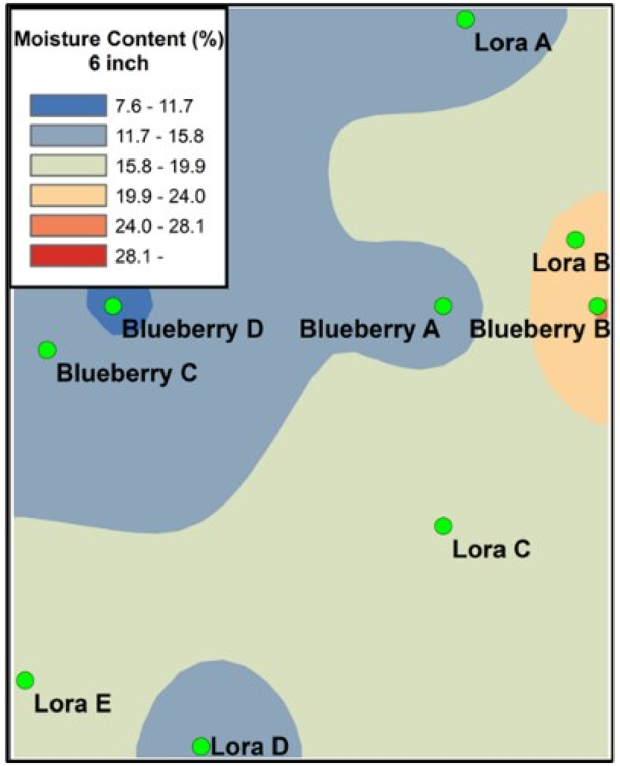
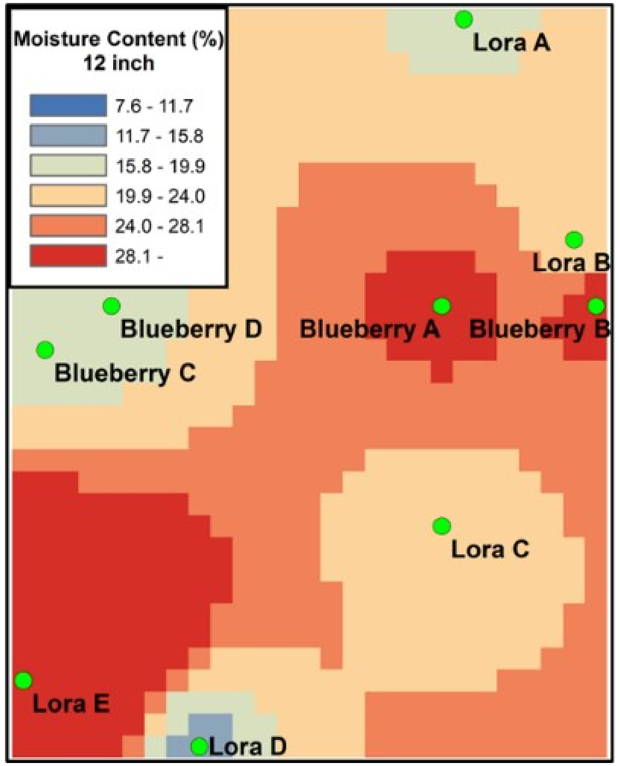
Michigan Department of Agriculture & Rural Development

