Mobile Drip Irrigation (MDI)

What we know so far

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Ogallala Aquifer Program

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

OgallalaWater.org
OPTIMIZING WATER USE TO SUSTAIN FOOD SYSTEMS

Kansas Water Office

My Background:

Philippine Agriculture

Avg. Annual Rainfall = 7.3 ft (±5 ft)
Avg. No. of Typhoons/yr = 21
No. of Islands = 7,107 (7,641 as of 2016)

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UPLBFI

FAO FIAT PANIS

US/Kansas Agriculture

Avg. Annual Rainfall = 16 in (12 –48 in)

Avg. No. of Tornadoes/yr = 92

No. of Lakes = 106

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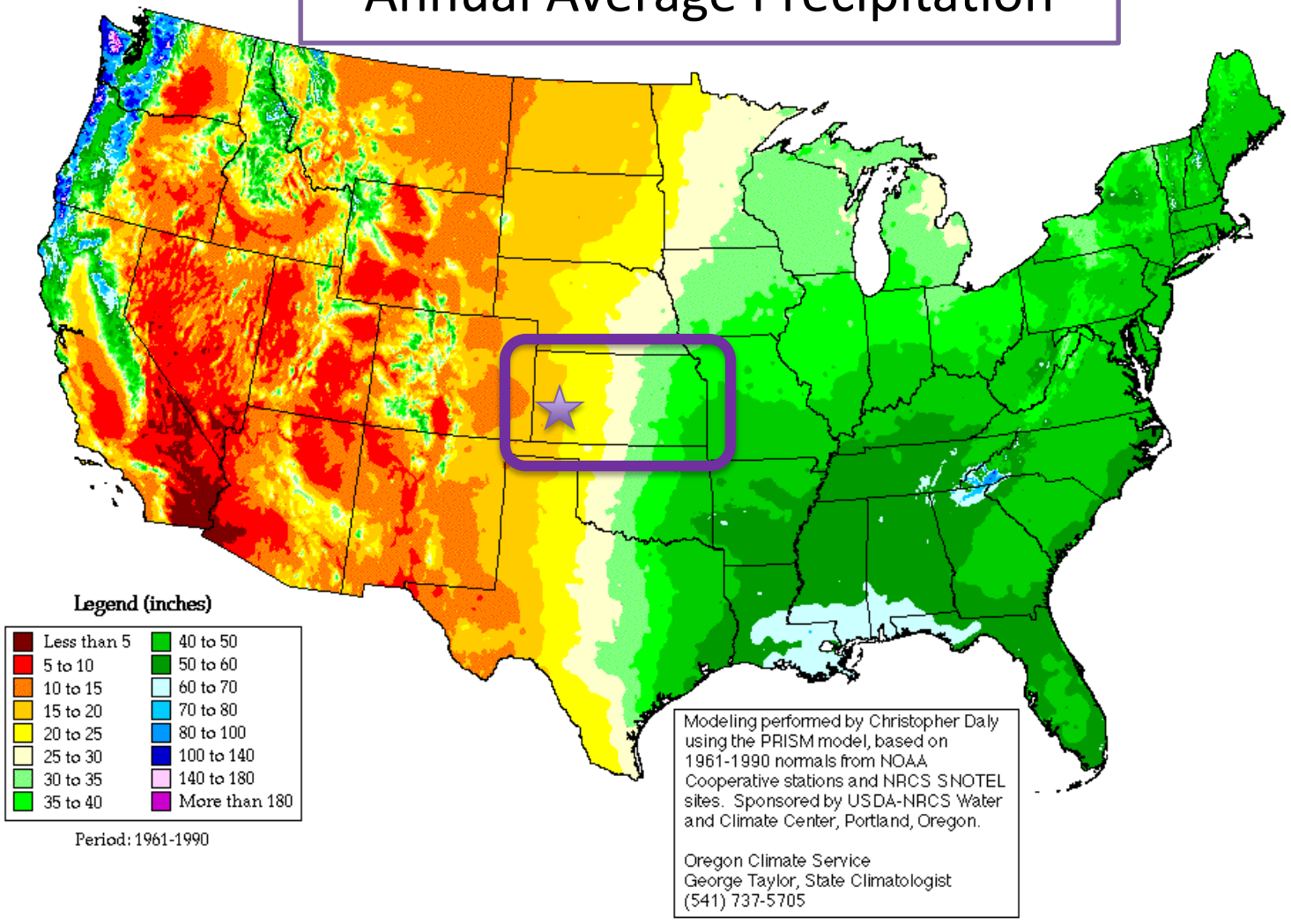
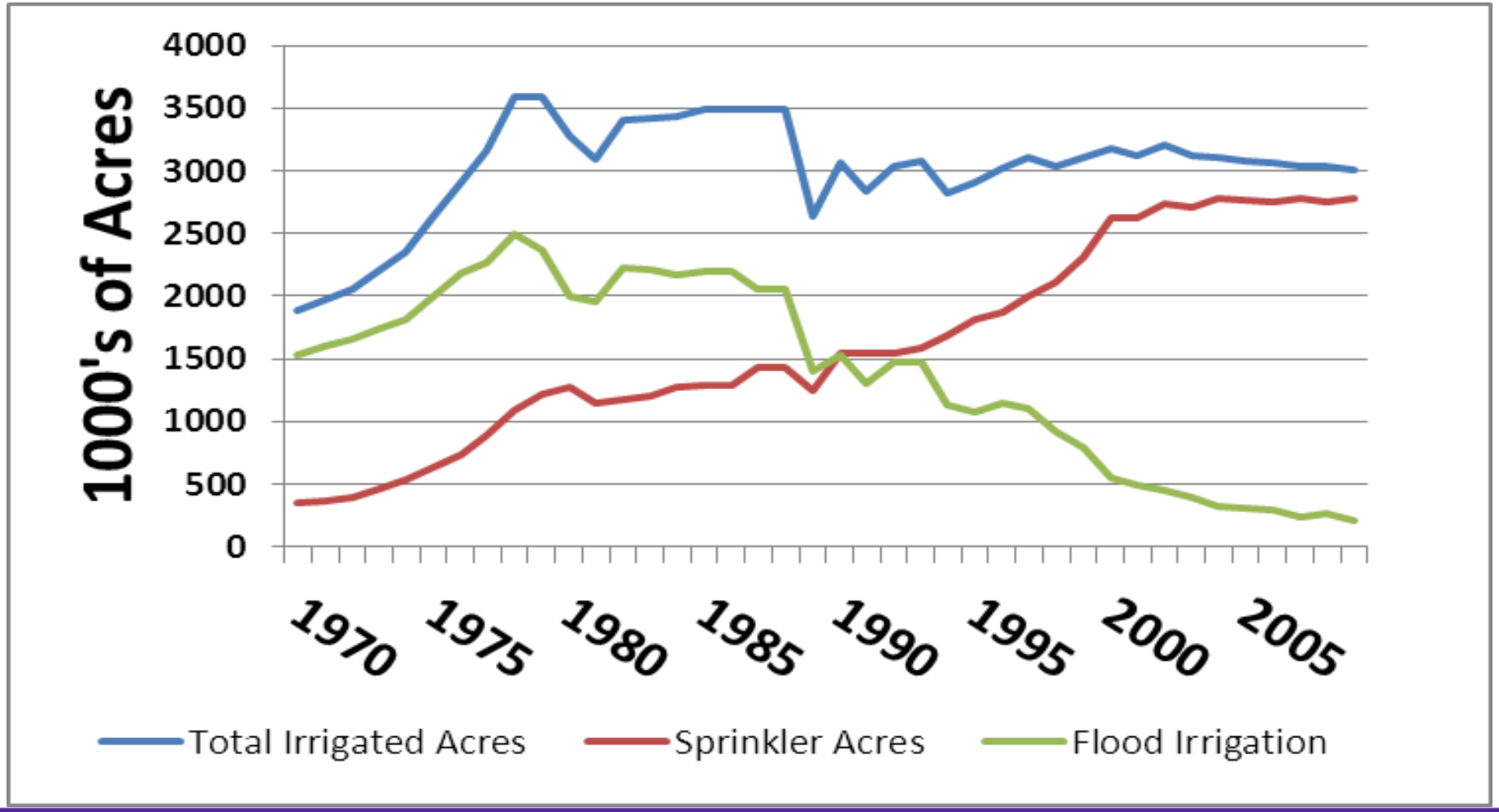
K-STATE

