Forage Sorghum Production with Limited Water

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February 2024

Hartley County, Texas May 11, 2022

photo credit: Jourdan Bell

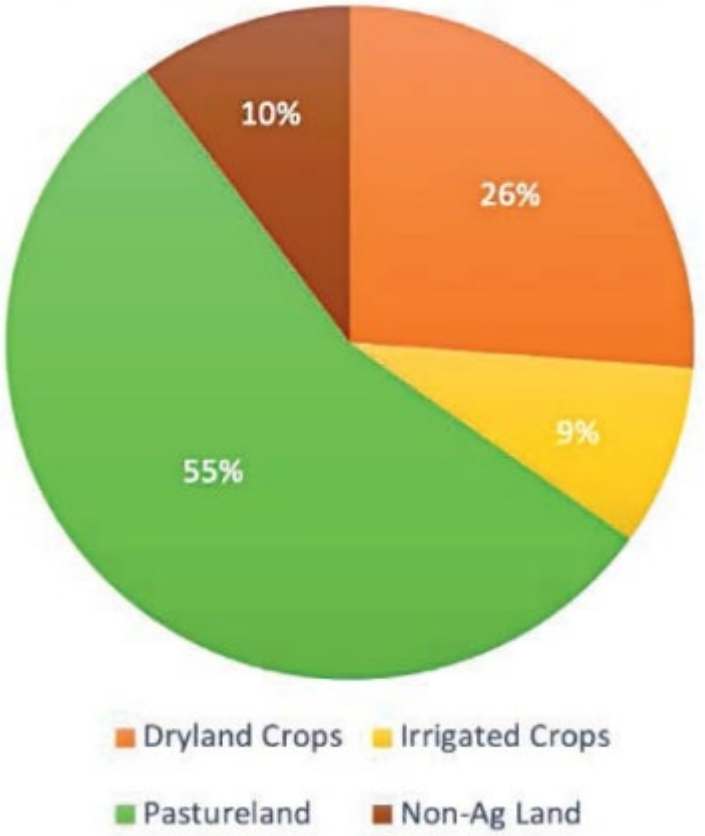
Moore County: Residue from Irrigated Corn vs. Dryland Corner – Snow January 8 and Picture taken January 25, 2024

That said, silage makes money…

Regionally, how much forage is needed?

- Dairy
  - ~25 lbs DM/day/cow x 750K cows = 18.8M lbs or 9,400 tons forage/day
- Beef Cattle Finishing
  - ~5 lbs DM/day/head x 2.5 M cattle on feed = 12.5M lbs or 6,250 tons forage/day
- 15,650 ton/day NEEDED
  - 12 ton DM/acre non-stressed corn silage = 1304 acres/day = ~476K acres per year
- Realistic: 9 ton DM/acre limited irrigated silage = 1,738 acres/day = ~635K acres per year in silage
- This does not include stockers or other livestock sectors.
- Future forage production is going to require strategic management of water resources.

Figure 2. High Plains Trade Area Land Use



Forage Options

- Annual Forages
  - Corn Silage
  - Wheat Silage
  - Sorghum Silage
- Perennial Forages
  - Improved Perennials
  - Native Grasses