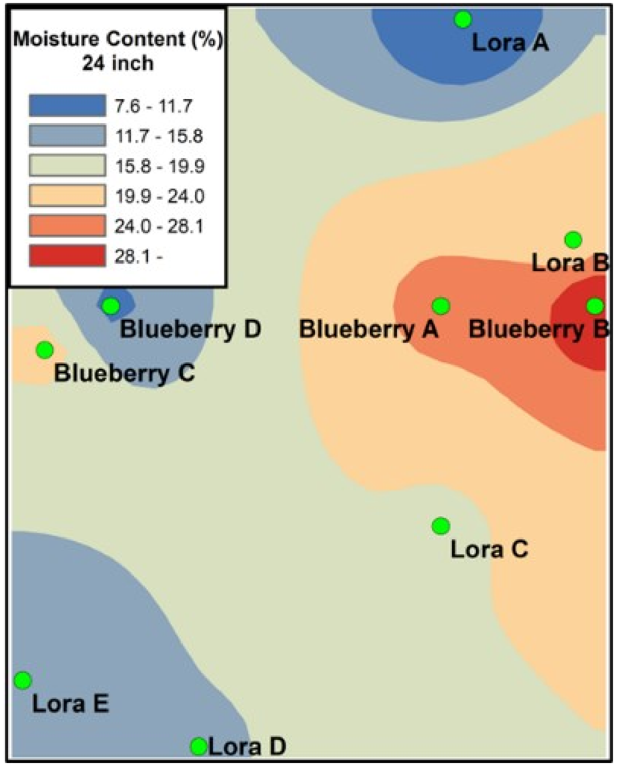




Michigan Department of AGRICULTURE & Rural Development

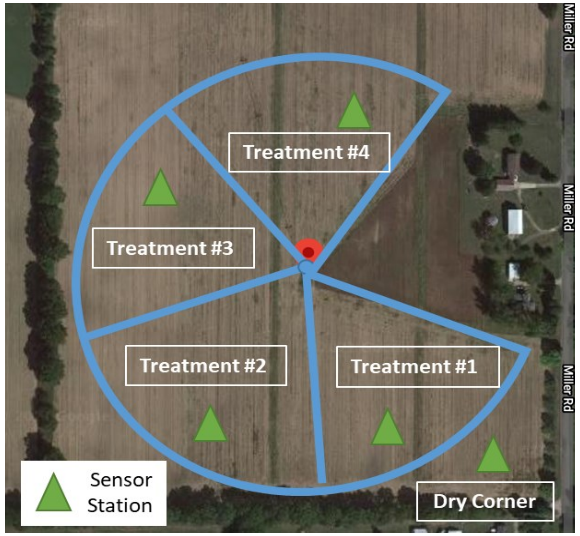




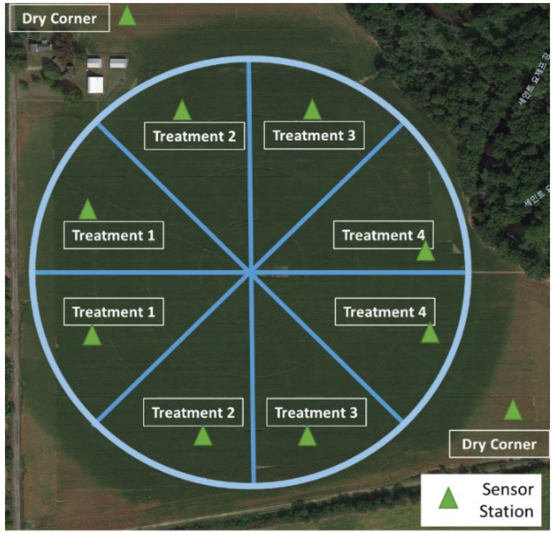


Irrigation Management with IoT Technology – Corn & Soybean & Potato

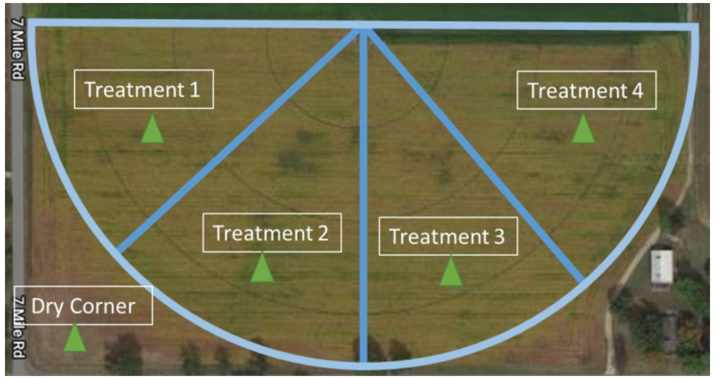
Constantine, MI (40 acres)