USDA ARS

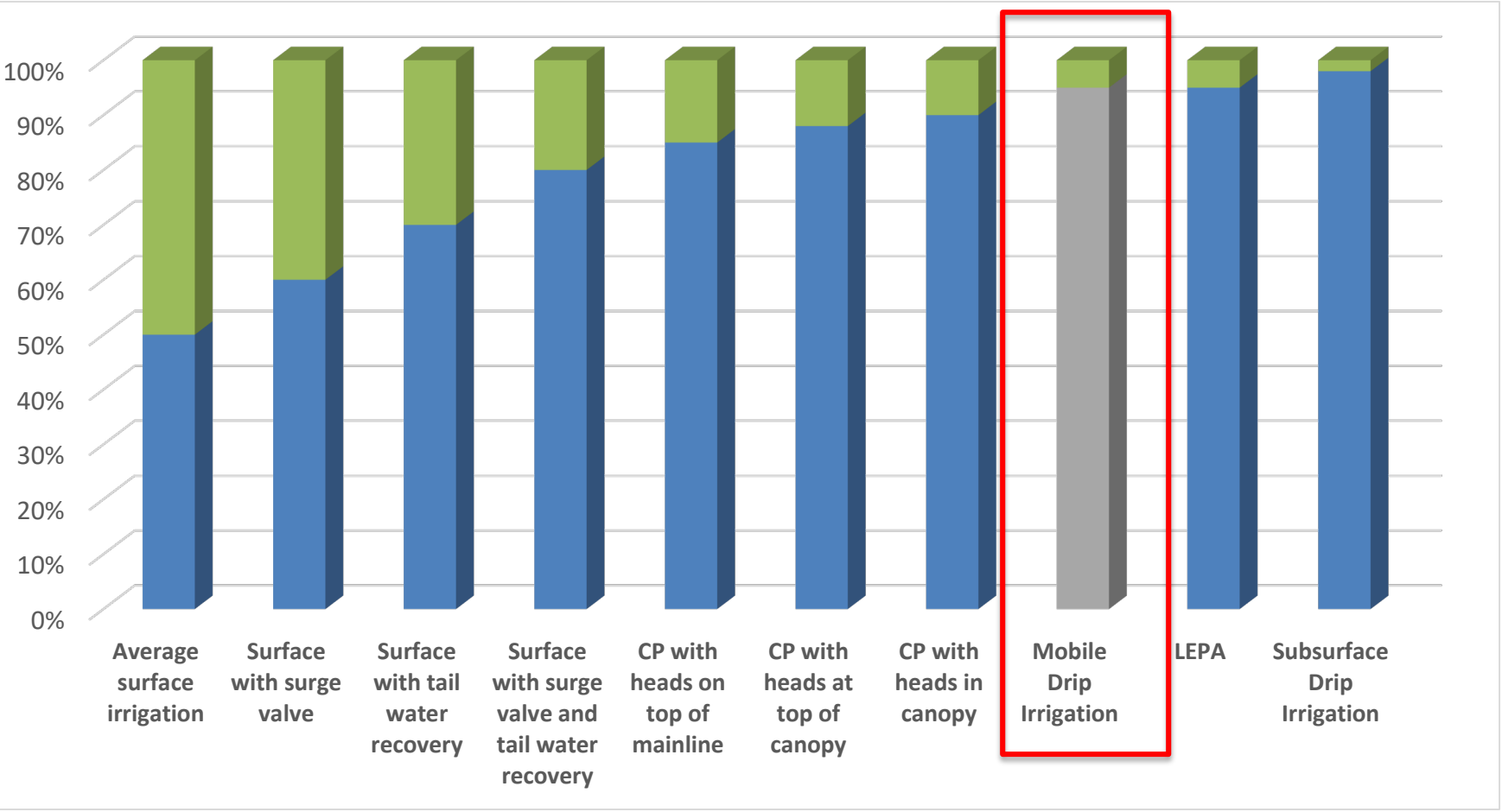
Continental US
Annual Average Precipitation



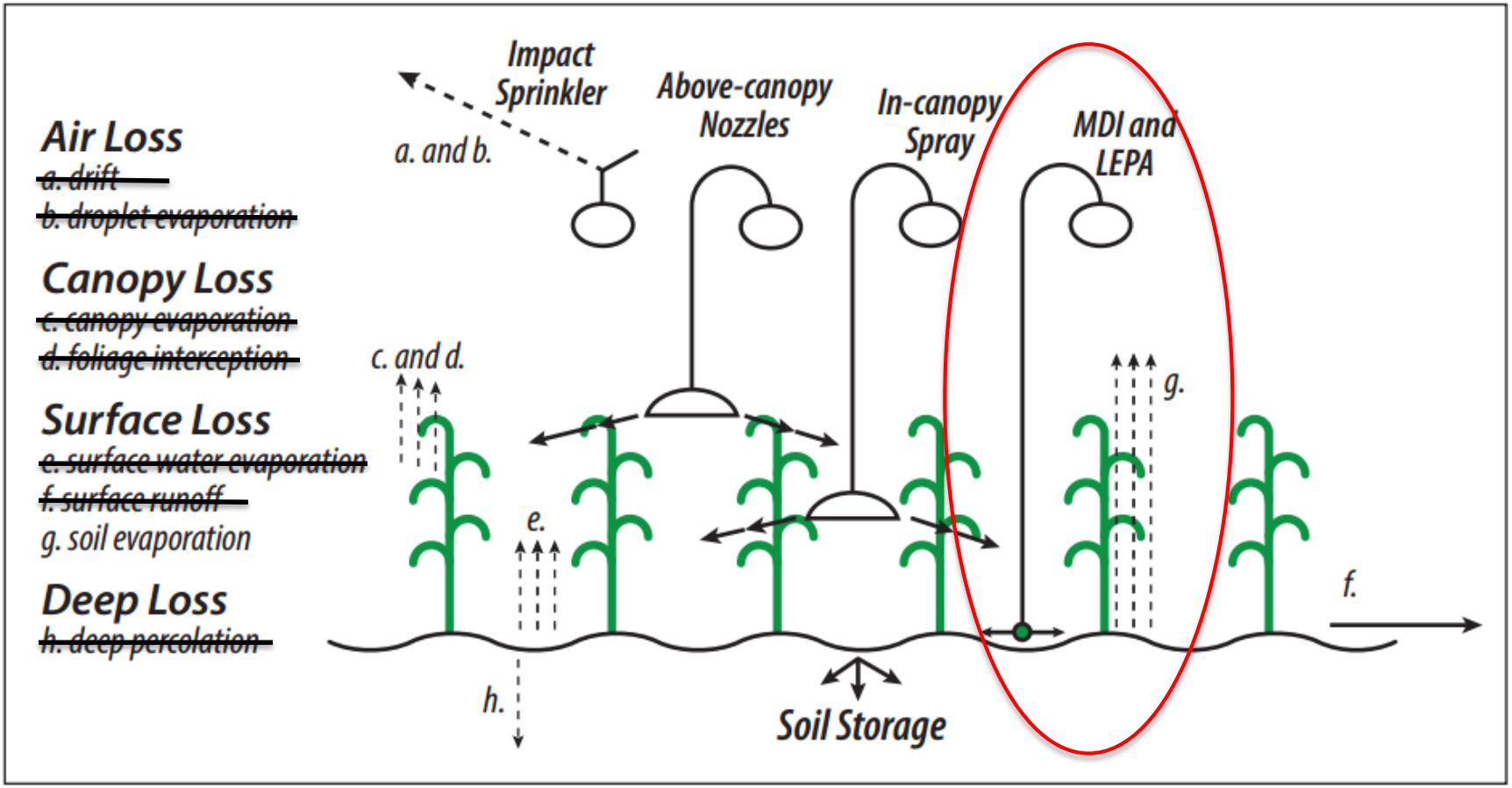
Total irrigated area, sprinkler systems, and flood irrigation system in Kansas



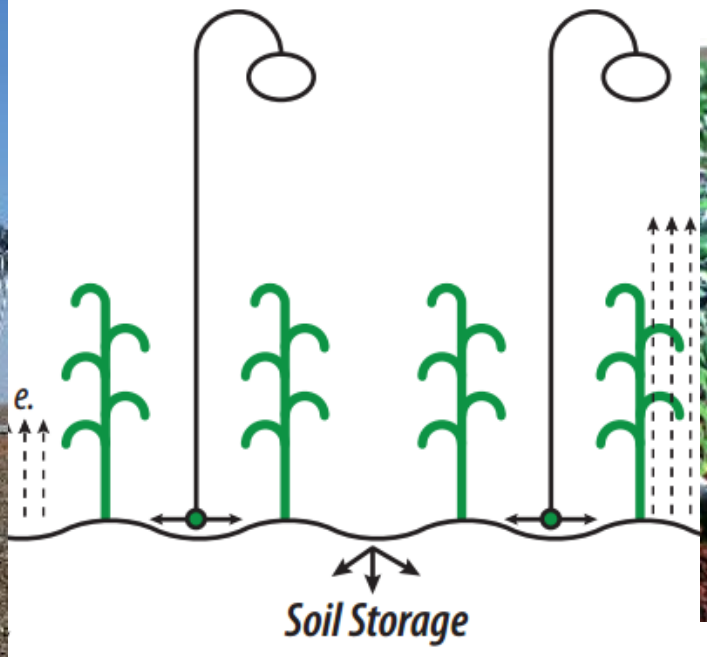
The Race for 100% Efficiency



Sources of Losses on Center Pivots



MDI and LEPA



Our Story Started BECAUSE…

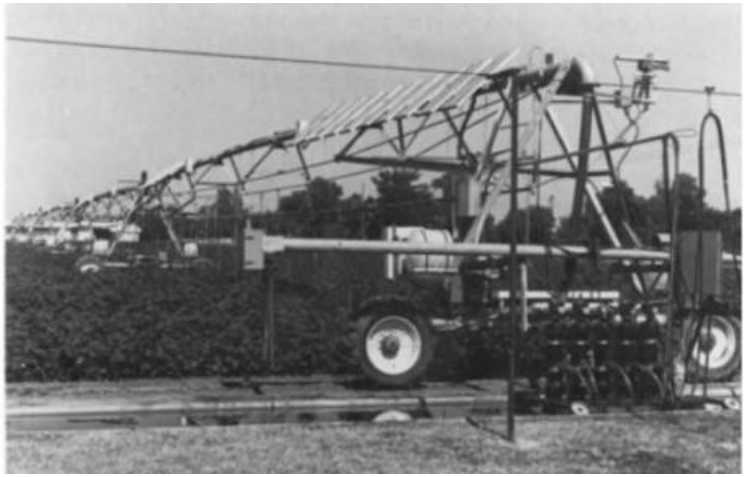
Farmers Asked

We Proposed

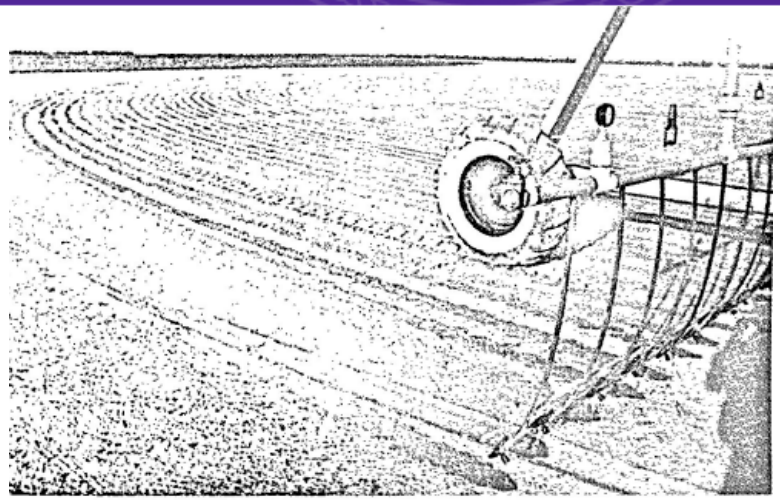
Partners Responded

1. *Is MDI more efficient compared to nozzles?*
2. *Do you get more yield with MDI?*
3. *At what well capacity should I consider MDI?*
4. *Water productivity?*
5. *Germination in dry years?*
6. *Effect of variable well capacity?*
7. *Herbicide incorporation?*
8. *Longevity of drip lines?*
9. *Economics: cost-benefit analysis?*
10. *Others.*

