PURDUE EXTENSION | LOCAL FACES COUNTLESS CONNECTIONS

MICHIGAN STATE UNIVERSITY | Extension

Soybean Irrigation Management

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http://msue.anr.msu.edu/resources/irrigation

https://engineering.purdue.edu/ABE/Engagement/Irrigation

Treat your irrigated field like star performers

Re-think your management practices and inputs

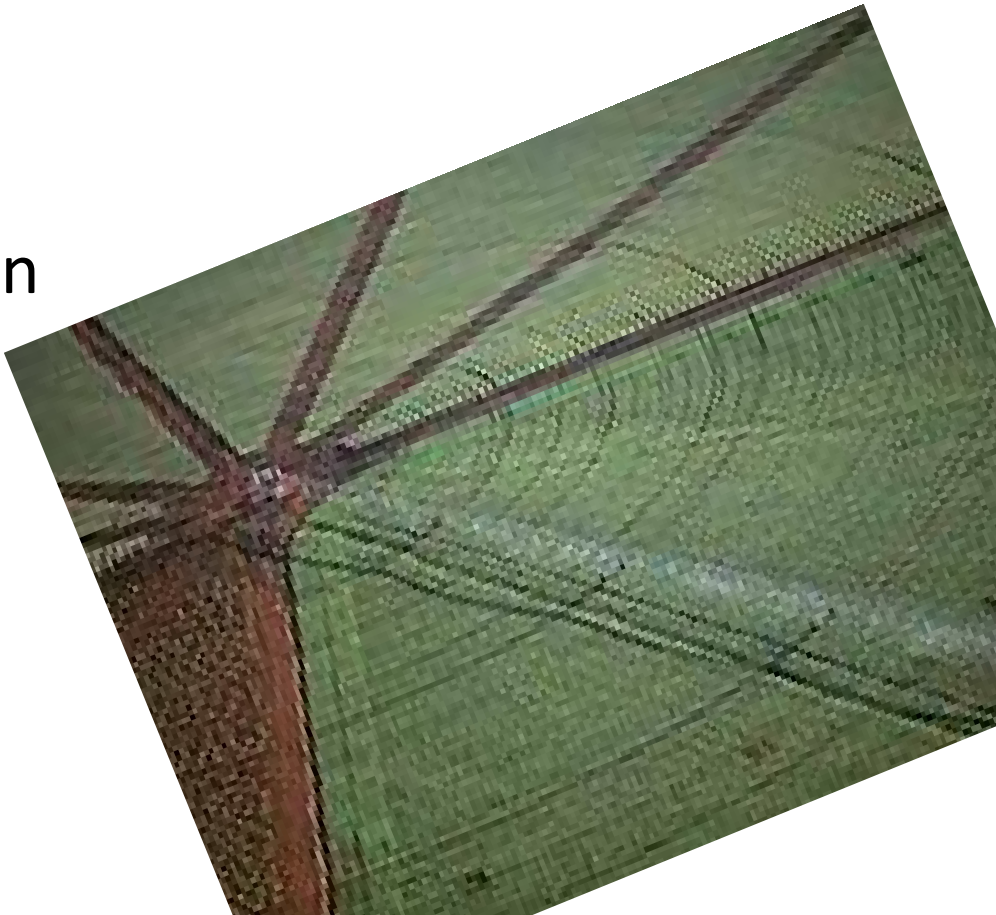
- Soil pH
- Variable rate lime applications
- P and K rate and placement
- N rate and timing
- Sulfur placement, rate and timing
- Zinc placement, rate and timing
- Weed control
- Crop herbicide risk / damage
- Weed resistance
- Herbicide carry-over issues

- Drainage
- Crop rotation
- Seed selection
- Seeding rate and placement
- Planting date
- Emergence
- Pest scouting
- Pest management thresholds
- Residue management
- Compaction issues

Tried & True vs. **Lead Dog**

Not all technologies are ready for your farm

- Cover crop seeded at sidedress
- Remote start equipment
- Variable rate irrigation
- Field scale trickle irrigation
- Sub-surface drip
- Soil moisture monitoring
- Soil surfactants
- . …….

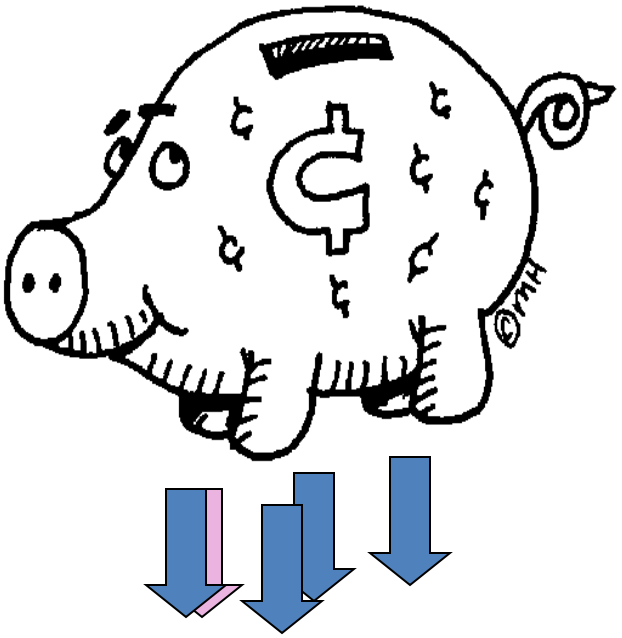


Think of your soil as a bank

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 can pull out only 30 - 60% of the total water

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

SMaRT Soybean Management and Research Technology

SOYBEAN FACTS

February 2011

Summary of Irrigated Soybean Research in Michigan

Kurt Thelen, MSU Biofuels Specialist
Mark Bernards, Weed Control Specialist, University of Nebraska
Mike Staton, MSU Extension CURE Soybean Educator
Lyndon Kelley, MSU Extension and Purdue Extension Irrigation Educator

Nearly 100,000 acres of soybeans are grown under irrigation in Michigan. Yield increases due to irrigation water applications are common in Michigan. However, the yield increases have been highly variable and lower than expected. This fact sheet summarizes soybean irrigation research conducted in Southwest Michigan from 2001 to 2003. Utilizing this information will help producers improve irrigated soybean yields.

different irrigation schedules, 3) learn how irrigation affects weed control with glyphosate and 4) learn how irrigation affects soybean aphid populations.