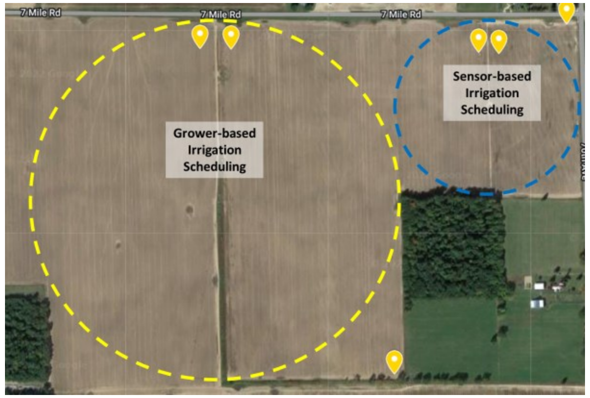
Sturgis, MI (40 acres)



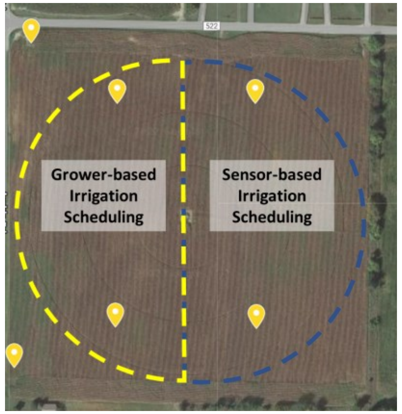
Tekonsha, MI (70 acres)



Union City, MI (40 acres)



Mecosta, MI (80 acres)



Lakeview, MI (40 acres)

Corn Irrigation On-Farm Demonstration Project Updates

Irrigation Treatment	Yield (bu/acre)	Irrigation Water Use Efficiency (bu/acre-inch)	Value ($/acre-inch)*
Producer's Irrigation Management	305	19.5	132
100% Irrigation Scheduling	319	22.4	152
130% Irrigation Scheduling	319	19.3	131
70% Irrigation Scheduling	309	20.3	137
Dry Corner	218		

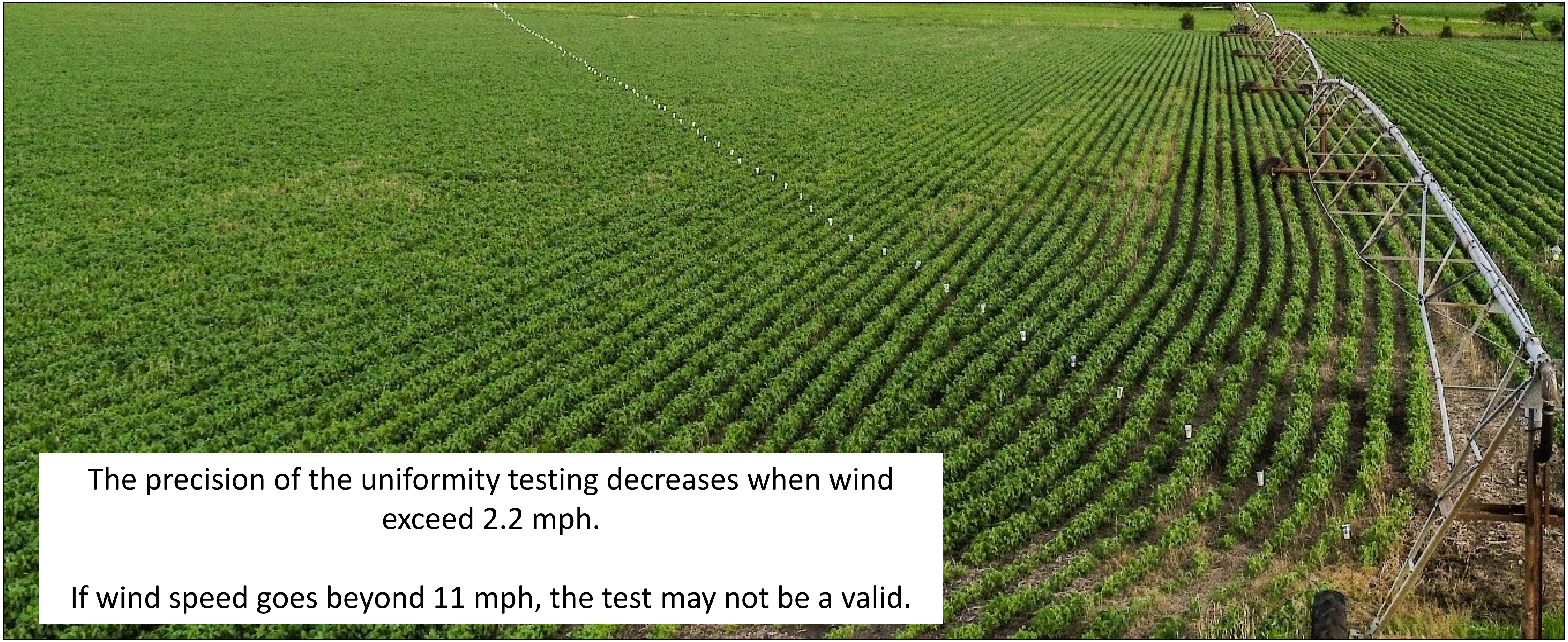
*Assumed that corn price is $6.77/Bushel (1/20/23)