Earlier work on Mobile Drip Irrigation (MDI)



Howell and Phene, 1983 in Fresno California



Helweg (1989) in Saudi Arabia

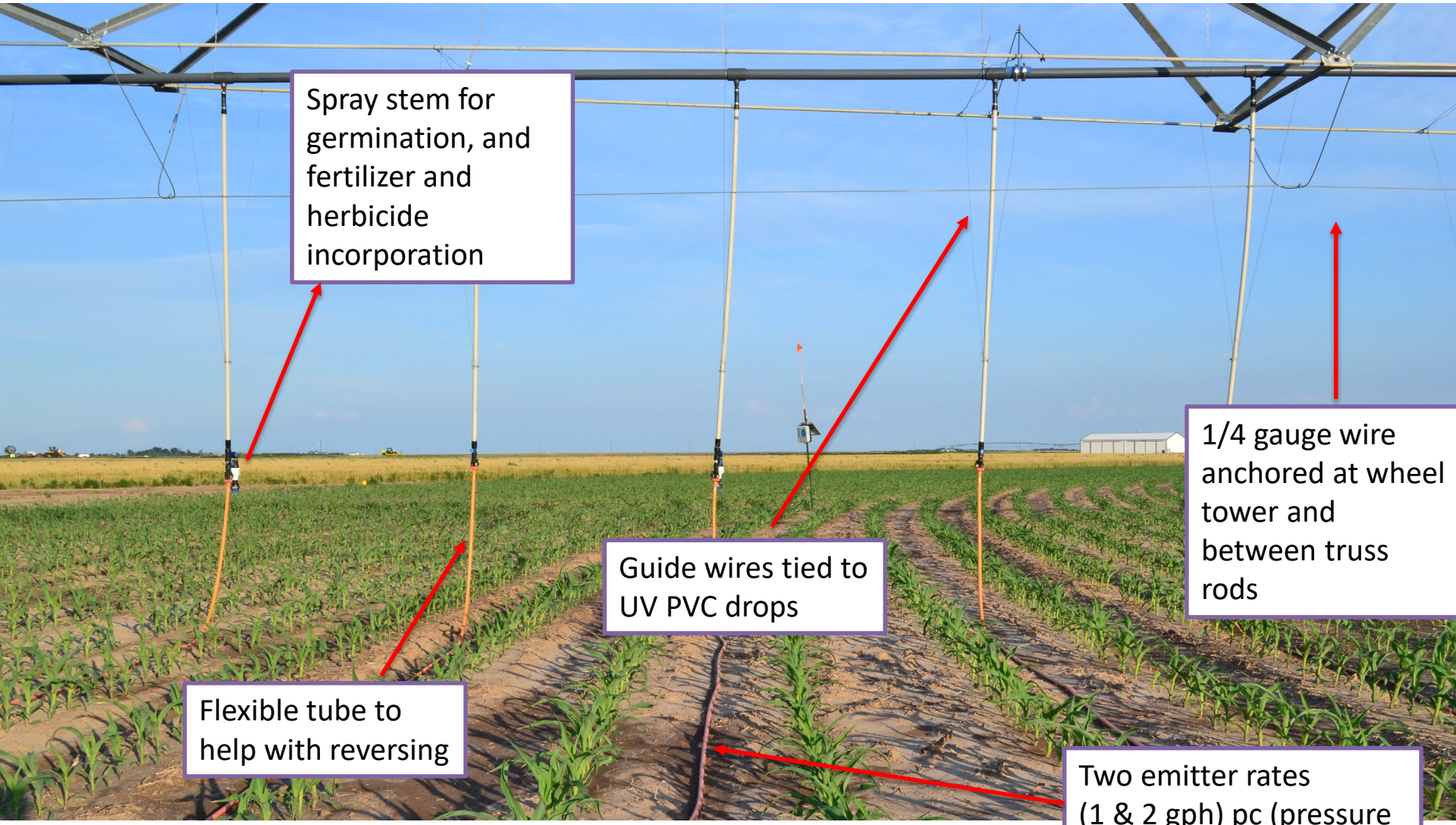
Sourcel (2003) in Germany

Olson and Rogers (2008) in NW Kansas

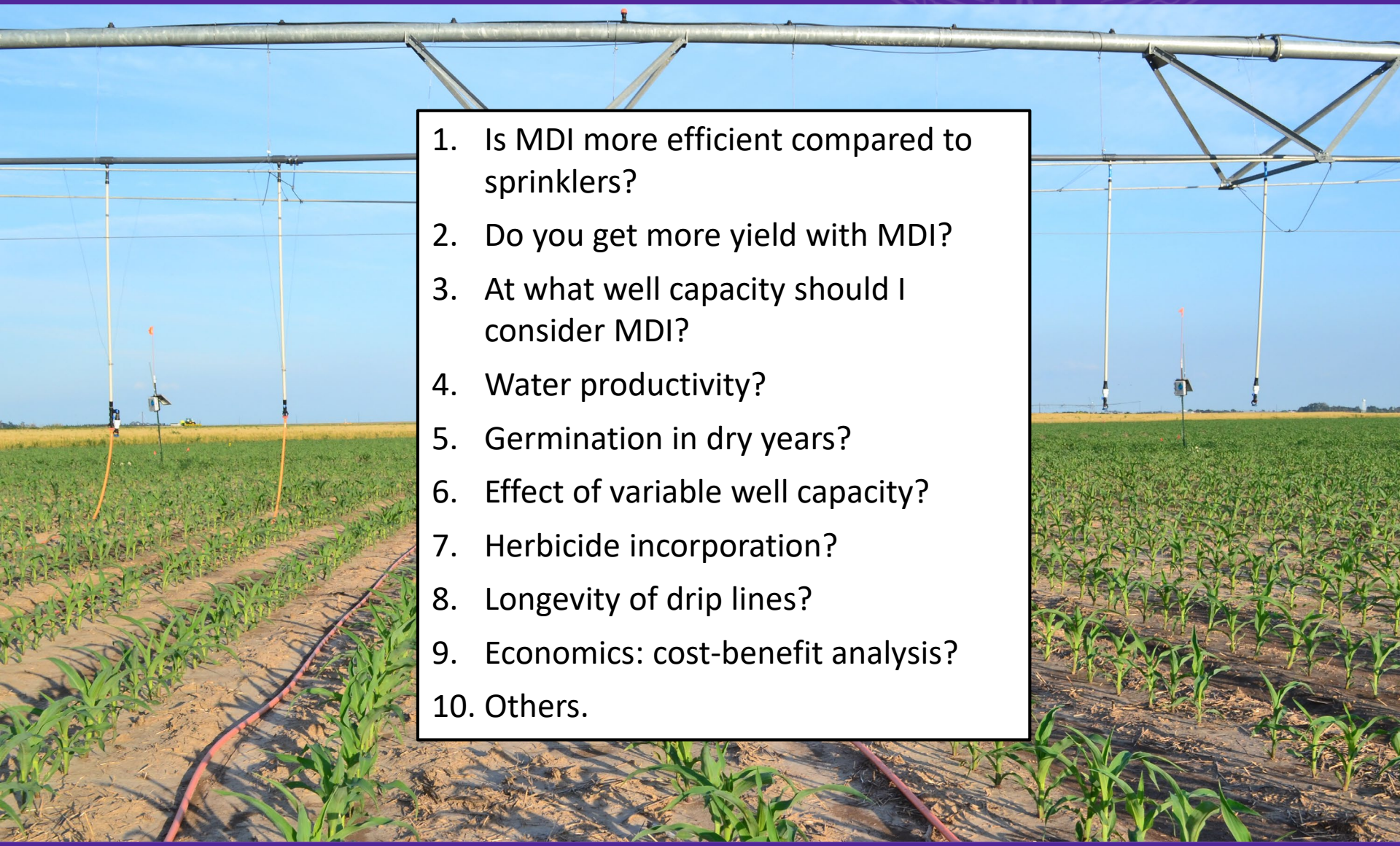
Mobile Drip Irrigation Research at SWREC