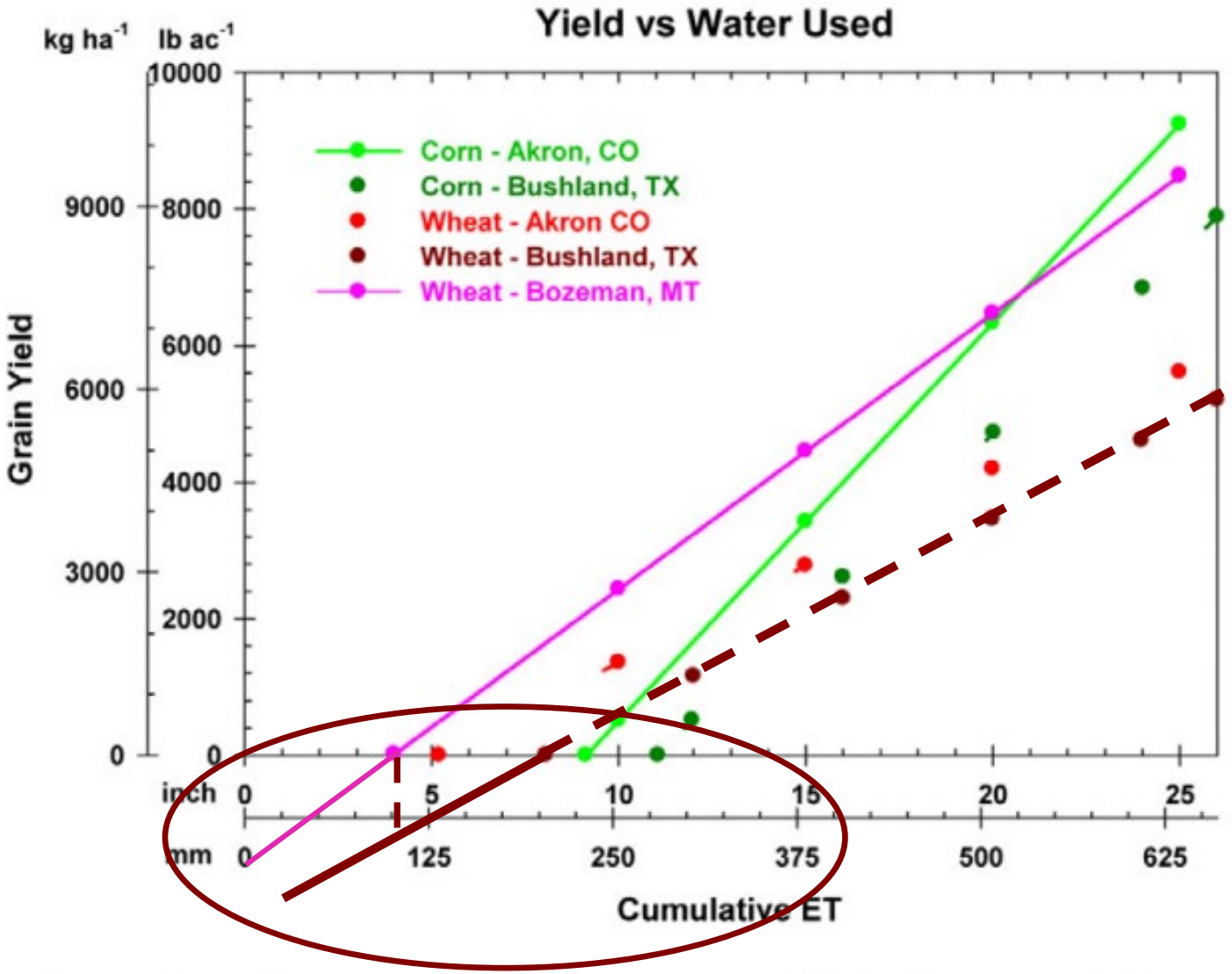


Fig. 7. Cumulative evapotranspiration (ET) and grain yield at Akron, CO; Bozeman, MT; and Bushland, TX.

Source: D.C. Nielsen

Why are forages a viable option with limited water?

Forage is the X-axis intercept:

- Wheat at Bushland = 8”
- Wheat at Akron = 5”
- Wheat at Bozeman = 4”