Materials and Methods

Five irrigation treatments were identified and implemented in each year of the project. The irrigation treatments were based on soybean

Summary of Irrigated Soybean Research in Michigan

SMaRT Soybean Facts – 2/2011

Summary

Based on the three years of data, it appears that maximizing soybean yields in Michigan is dependent on maintaining adequate soil moisture beginning at full bloom (R2) or beginning pod (R3), provided that the soil water deficit does not exceed 75% prior to that growth stage.

Waiting to irrigate until pod elongation (R3-R4)

maximized water use efficiency in two of the three years as long as the soil water deficit never reached 75%.

R3: Beginning Pod

Any pod that is *~3/16 inch long* and is on one of the four uppermost nodes of the main stem.

Developing pods, withering flowers, open flowers, & flower buds can all be found during this stage.

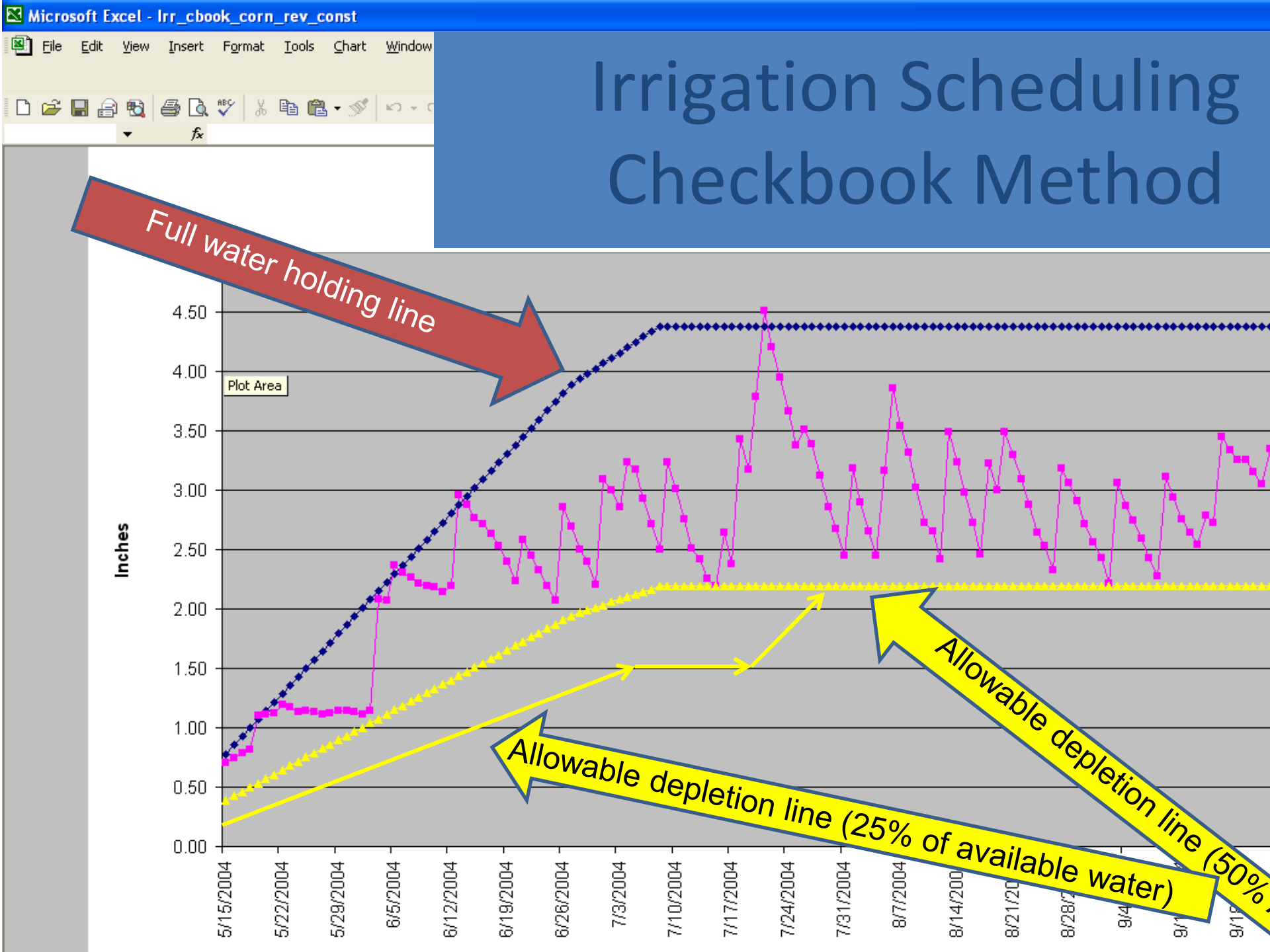
Summary – con't

Waiting to irrigate until pod elongation (R3-R4) maximized water use efficiency in two of the three years as long as the soil water deficit never reached 75%.

In two of the three years, an emergency irrigation water application was required to prevent the soil water deficit from reaching 75% so waiting until pod elongation may not be recommended in some years.

Use data from irrigated soybean variety performance trials to select high-yielding, disease resistant/tolerant varieties that resist lodging to maximize irrigated soybean yields.