Installed and started 5 months after advisory meeting

Mobile Drip Irrigation Research at SWREC



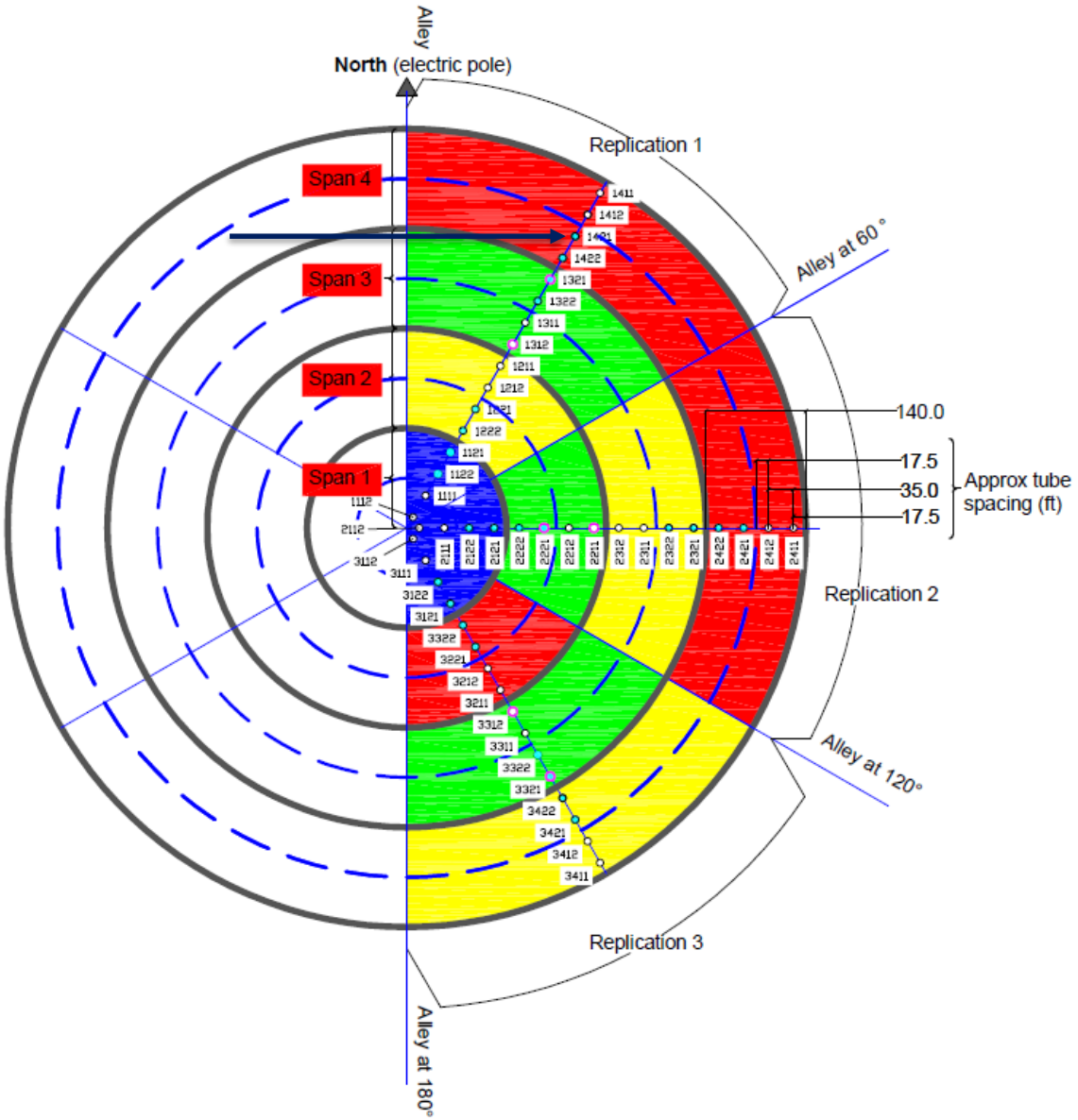
Questions about MDI from producers in SW Kansas



1. Is MDI more efficient compared to sprinklers?
2. Do you get more yield with MDI?
3. At what well capacity should I consider MDI?
4. Water productivity?
5. Germination in dry years?
6. Effect of variable well capacity?
7. Herbicide incorporation?
8. Longevity of drip lines?
9. Economics: cost-benefit analysis?
10. Others.

Experimental Layout 2016-2017

Center pivot Spinkler and Drip Irrigation Experiment for Corn (2016)



KEY

Numbering Code: R-S-T-N (Replication/ Span/ Drip or Sprinkler/ Number

Total tubes installed = 66

Note: Tubes NOT in exact straight line as depicted in drawing

- Drip (code 1)
- Sprinkler (code 2)
- 3 tubes installed (Sprinkler)
- 5 tubes installed (Drip)

600 gpm

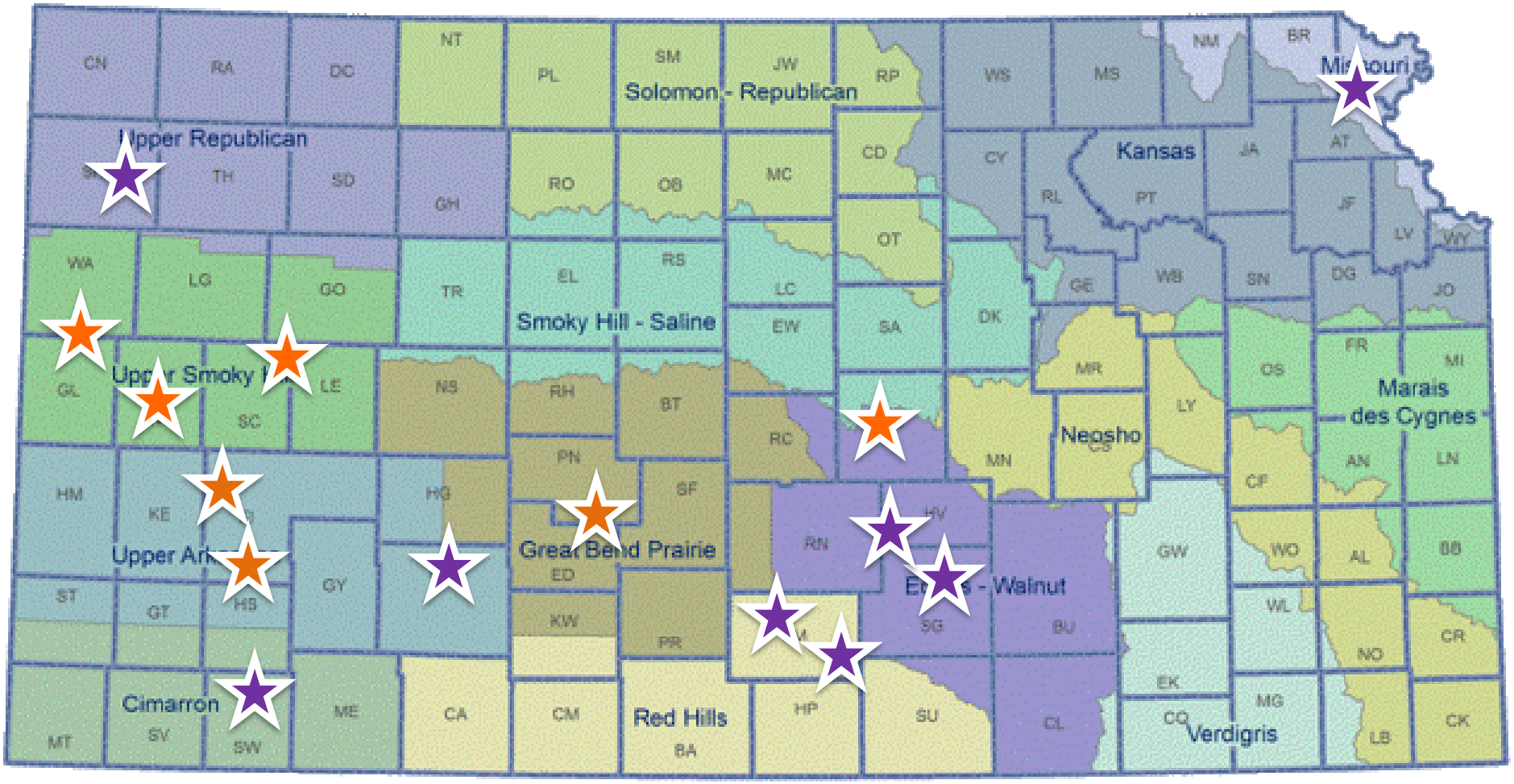
300 gpm

150 gpm

- Always on

Drawn by: Tobias Oker Date: 05/19/2016

2019 Network of Water Technology Farms



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★ farms with MDI

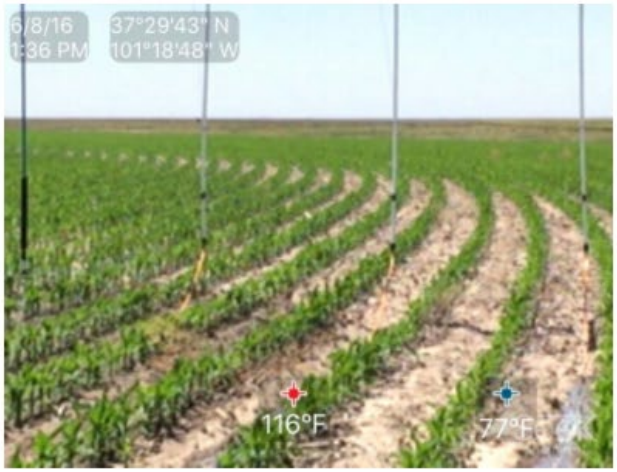
What we know so far…

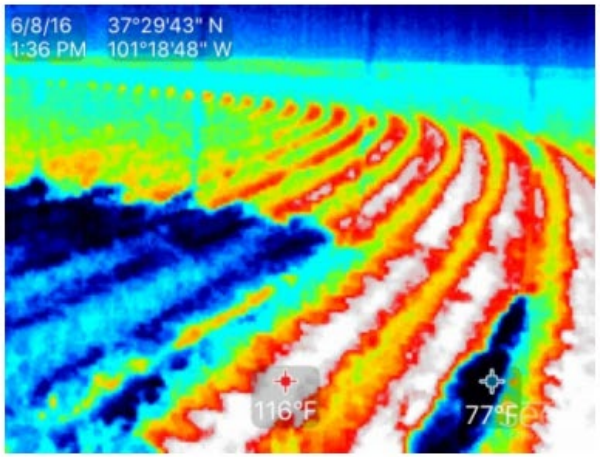
- **Application and Water Use Efficiencies**
- **Management**
- **Suitability**
- **Cost**
- Longevity