Soybean Irrigation On-Farm Demonstration Project Updates

Irrigation Treatment	Yield (bu/acre)	Irrigation Water Use Efficiency (bu/acre-inch)	Value ($/acre-inch)
Producer's Irrigation Management	64	6.3	9
100% Irrigation Scheduling	66	8	122
130% Irrigation Scheduling	66	6	92
70% Irrigation Scheduling	58	4.5	69
Dry Corner	54		

**Assumed that soybean price is $15.3/Bushel (1/19/23)

Irrigation System Uniformity Evaluation

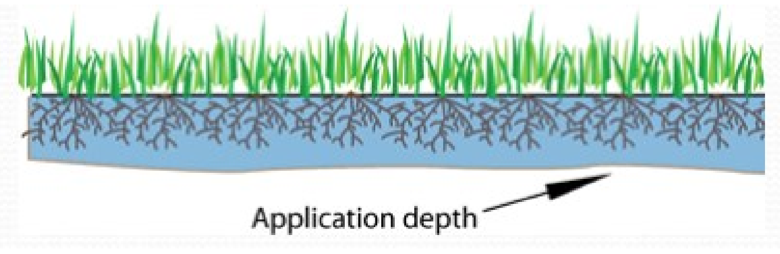


The precision of the uniformity testing decreases when wind exceed 2.2 mph.

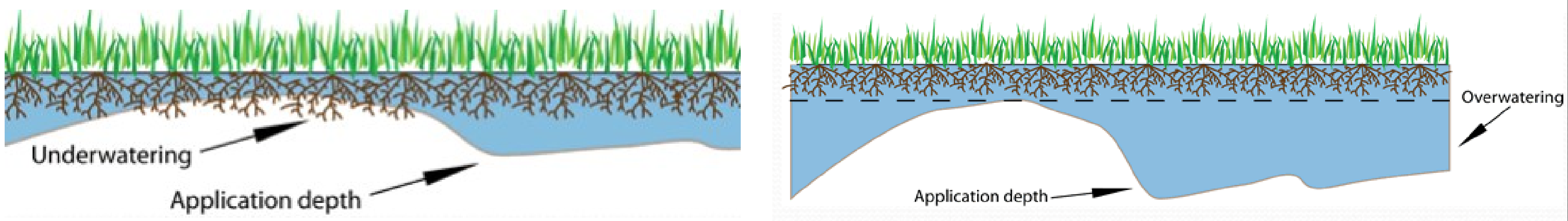
If wind speed goes beyond 11 mph, the test may not be a valid.

Importance of Checking Irrigation System Uniformity

- Poor water distribution can result in over- and under-irrigated areas.
- Under-irrigation can reduce crop yield and grain quality.
- Over-irrigation can cause runoff and leaching water and nutrients below the root zone.
- Low uniformity can negatively impact on a farm's net return and environmental impacts.