Irrigation Scheduling Checkbook Method



	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/

Scheduler- MSU Mawn-irrigation 2013, Constantine , rain fall 14.5 “, 110 growing days, May 1 emergence.

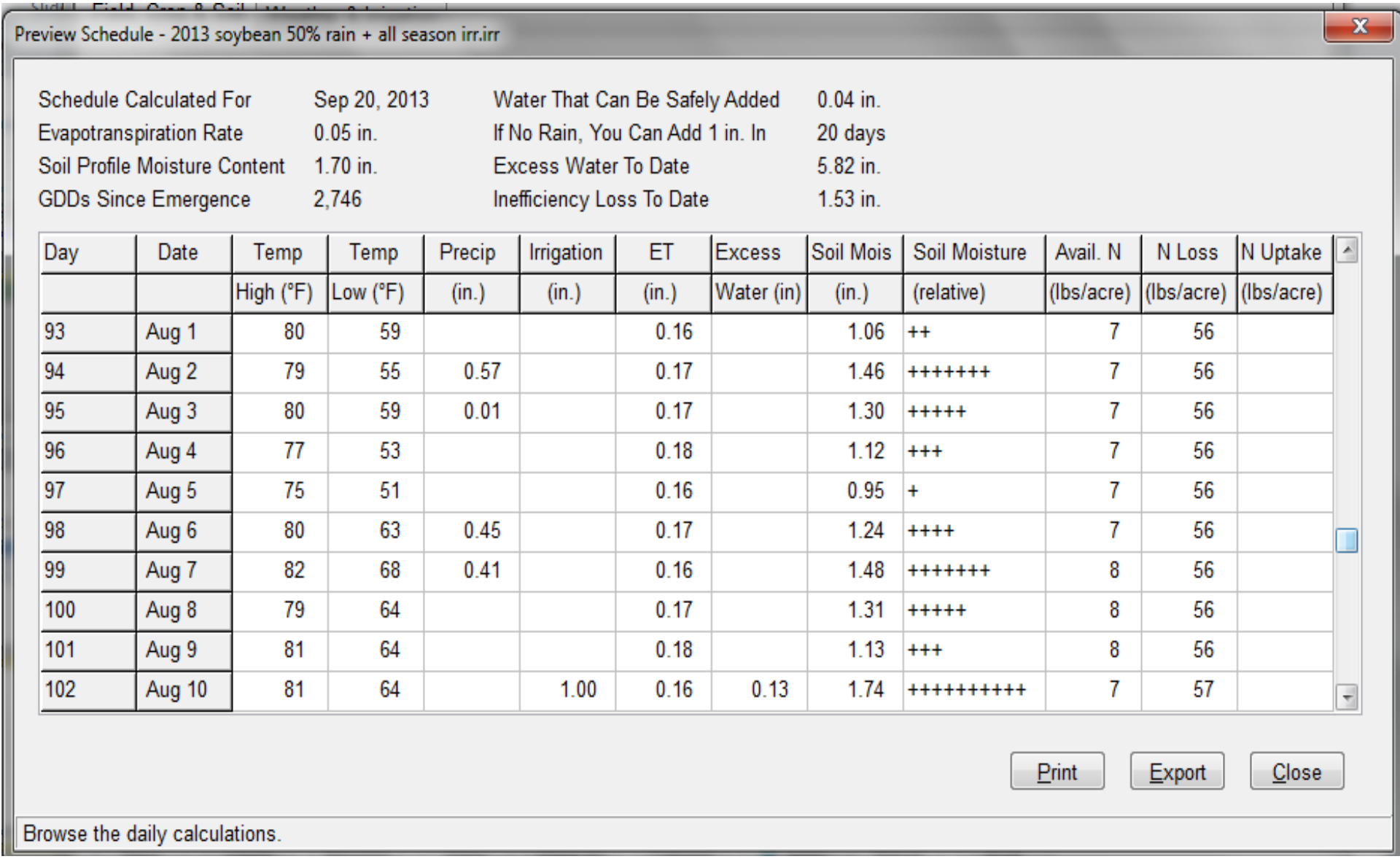
Irrigation applications of 0.5” in June, 0.75 early/mid July, 1.0”August, 0.5 September

75%/50% depletion :

- planting to July 20th -soil allowed to dry to 75% depletion before irrigating .
- July 20th till harvest 55% depletion as threshold to irrigate.

Management Practice	Irrigation	Total E.T.	Excess Water	5 day total E.T. July 1-5/August 1-5
Rain only	0.0	11.6	11.8	0.42” /0.67”
50% depletion	3.75	11.6	12.8	0.42” /0.67”
75%/50% depletion	2.75	11.6	12.8	0.42” /0.67”

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



Day	Date	Temp High (°F)	Temp Low (°F)	Precip (in.)	Irrigation (in.)	ET (in.)	Excess Water (in)	Soil Mois (in.)	Soil Moisture (relative)	Avail. N (lbs/acre)	N Loss (lbs/acre)	N Uptake (lbs/acre)
93	Aug 1	80	59			0.16		1.06	++	7	56	
94	Aug 2	79	55	0.57		0.17		1.46	+++++++	7	56	
95	Aug 3	80	59	0.01		0.17		1.30	+++++	7	56	
96	Aug 4	77	53			0.18		1.12	+++	7	56	
97	Aug 5	75	51			0.16		0.95	+	7	56	
98	Aug 6	80	63	0.45		0.17		1.24	++++	7	56	
99	Aug 7	82	68	0.41		0.16		1.48	+++++++	8	56	
100	Aug 8	79	64			0.17		1.31	+++++	8	56	
101	Aug 9	81	64			0.18		1.13	+++	8	56	
102	Aug 10	81	64		1.00	0.16	0.13	1.74	++++++++++	7	57	

http://www.purdue.edu/agsoftware/irrigation/

Irris Scheduler- Purdue Agronomy

2013, Goshen Airport, rain fall 14.5 “, 110 growing days, May 1 emergence.