Better than Spray (LESA and MESA)

BUT not as good as Subsurface Drip Irrigation (SDI)

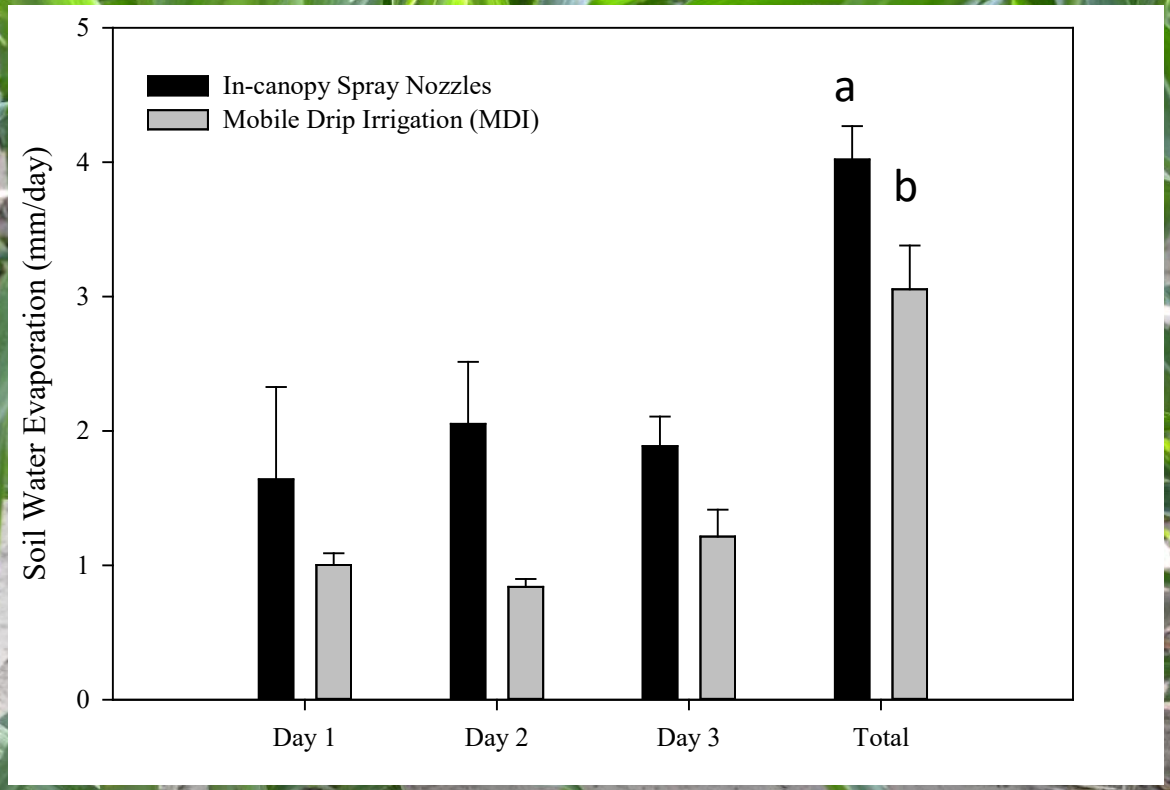
Evaporation under MDI and Sprinklers





Limited wetting of the soil surfaces reduces soil water evaporation losses.

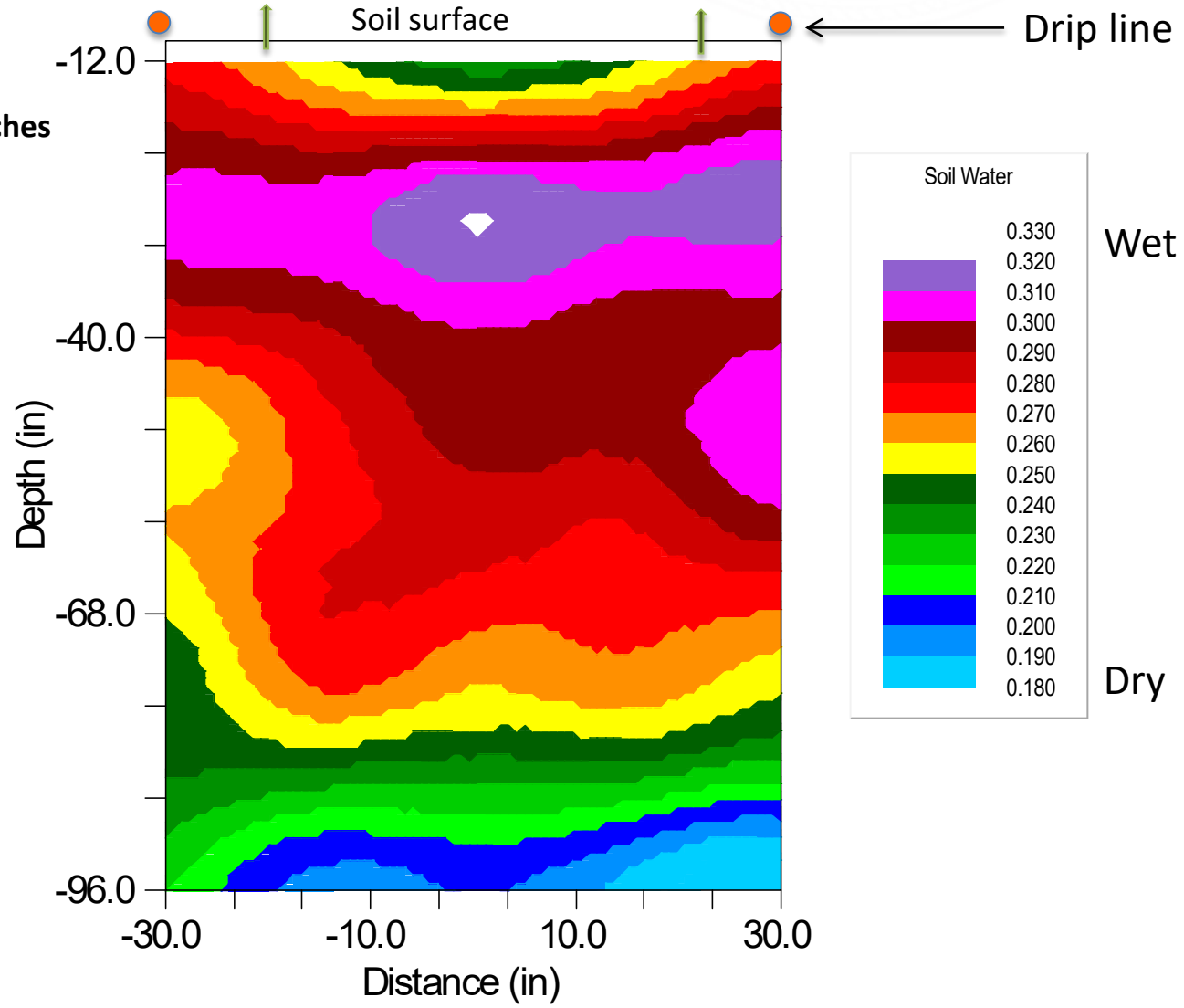
Soil water evaporation under LESA and MDI