Good Distribution Uniformity



Poor Distribution Uniformity

(MJC Irrigation Technology, n.d.)

Irrigation System Uniformity Evaluation

1	MSU Extension Irrigation System Evaluation Tool, 1-23-07			
2	Farm Name	[redacted] Farm		
3			System Uniformity Coefficient =	79
4	System Identification	Cornering Arm System on [redacted] Farm-Behind House	Good System uniformity coefficient are 85 or greater	
5		Cornering Arm Extended	Deviation from desired application =	-0.04
6	System Settings			
7	Application rate (in)	0.5	Wind speed (mph)	4 mph
8	Percent timer Setting (%)	19	Wind Condition (variable or steady)	steady
9	Operating Pressue (psi)			
10	Rate of application calculator			
11	Time from start to end of application at highest rate section of system (min.)	22	Inches/Hour	1.25
12	Rate of application for the highest rate section of system (minute /one inch)	48.00		
13			Average Application (cm)	1.164
14	Length of evaluation area (ft)	1340	Average Application (in)	0.46
15	Catch Can Spacing Distance (ft)	10		
16			Average catch, collected only (ml)	88.95
17	number of cans data collected from	129	*70% average catch can (ml)*	*59.94*
18	number of cans set	134	Evaluation area, full circle (acres)	122.82
19			catch can openning area (sq cm)	76.977
20	Diameter of catch can (cm)	9.9	catch can openning area (sq in)	11.767
21				

Application is 4 % under expectation

22–24	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
25	1	10		88.95		1.156	0.455	99.26%	-0.74%	0.01623	0.01%	0.0001
26	2	20		88.95		1.156	0.455	99.26%	-0.74%	0.02885	0.02%	0.0002
27	3	30		88.95		1.156	0.455	99.26%	-0.74%	0.04327	0.04%	0.0003
28	4	40		88.95		1.156	0.455	99.26%	-0.74%	0.05770	0.05%	0.0005
29	5	50		88.95		1.156	0.455	99.26%	-0.74%	0.07212	0.06%	0.0006
30	6	60		88.95		1.156	0.455	99.26%	-0.74%	0.08655	0.07%	0.0007
31	7	70	125	0.00		1.624	0.639	139.48%	39.48%	0.10097	0.08%	0.0011
32	8	80	75	0.00		0.974	0.384	83.69%	-16.31%	0.11539	0.09%	0.0008
33	9	90	115	0.00		1.494	0.588	128.32%	28.32%	0.12982	0.11%	0.0014
34	10	100	105	0.00		1.364	0.537	117.16%	17.16%	0.14424	0.12%	0.0014

Data Entry / Uniformity Graph

If the CU is 85% or greater, the irrigation system is not likely to need major adjustments to the sprinkler package,