Irrigation applications of 0.5” in June, 0.75 early/mid July, 1.0”August,
0.5 September

75%/50% depletion :

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Management Practice	Irrigation	Total E.T.	Excess Water	5 day total E.T. July 1-5/August 1-5
Rain only	0.0	13.5	1.0	0.89”/0.65”
50% depletion	15.2	22.5	5.8	0.91” / 0.84”
75%/50% depletion	8.75	19.9	2.5	0.89”/0.85”

http://www.purdue.edu/agsoftware/irrigation/

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

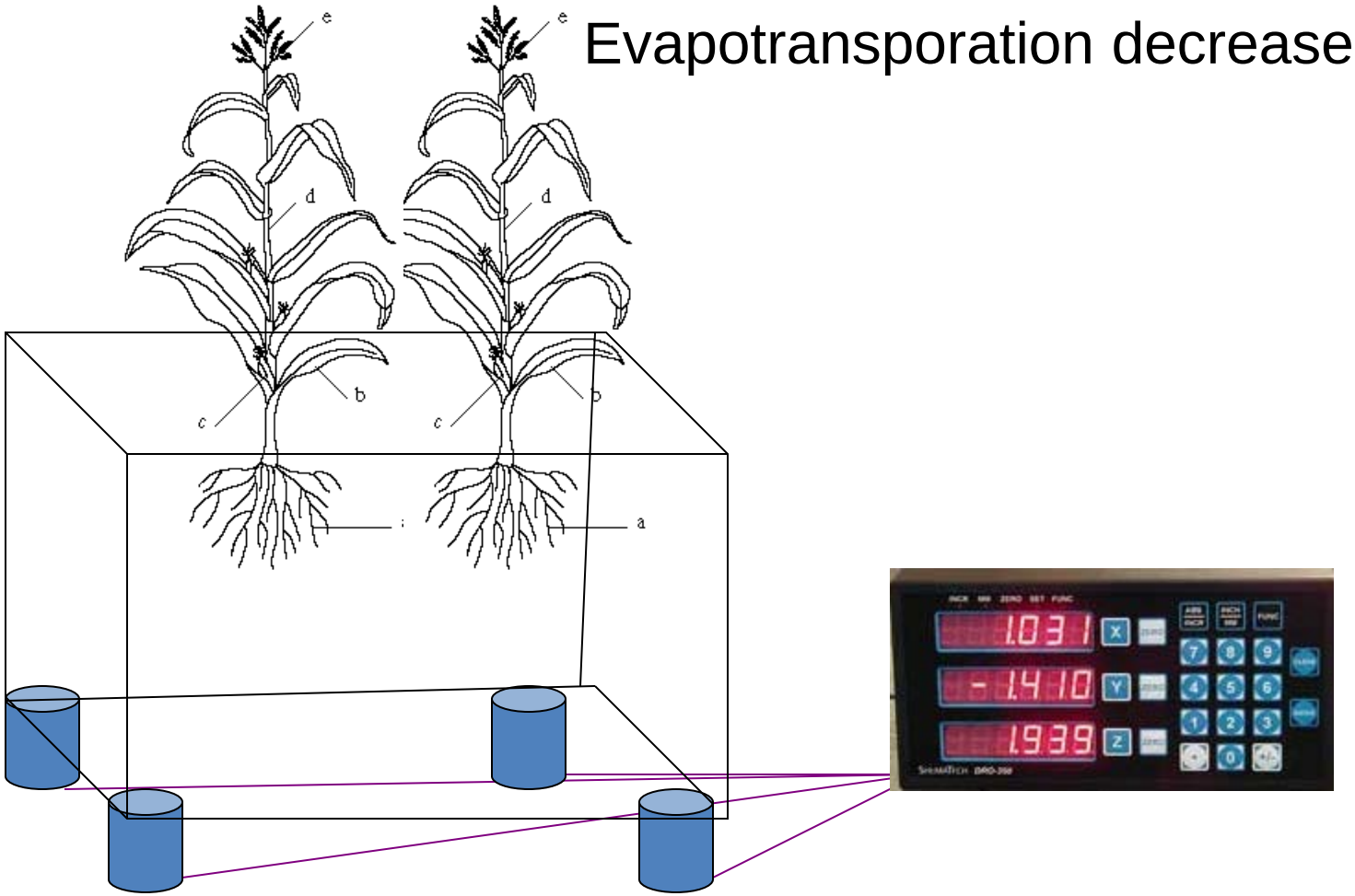
- estimate evapotranspiration (ET) using weather data