Percent difference in soil water evaporation ~35%
Before the canopy closes

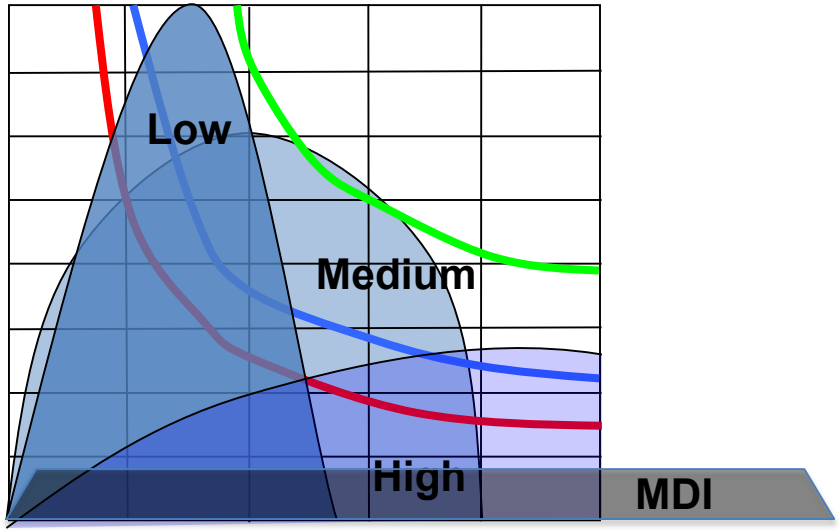
Soil water redistribution under MDI

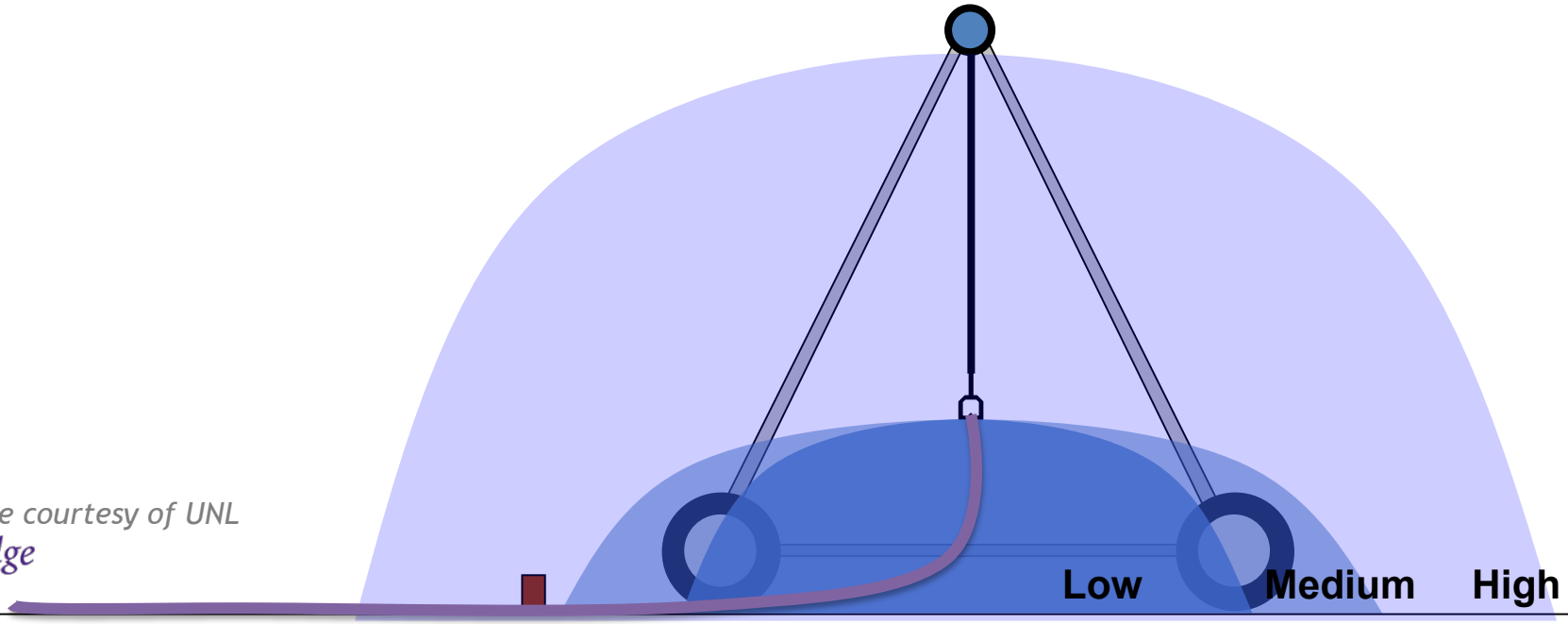
- **Drip line spacing 60 inches**
- **Corn spacing 30 inches**



Sprinkler Pressure vs. Intake Characteristics

Timed Rain Gauge Analysis Thunderstorm Intensity

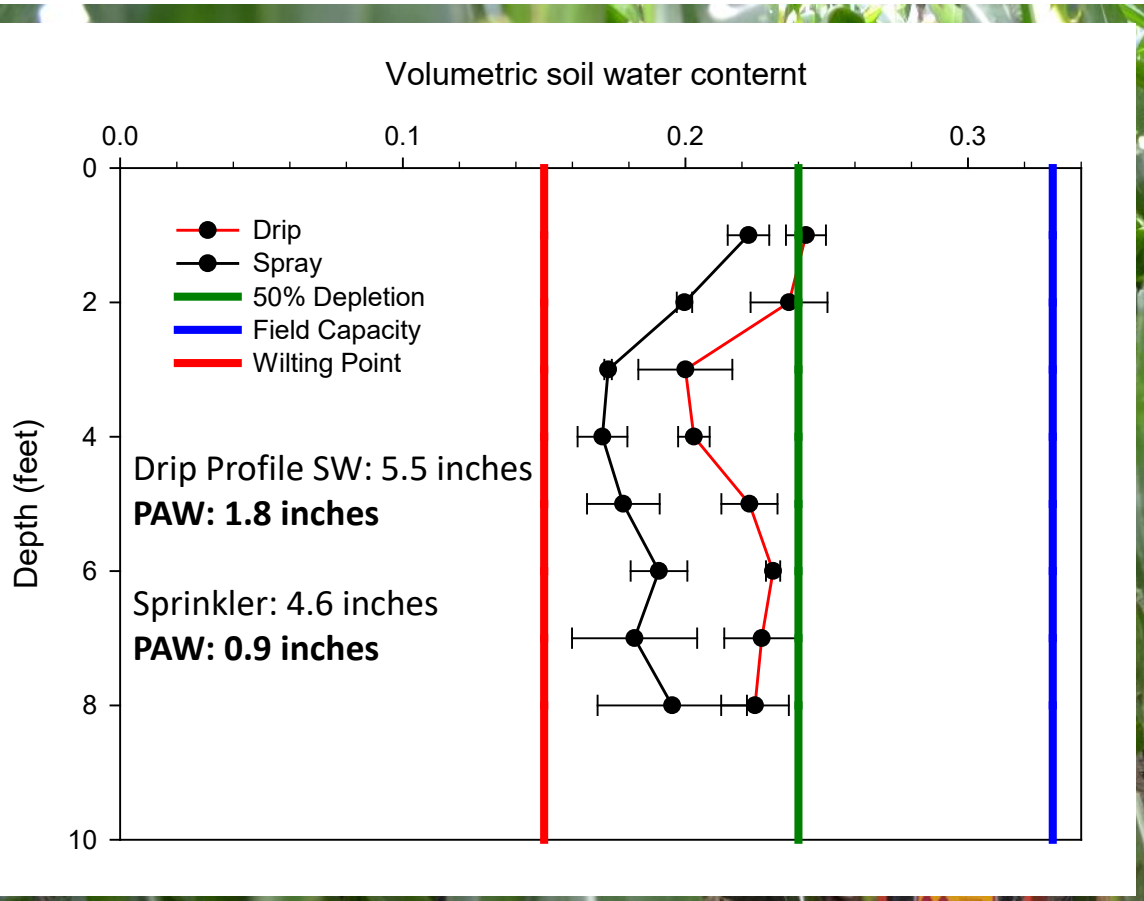




Original slide courtesy of UNL

Knowledge for Life

End of season soil water under 0.12 in d^{-1}



P-value<0.05, α=5%

MDI 2016 Results

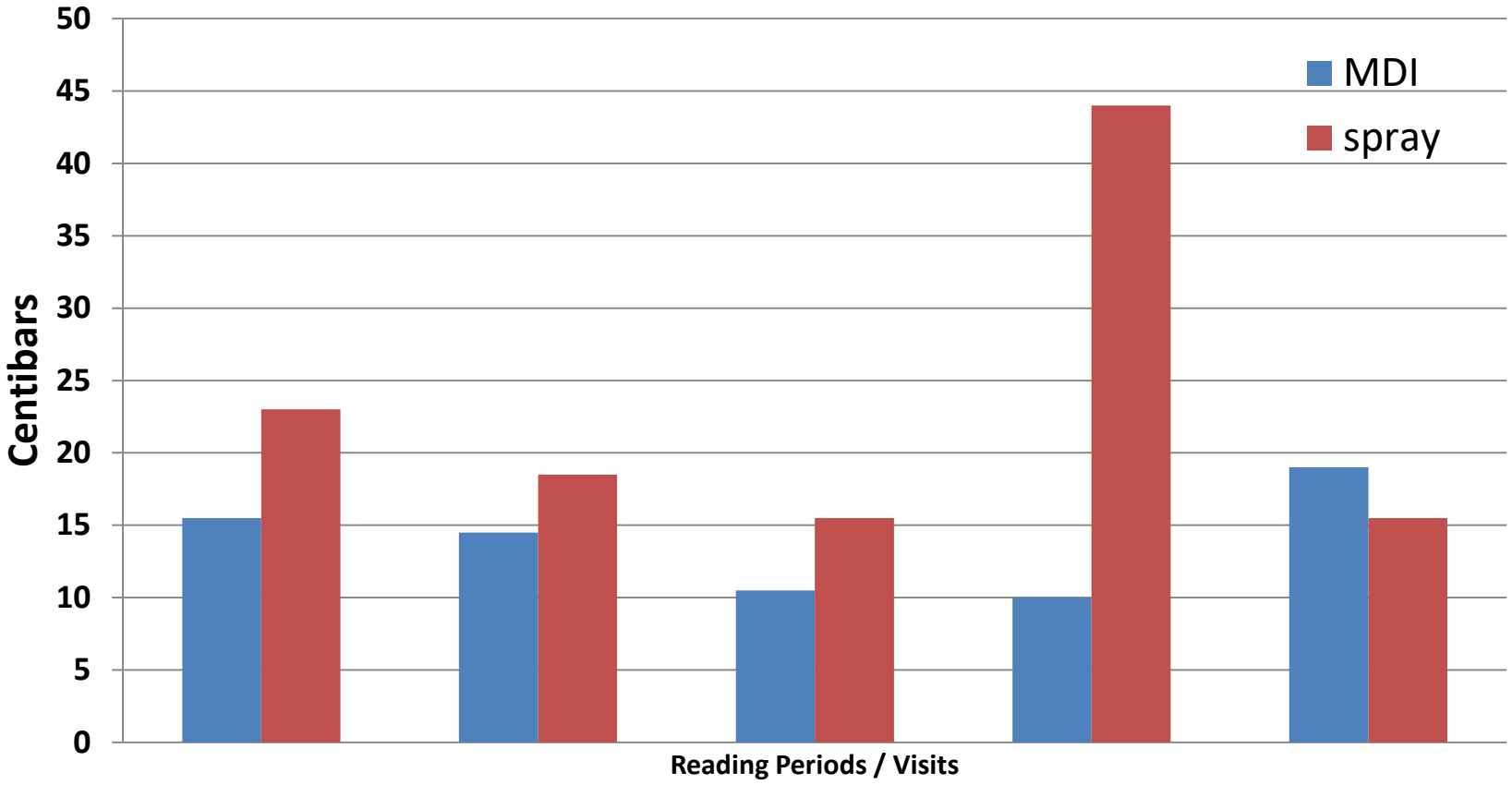
Simulated well gpm on 125 ac	600	300	150
Drip 2 gpm	245 b	271 a	243 ab
Drip 1 gpm	294 ab	263 a	268 a
Bubbler	275 ab	256 a	239 ab
Spray	265 a	240 a	**212 b**
Irrigation (in)	11	6	4