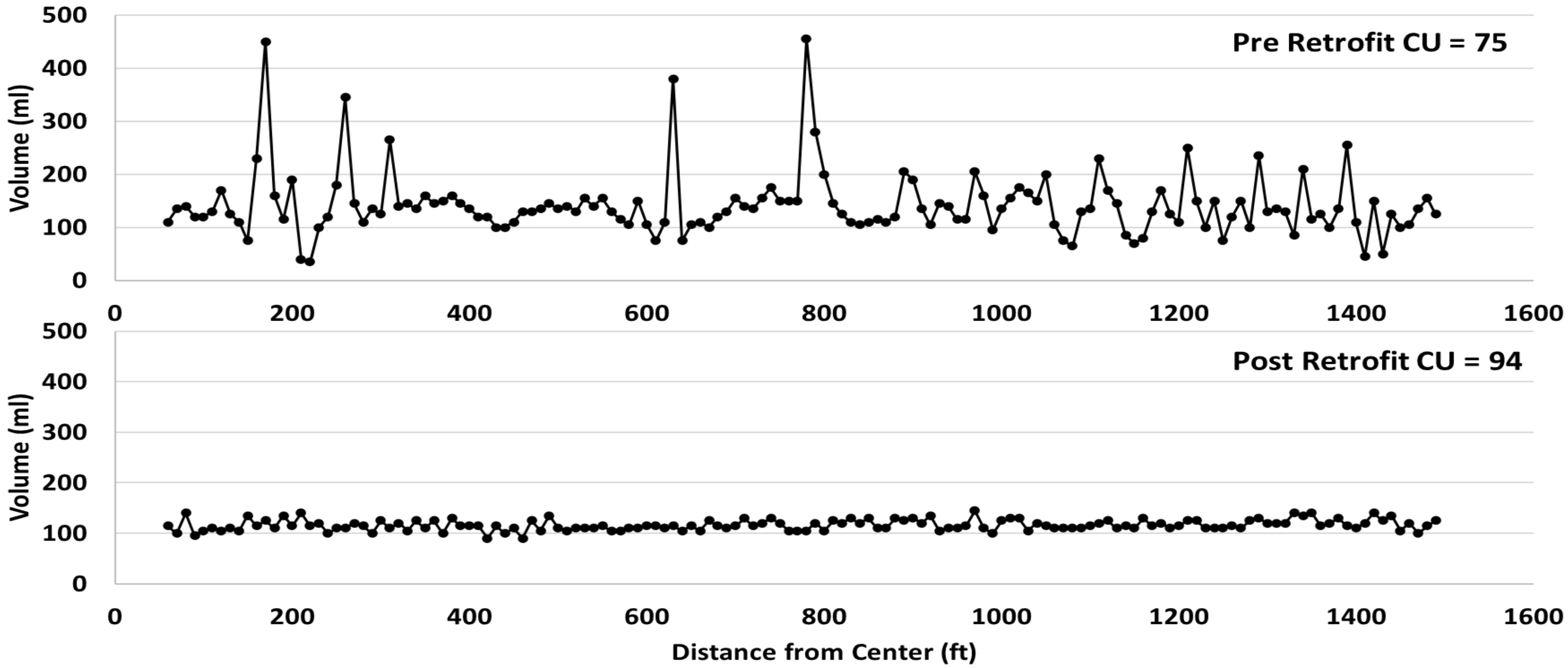
A CU of 80 to 85% may need further analysis of the sprinkler package, and individual sections of the irrigator would benefit from corrections.

A CU of less than 80% requires an adjustment to the sprinkler package design and correction of individual sections of the sprinkler package.

http://msue.anr.msu.edu/uploads/236/43605/lyndon/Uniformity_Spreadsheet_6.11.xls

Irrigation System Evaluation – Case study

- Material and labor costs for replacing sprinkler package were $4,360 and $2,220, respectively. Total cost was **$6,580**.
- With $1,617 in energy savings per year, the payback period of updating the sprinkler system is approximately **4 years.**



Project GREEEN

Looking for Collaborators!!

Younsuk Dong
dongyoun@msu.edu
(517) 432-8751

Lyndon Kelley
kelleyl@msu.edu
(269) 467-5511

Support $1,000 for the cost of the retrofit.

MICHIGAN STATE UNIVERSITY | Extension

USDA NRCS EQIP (Environmental Quality Incentives Program)

USDA United States Department of Agriculture

441-CPS-1

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION

CODE 441

(Ac.)

DEFINITION

An irrigation system for frequent application of small quantities of water on or below the soil surface: as drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line.

PURPOSE

This practice is applied to achieve the following purpose:

- Efficiently and uniformly apply irrigation water and maintain soil moisture for plant growth.
- Prevent contamination of ground and surface water by efficiently and uniformly applying chemicals.
- Establish desired vegetation (e.g., windbreaks).

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on sites where soils and topography are suitable for irrigation of crops or other desirable vegetation and an adequate supply of suitable quality water is available for the intended purpose(s).

Microirrigation is suited to virtually all agricultural crops, and residential and commercial landscape systems. Microirrigation is also suited to steep slopes where other methods would cause excessive erosion, and areas where other application devices interfere with cultural operations.