Potential ET estimated originally by weighing lysimeter

Weighing Lysimeter

Rain and Irrigation increase weight

Evapotransporation decrease weight



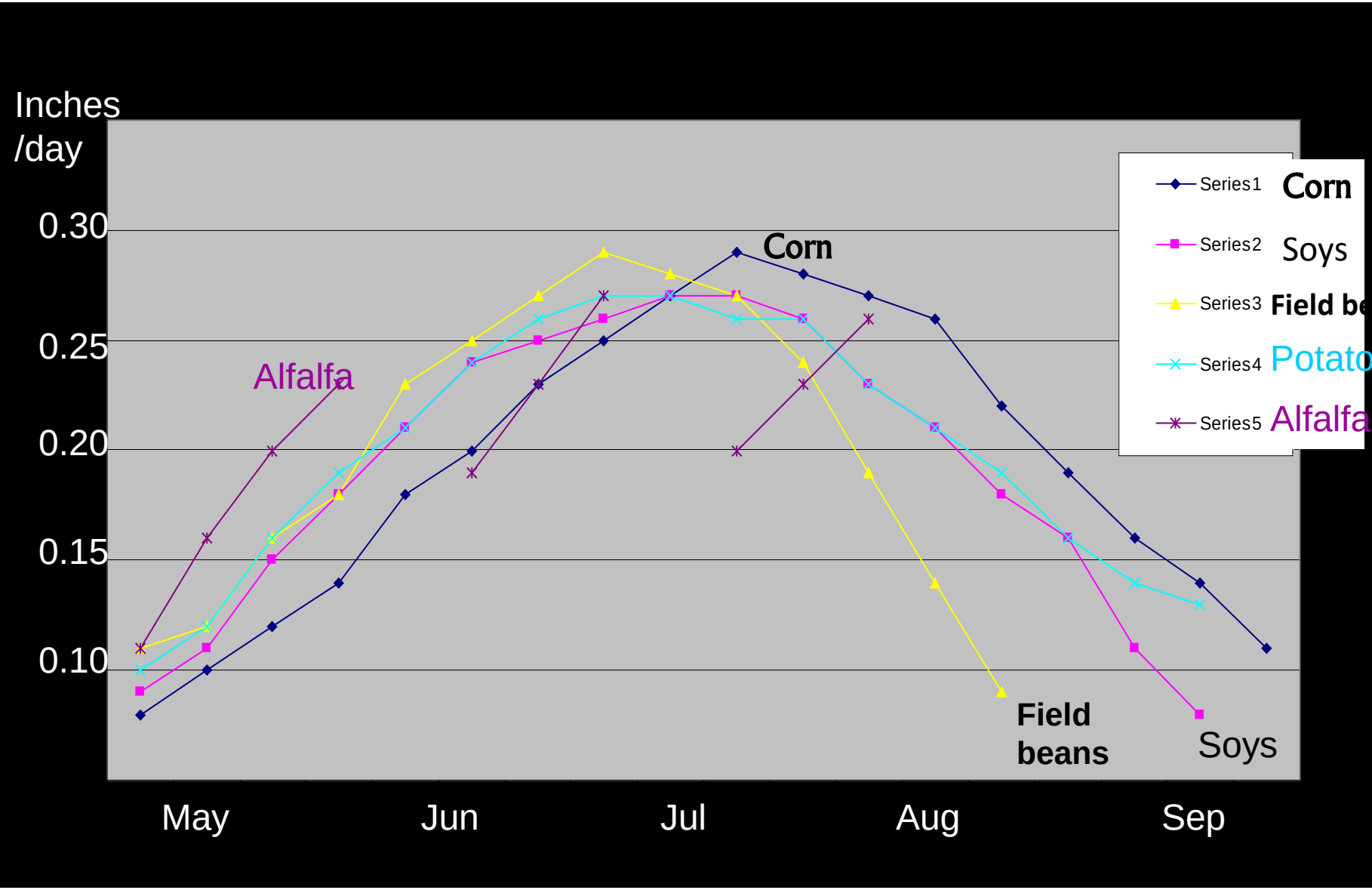

Avoid elongated internodes:

Available Water Holding Capacity

Soybeans rooting depth - 24”

“Not much room from wet to dry”

Soil Type / depth	Bronson	Capac	Oshtemo	Spinks
0”to 6” 0”to 6”	.84” .84”	1.2” 1.2”	.75” .75”	.54” .54”
6”to 12” 0”to 12”	.86” 1.70”	1.2” 2.4”	.75” 1.50”	.54” 1.08”
12” to 18” 0”to 18”	.90” 2.60”	.99” 3.39”	.87” 2.37”	.54” 1.62”
18” to 24” 0” to 24”	.90” 3.50”	.99” 4.38”	.93” 3.30”	.54” 2.16”
24” to 30” 0” to 30”	.58” 4.80”	.99” 5.37”	.93” 4.23”	.42” 2.58”
30” to 36” 0”to 36”	.34” 5.14”	.93” 6.45”	.86” 5.06”	.36” 2.94”



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

FO-01322 Revised 2002

Irrigation Scheduling Checkbook Method

Table 2. Average water use for CORN 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	18
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			

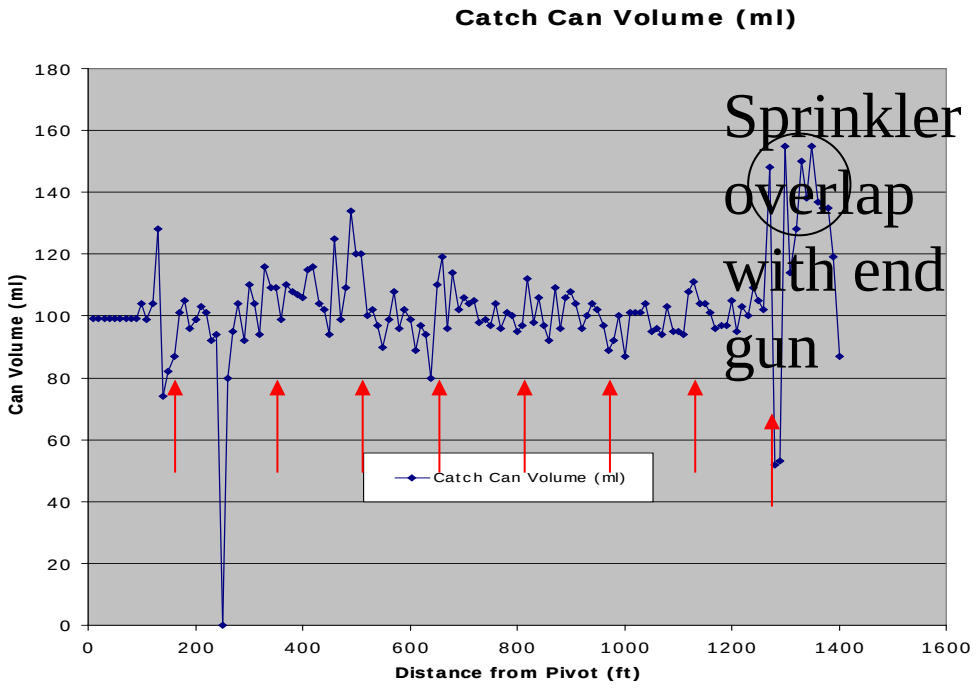
Table 3. Average water use for SOYBEANS in inches/day