Rainfall May to October: 14.8 inches

At very low well capacity, highly efficient irrigation systems are inevitable

ILS/WaterPACK WTFarm

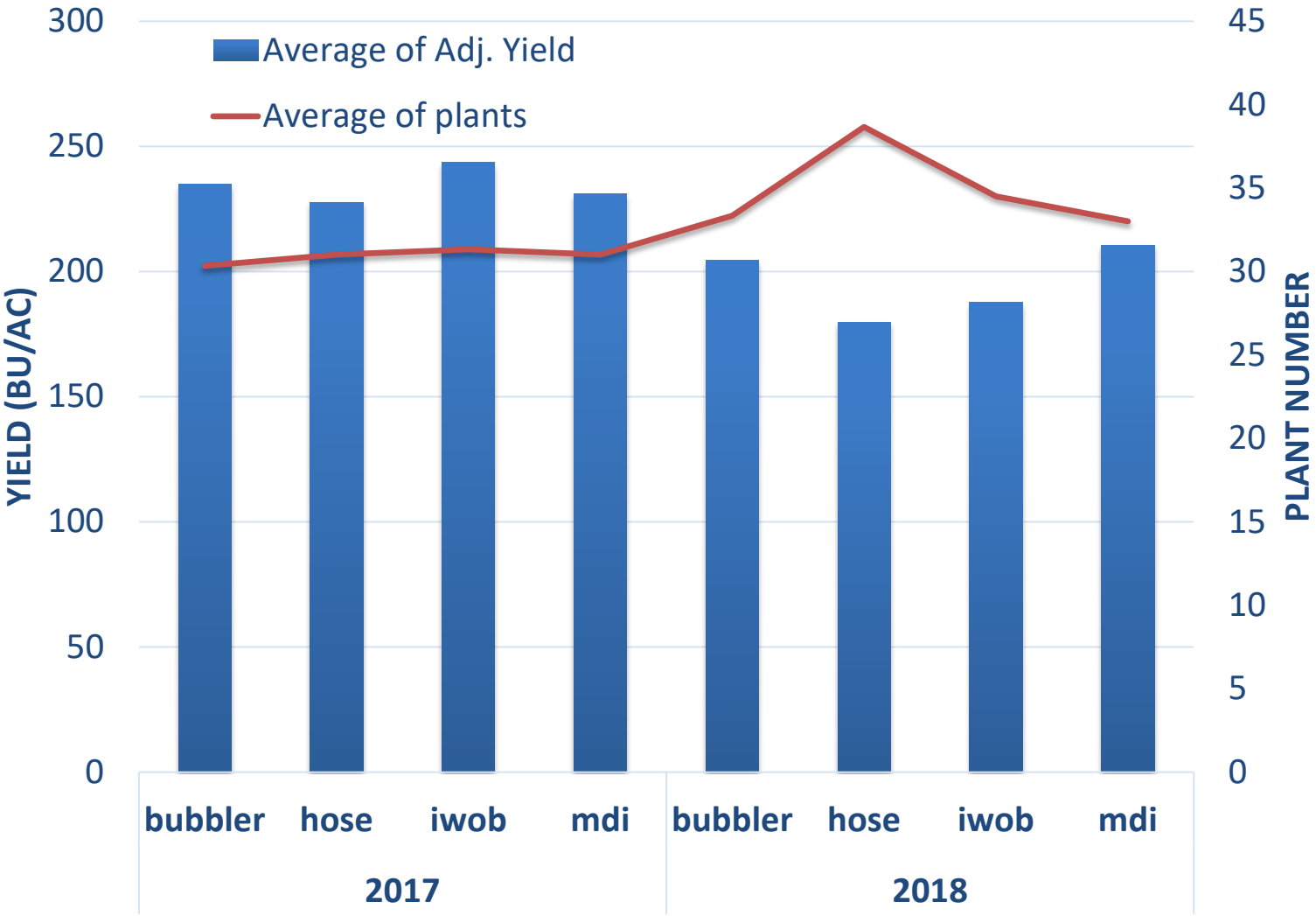
MDI vs Spray Soil Comparison



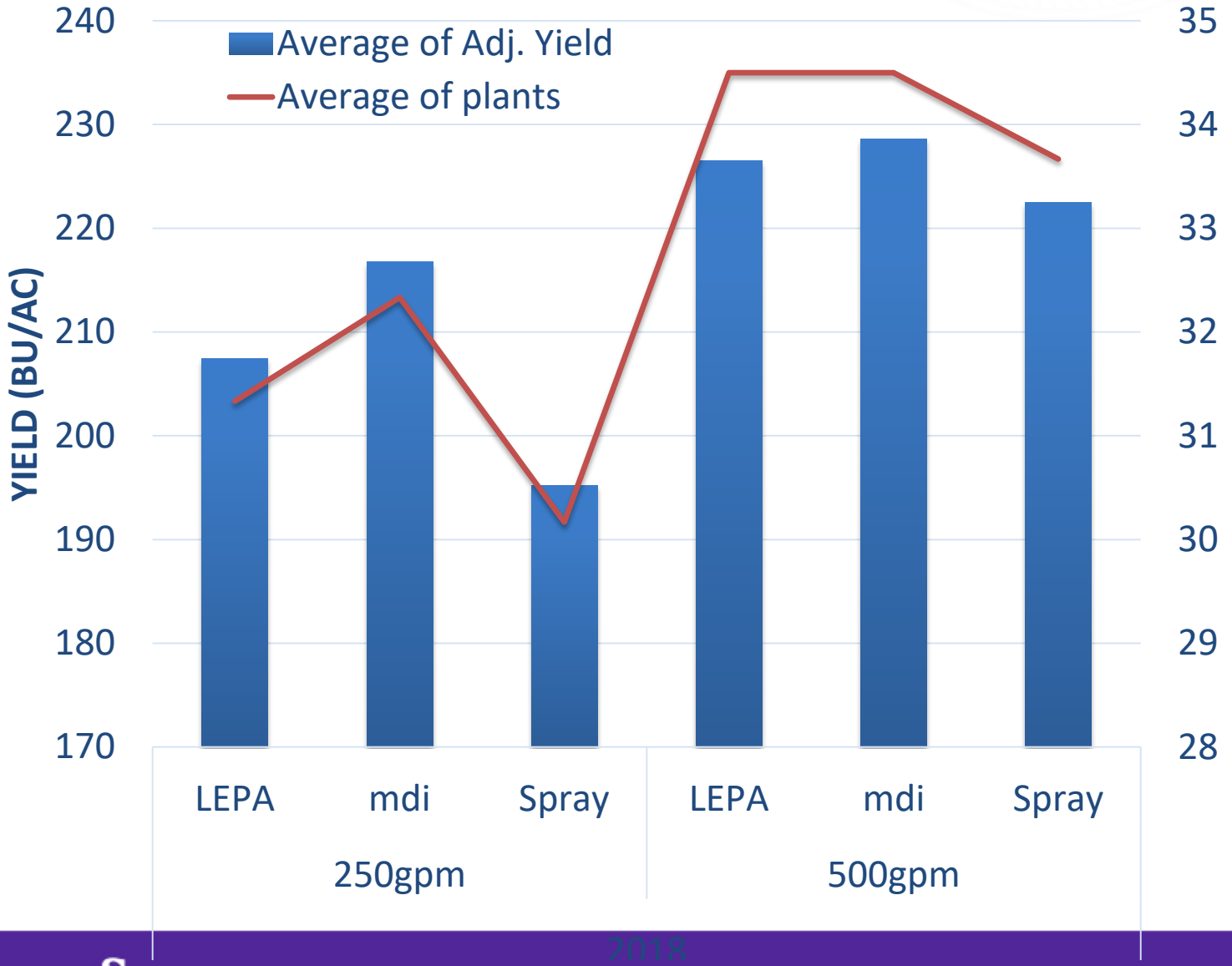
2018 ILS/WaterPACK Farm Data

FIELD	TREATMENT	YIELD (Combine) (BU/AC)	YIELD (Hand) (BU/Ac)	IRRGN APPLIED (IN)	WATER USE EFFICIENCY (BU/Ac-IN)
NORTH 16	ALL	234	244	13.1	18.62
	MDI (70%)	231	243	9.8	24.8
	MDI (80%)		237	11.2	21.2
	SPRAY (100%)	249	259	14.0	18.5
SOUTH 15	SPRAY	232	237	15.3	15.5

Roth/GC Co Farm Data



Long WTFarm


Average of Adj. Yield
Average of plants
YIELD (BU/AC)
240
230
220
210
200
190
180
170
35
34
33
32
31
30
29
28
LEPA
mdi
Spray
LEPA
mdi
Spray
250gpm
500gpm

Less critical than SDI

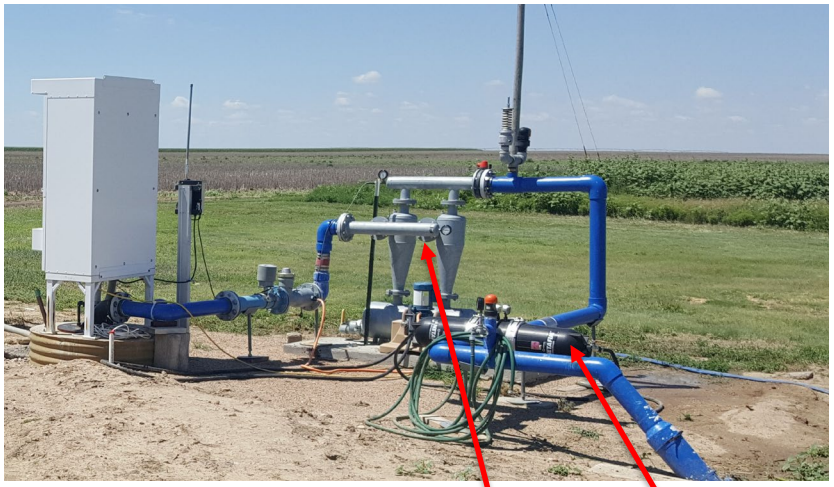
BUT more involved

than Spray (MESA/LESA)