Microirrigation is suited for use in providing irrigation water in limited amounts to establish desired vegetation such as windbreaks, living snow fences, riparian forest buffers, and wildlife plantings.

This practice standard applies to systems that wet only a specific area (e.g., an individual plant or tree) and typically have design discharge rates less than 60 gal/hr at individual application discharge points.

Use NRCS Conservation Practice Standard (CPS) Code 442, Sprinkler System, for systems that uniformly wet the entire field and typically have design discharge rates of 60 gal/hr or greater at individual application discharge points.

USDA United States Department of Agriculture

442-CPS-1

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

SPRINKLER SYSTEM

Code 442

(Ac.)

DEFINITION

A distribution system that applies water by means of nozzles operated under pressure.

PURPOSE

This practice is applied as part of a conservation management system to accomplish one or more of the following:

- Efficient and uniform application of water on irrigated lands
- Improve plant condition, productivity, health and vigor
- Prevent the entry of excessive nutrients, organics, and other chemicals in surface and groundwater
- Improve condition of soil contaminated with salts and other chemicals
- Reduce particulate matter emissions to improve air quality
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to the planning and functional design of all sprinkler system components (e.g., laterals, risers, nozzles, heads, and pressure regulators).

Individual sprinkler design discharge rates covered by this standard typically have design nozzle discharge rates exceeding 1 gallon per minute and wet the entire field surface uniformly.

Areas must be suitable for sprinkler water application, and have a water supply of adequate quantity and quality for intended purpose(s).

This standard applies to planning and design of sprinkler application systems for:

- meeting crop water demands
- crop cooling, frost protection, or bloom delay
- leaching or reclamation of saline or sodic soils, or soils contaminated by other chemicals that can be controlled by leaching
- application of chemicals, nutrients, and/or waste water

Notice of Proposed Changes to the National Handbook of Conservation Practices for the Natural Resources Conservation Service

[Docket No. NRCS-2020-0001]

PROPOSED FULL TEXT FOR PRACTICE STANDARD CODE 449

USDA United States Department of Agriculture

449-CPS-1

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

IRRIGATION WATER MANAGEMENT

CODE 449

(ac)

DEFINITION

The process of determining and controlling the volume, frequency, and application rate of irrigation water.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Improve irrigation water use efficiency
- Minimize irrigation-induced soil erosion
- Protect surface and ground water quality
- Manage salts in the crop root zone
- Manage air, soil, or plant microclimate
- Reduce energy use

CONDITIONS WHERE PRACTICE APPLIES

This practice is applicable to all currently irrigated lands.

CRITERIA

General Criteria Applicable to All Purposes

Develop an irrigation water management (IWM) plan that defines when irrigation is needed (timing) and the amount and rate of water to apply for each irrigation event.

Base the timing of irrigation on one or more of the following methods:

- Evapotranspiration of the crop, using appropriate crop coefficients and reference evapotranspiration data,
- Soil moisture monitoring,
- Computerized irrigation scheduling, utilizing local real-time climate data, soil, and crop growth characteristics (e.g., remote telemetry data systems coupled with cloud-based irrigation scheduling using the soil-water balance method),
- Plant monitoring (e.g., leaf water potential or leaf/canopy temperature measurements).

Resources

MSU Extension – Irrigation

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

https://engineering.purdue.edu/ABE/extension/H2OQual/Irrigation

Considerations for Planning and Selecting Pumping Plants for Sprinkler Irrigation

Younsuk Dong and Lyndon Kelley

E3439 • April 2020 | MICHIGAN STATE UNIVERSITY | Extension

Efficient Irrigation Management With Center Pivot Systems

Younsuk Dong, Lyndon Kelley, Steve A. Miller

E3445 • July 2020 | MICHIGAN STATE UNIVERSITY | Extension

Improving Irrigation Water Use Efficiency: Using Soil Moisture Sensors

Younsuk Dong, Steve A. Miller, Lyndon Kelley

RISK OF IRRIGATION WATER ON THE ROAD

PUBLISHED ON AUGUST 25, 2023

The risk associated with irrigation water on the road depends on the pressure and volume of water hitting the road and amount of traffic encountering it.