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	.02	.04	.04	.06	.07	.08	.09	.09	.09	.09	.08	.07	.05	.05	.03	.02
60-69	.02	.03	.05	.07	.09	.10	.11	.13	.13	.13	.13	.11	.10	.08	.07	.04	.02
70-79	.03	.05	.07	.09	.12	.13	.15	.17	.18	.18	.17	.15	.13	.10	.09	.05	.03
80-89	.04	.06	.10	.13	.16	.19	.20	.21	.22	.22	.21	.18	.16	.13	.11	.06	.03
90-99	.05	.07	.11	.14	.17	.20	.22	.25	.26	.26	.25	.22	.19	.16	.13	.08	.05
Soybean growth stages				↑ 3rd trifoliate				↑ 1st flower	↑ full flower			↑ upper pod filling			↑ 1st yellow pod		

Three factor reducing effective water application

2. Lack of system uniformity

- 5-35% loss in effectiveness



1. Irrigation Runoff

(comparing irrigation application rate to soil infiltration rate) 0 -30 % loss

3. Evaporative loss to the air

- Minimal loss in our humid area
- 0 – 6%
- Estimated 4-6% loss in Nebraska

Do I have enough capacity

- 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

Limited Water Supply Irrigation Management

- ❖ Diversify the crops sharing the water supply between high and low water use. (? Potato and soybeans ?)
- ❖ Diversify the crops sharing the water supply and peak water use times (? corn and soybeans ?)
- Start irrigating early to bank water ahead.

(Soybeans lack rooting depth to make bank ahead work well)

Nebraska limited water plan:

- R3
- R6
- Sizing (soybean seed production concern)

Ideal Irrigation Application Volume

- wet at least top half of root mass
- allow room for a predictable rain fall – 1”
- never wet below the root zone
- large enough to minimize the number of times soil surface and crop are wetted. (save water / reduce disease)

Typical applications:

- May to mid July 0.3” to 0.5”
- July 0.5” to 0.7”
- August 0.7” to 1.0”
- September 0.3” to 0.7”

Irrigate to assure the best plant stand possible "It's an ART"

- Irrigate, if necessary, to make sure to get maximum germination and uniform emergence.
- ½ inch in most irrigated soil within five days of planting. Monitor crusting issues
- Maintain a moist surface, 0.10" to 0.20" applications, (rotary hoe if necessary).

Are you ready to irrigate the day you plant?

Using irrigation to get the most from pesticides and nutrients

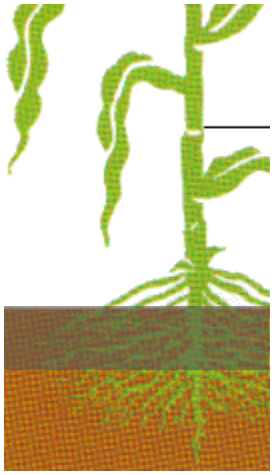
Timely application of irrigation water:

- Improves incorporation of herbicides.
- Improves activation of herbicides.
- Humid irrigated environment slow some insects.

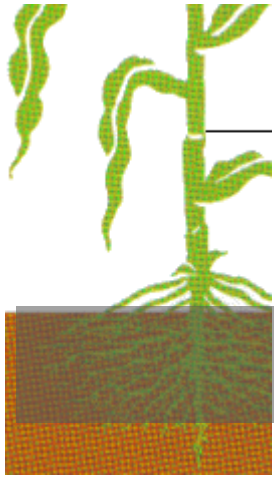
- Reduces nitrogen volatilization.
- Maximizes yield to utilize the resources.

(Water stressed weed to get better glyphosate kill)

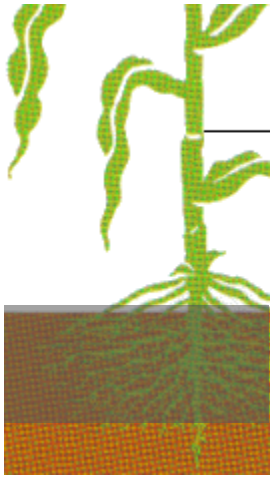
Monitoring soil wetted front -12 hrs. after irrigation



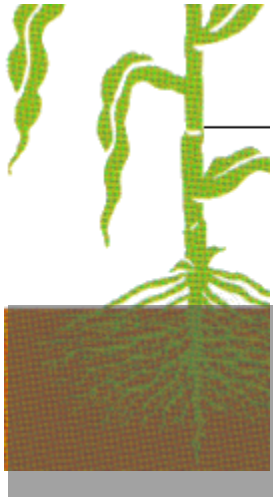
½” into dry soil



½” into moist soil



1” into dry soil



1” into moist soil

If your 1” application did not go down as far as it did last week ???