MDI vs Spray on
Circular vs
Straight Planting
Corn

MDI Filtration System

Disc Filter 2 Inch
Mesh 200
Flow up to 200 gpm



Combination of cyclone and disc filters

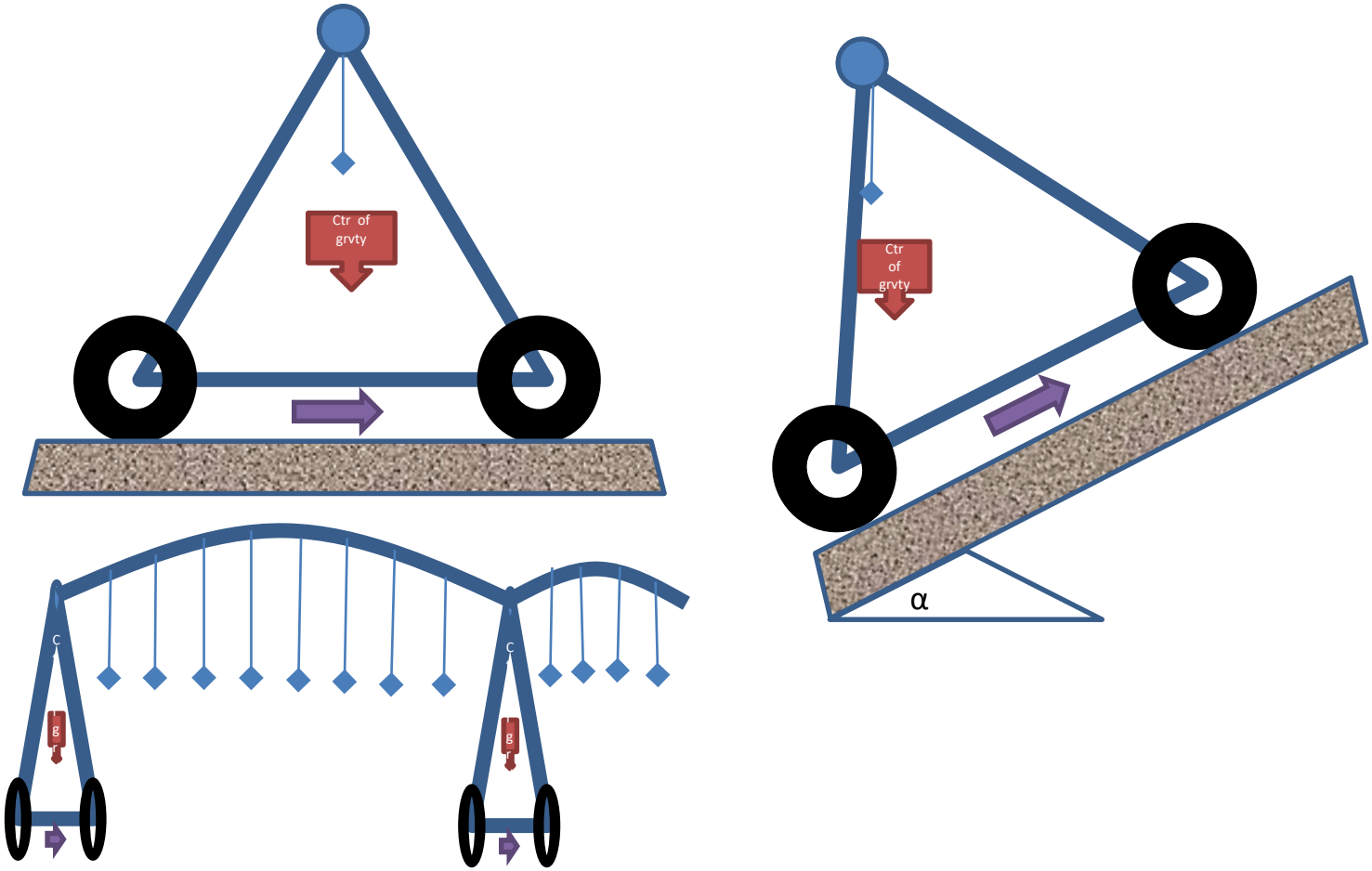
<u>This is Drip, so clogging can be a major problem</u>

May have an advantage in some:

- locations (e.g. flat)
- conditions (e.g. limited capacity, improve inside two towers)
- situations (e.g. preventing wheel track rutting, avoiding salt on leaves)
- crops (e.g. better for low profile crops)

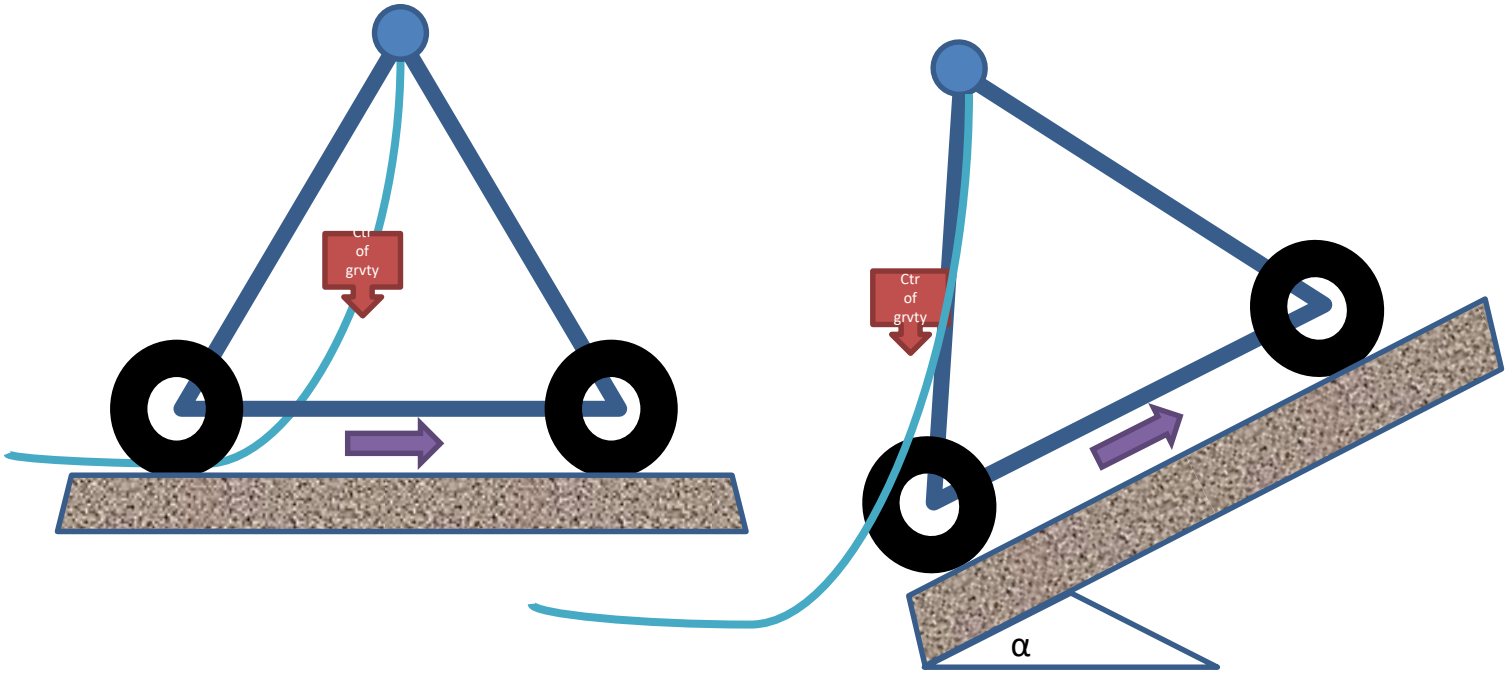
Structural Static and Dynamic Forces

Typical Spray Nozzle Center Pivot System



Structural Static and Dynamic Forces

Mobile drip irrigation system



Low height crop MDI system

- *More expensive than spray but a lot cheaper than SDI*
  > Other conditions may help justify the cost

Repair Cost at T&O WTFarm

MODE	TOTAL COST	AVERAGE COST
SPRAY (6 circles)	$ 4,596.00	$766.00
MDI (4 circles)	$ 180.00	$ 45.00

2016 Partial Budgets

Pivot Designation	NE20	SW20	SE20	NW20
Technology	MDI	Spray	MDI	Spray
Crop	Alfalfa	Alfalfa	Sorghum	Sorghum
Income				
Acres	123	123	123	122
Yield per Acre	2.97	3.13	140.04	145.25
Price	$161.48	$161.48	$4.46	$4.46
Gross Profit ($/ac)	$479.19	$505.45	$624.58	$647.80
Expenses				
Seed	$74.63	$96.59	$8.45	$9.00
Herbicide	$13.18	$13.18	$60.68	$59.37
Fertilizer	$25.06	$40.88	$77.69	$91.69
Drive Train Repairs	$0.00	$3.86	$0.00	$12.88
Variable Expenses	$112.87	$154.51	$146.82	$172.94
Profit Above Variable Expenses	$366.31	$350.94	$477.76	$474.86
Water Use (ac-in/ac)	4.46	3.77	9.65	9.36
Profit per ac-in/ac	$82.14	$93.10	$49.53	$50.71
Yield per ac-in/ac	0.67	0.83	14.52	15.51

Longevity depends on

- management (e.g. circular planting, grazing on field)
- field (e.g. better on flat than undulating field)
- crop (e.g. better on short crops)
- who you ask

Future Research on MDI / Other unanswered questions

- How will fertigation affect the management and crop performance?
- How do we capitalize on the reduced soil water evaporation?
- Are there other benefits and improvements that we could still identify on this technology?

THANK YOU

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