THE IMPORTANCE OF CHECKING IRRIGATION SYSTEM UNIFORMITY

PUBLISHED ON AUGUST 18, 2023

Evaluating and retrofitting your irrigation system can help to improve irrigation water use efficiency.

ADEQUATE WATER SUPPLY IS THE HEART OF AN IRRIGATION SYSTEM

PUBLISHED ON AUGUST 16, 2023

Irrigation investments start with securing an adequate water supply that meets the state legal requirements for large-scale water use and minimal potential for conflict with neighbors or adverse resource impacts.

MSU EXTENSION HOSTS SECOND ANNUAL BLUEBERRY RESEARCH FIELD DAY

PUBLISHED ON JULY 18, 2023

Join Michigan State University Extension for this blueberry-focused event on Sept. 6 in Fennville.

JUNE CROP WATER NEEDS

PUBLISHED ON JUNE 15, 2023

If soils are depleted of moisture beneath the developing plants, irrigators need to supply enough water to help establishing roots grow down into natural soil moisture.

Future Irrigation-Related Events

Feb 27. 2024
Zoom

- Irrigation Scheduling
- Value of Irrigation Uniformity and Sprinkler Choice
- Irrigation Electrical Safety
- Pivot Control System

MSU WATER USE EFFICIENCY EXTENSION EDUCATOR

POSITION SUMMARY

MSU Extension is searching for educators to fill two Water Use Efficiency positions. One position will be located in West Michigan in Mason County. The other position will be located in Southern Michigan in Branch County.

MICHIGAN STATE UNIVERSITY | Extension **Agriculture & Agribusiness**

MSU EXTENSION AGRICULTURE AND AGRIBUSINESS INSTITUTE

Position Information

Position Title

Extension Educator

Salary

$55,000 or Commensurate with education and experience

Benefits

Comprehensive benefits package: https://www.hr.msu.edu/benefits/index.html

Location

Coldwater (Branch County) or Scottville (Mason County)

To Apply

Current MSU Employees: Access the EBS portal. Under the My Career and Training section, select the Careers @ MSU tile to view Internal Job Postings.

External Applicants: Visit http://careers.msu.edu

Posting Number: 875065

Application Deadline: August 21, 2023

Contact for Questions

msue.hr@msu.edu

Water Use Efficiency Extension Educator (2 positions available)

Position Overview

These positions will provide leadership and programming expertise in water efficiency, water use, and conservation practices related to sustainable irrigation. With an emphasis on best management practices to improve water use conservation and efficiency, these positions help farmers improve water and energy use efficiency in their production systems through education programs, resource development, and individual consultation to reduce water use while maintaining profitable and viable production systems.

West Michigan Water Use Efficiency Educator
The focus of this position will be to emphasize best management practices to improve water use conservation and efficiency in irrigation systems for specialty crop production. Provide support for efficient use of irrigation and other water use systems in sustainable production of agricultural products.

Although negotiable, there will be space available for this position to work from the Mason County MSU Extension office located in Scottville, Michigan.

Southern Michigan Water Use Efficiency Educator
The focus of this position will be to emphasize best management practices to improve water use conservation and efficiency in irrigation systems for annual field crop production and provide education regarding large volume water withdrawal for persons operating animal agricultural facilities. Provide support for efficient use of water in annual crop and livestock production systems for the sustainable production of agricultural products.

Although negotiable, there will be space available for this position to work from the Branch County MSU Extension office located in Coldwater, Michigan.

These positions may be eligible to utilize a flexible work environment.

Qualifications

Minimum Qualifications (see full description for complete list of requirements)

- Master's degree from an accredited institution in a field of study related to agronomy, agriculture engineering, animal science, biosystems, hydrology, or related field must be earned by date of hire.

Application Process

View full description and apply through the MSU careers page. **Search for posting 875065 using the Job Search field.** Candidates can indicate their preference for location within their cover letter.

Younsuk Dong

dongyoun@msu.edu

Lyndon Kelley

kelleyl@msu.edu

MSU Extension – Irrigation

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