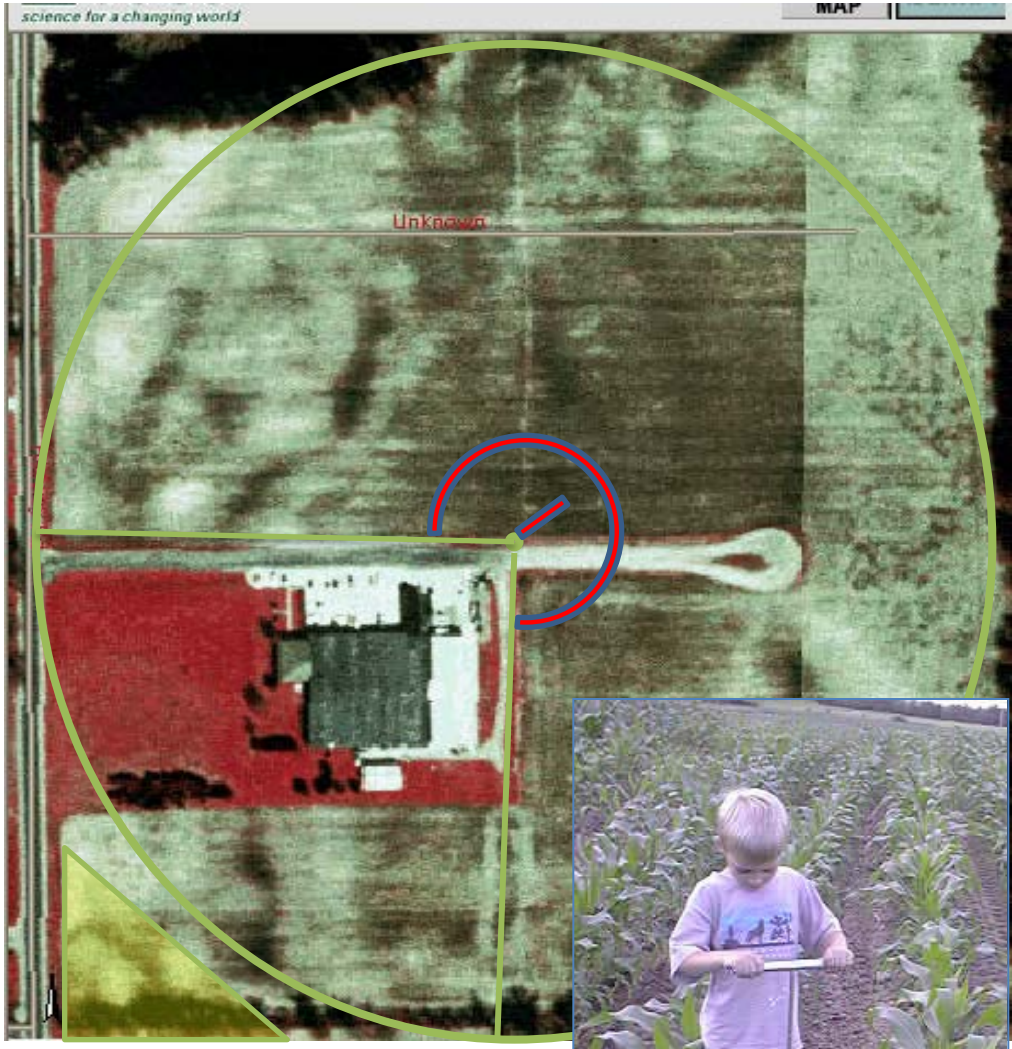
- your irrigation is not keeping up.

Scheduling by comparison

Irrigated portion of field should look better than the dry corners/area

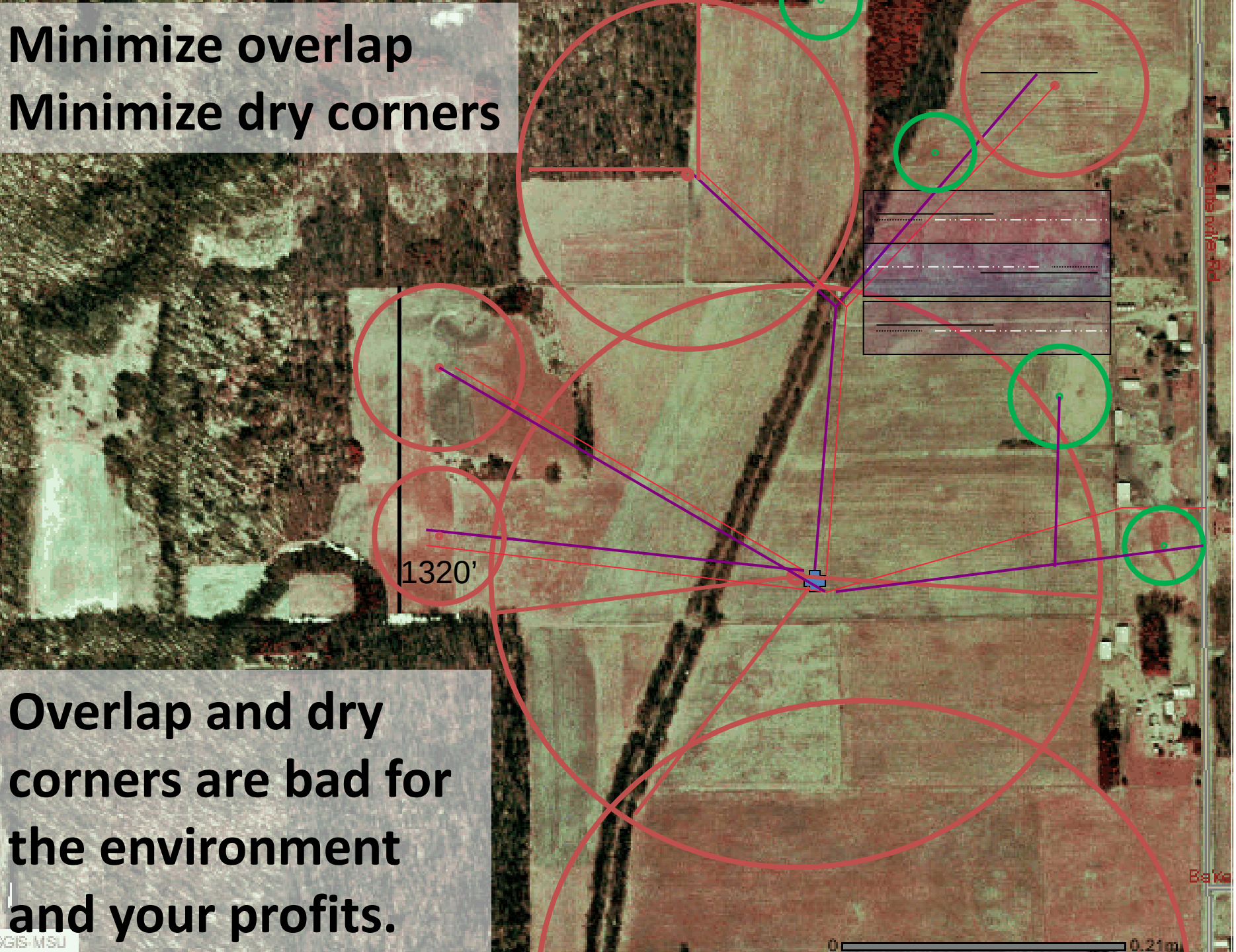
Over water observation area should not look significantly better than the adjacent irrigated portion of field.

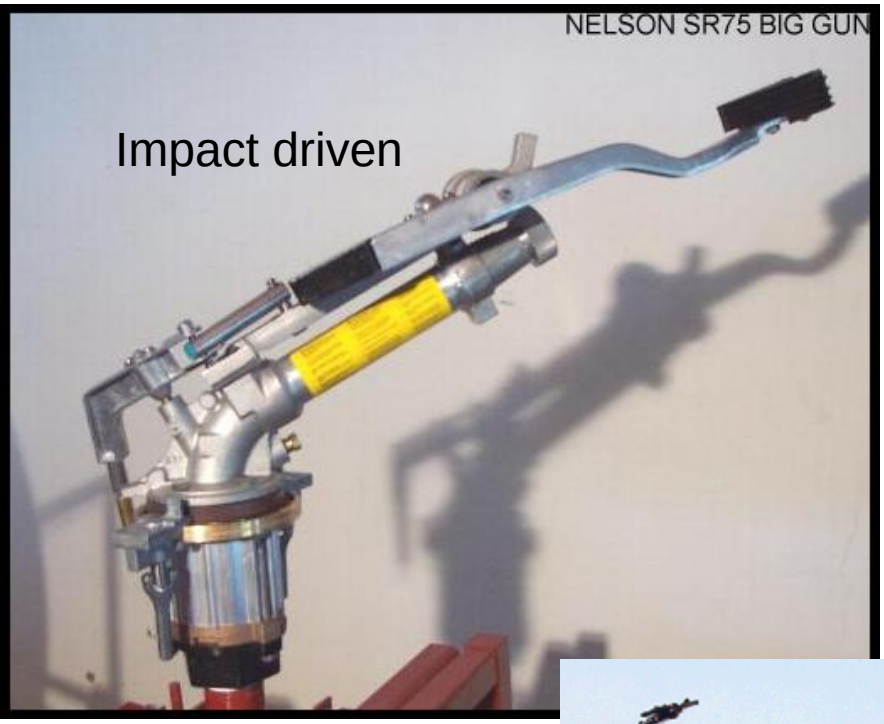
Probe and compare:
- Dry corners
- Over irrigated
- Normal irrigated field

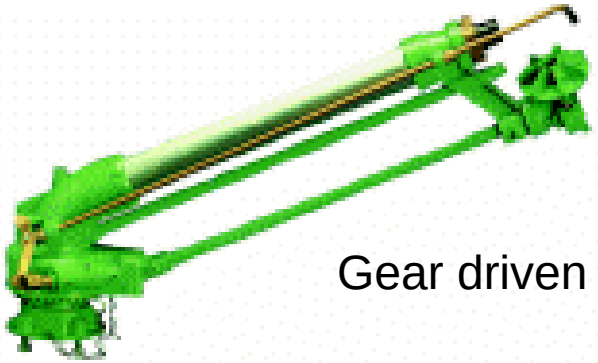


- Soaker hose attached at pivot point
- 100% higher output sprinkler

Too much water and/or N can leads to White Mold concerns


Minimize overlap
Minimize dry corners
1320’
Overlap and dry corners are bad for the environment and your profits.





Lodging and knock down issue vary greatly with gun design

Estimated Annual Irrigation cost/acre,

10 yr. at 7” of irrigation

From http://www.msue.msu.edu/stjoseph
12/2013 survey of five irrigation suppliers

Type of System	Ownership cost	Operating cost	Total Cost / Acre
160 Acre Center Pivot	**100.70**	**33.25**	**$133.32**
Corner Arm System 160 Field	**100.74**	**33.25**	**$133.99**
Traveler System Soft Hose	**99.56**	**70.00**	**$187.06**
40 Acre Two Circle Towable System	**149.43**	**38.50**	**$187.93**
160 Acre Drag Pod	**133.70**	**45.50**	**$196.70**
Single Tower Towable, 5 circles	**148.33**	**45.50**	**$197.33**
Traveler System Hard Hose	**125.69**	**70.00**	**$213.19**
80 Acre Center Pivot	**208.65**	**33.25**	**$241.90**
40 Acre Center Pivot	**241.51**	**33.25**	**$274.76**

What is your cost to Irrigate?

Energy + Labor

For many one bu. increase would pay for 2-3" of irrigation

Indiana Average energy cost / acre" = $3.50 2007 Ag census

Extremely variable - ($1.67 to $14.70) Kelley

Cost per acre inch of irrigation water - Average fuel cost for pumping NE.

Energy source Pressure	Electric	Diesel / propane
Low <35 psi	$1.76	$2.56 / 2.30
Med. 35 to 95 psi	$2.48	$3.76 / 3.27
High >100psi	$ 3.56	$ 4.87 / 3.90

2007 census of Agriculture