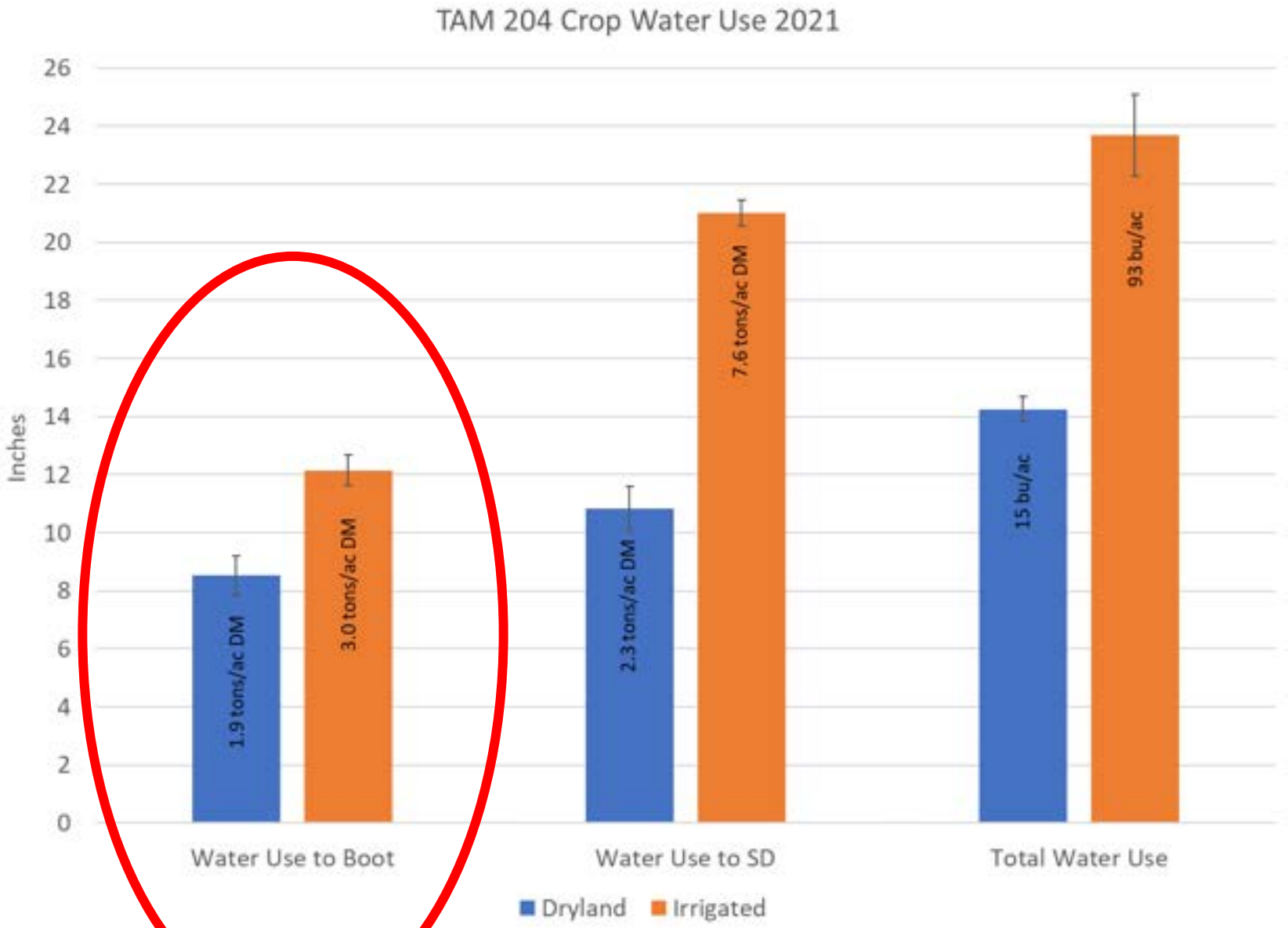
-With forage, we can focus on water for biomass rather than water for grain.

-BUT… early reproductive stage forages cannot be directly ensiled.

Winter Small Grain Silages

Filling the High Plains' "Silage Gap" (M. Marsalis, NMSU)

- Wheat (Wheatlage)
- Rye
- Barley
- Triticale



Irrigated: 8.3 inches irrigation + 6.8 inches precip. + 4.1 soil water
Dryland: 5.8 inches precipitation + 8.5 inches soil water

More recent water use data:

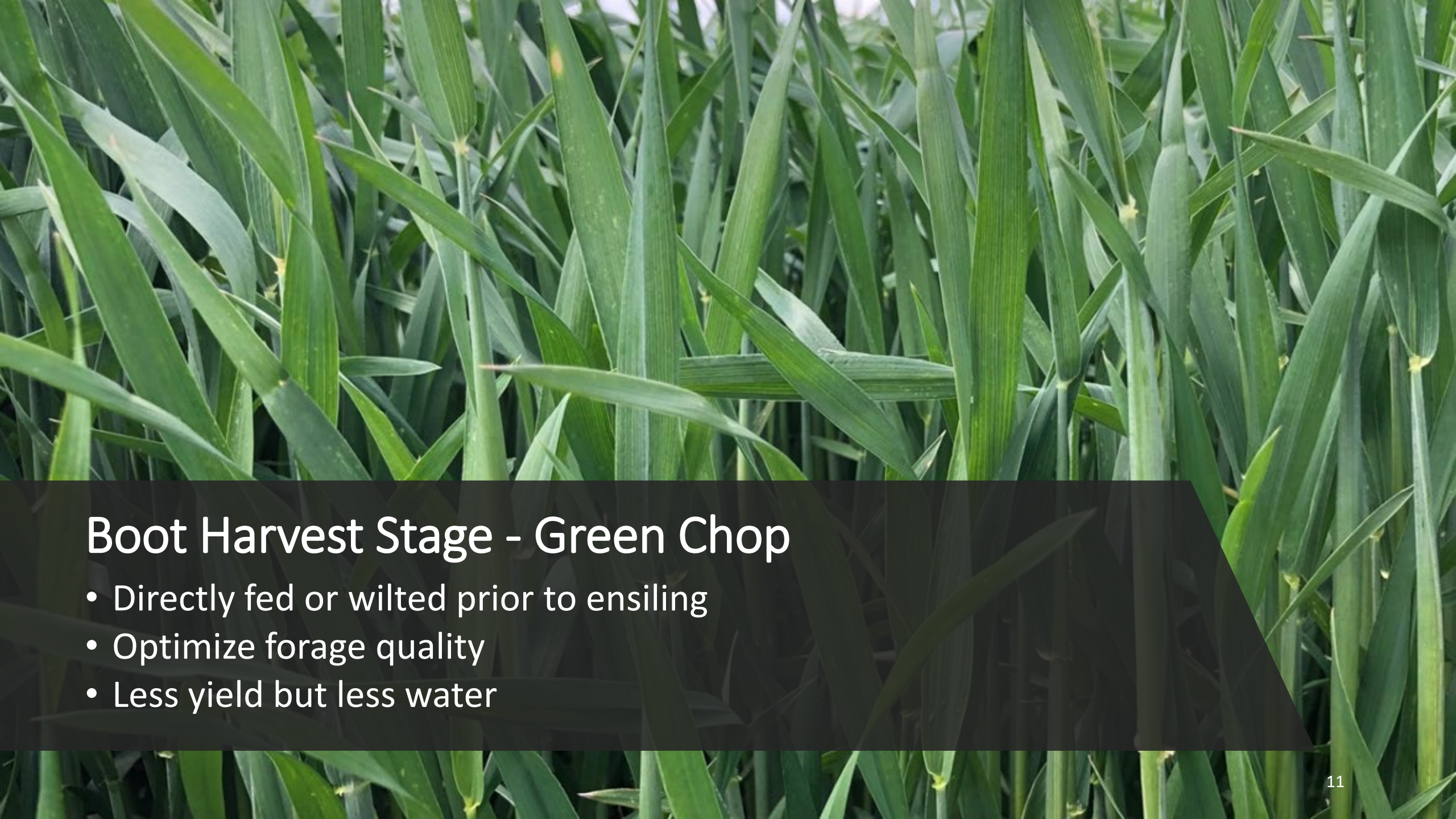
- Variety yield potentials have increased but water use has not changed.
- Wheat at boot uses about 8” water on dryland….but it will use more if you have the water.
  - When are you terminating? Heading?

Wheatlage and the "Forage Gap"

- **Planned** – no longer an "opportunity crop"
- Insufficient summer silage produced to meet regional livestock needs
- Wheatlage: lower yielding than summer silages but a high-quality option
- Forages provide farmers an alternative market
- Forages generally use less water than grain crop because of earlier harvest stage – **opportunity for farmers with low well capacities**

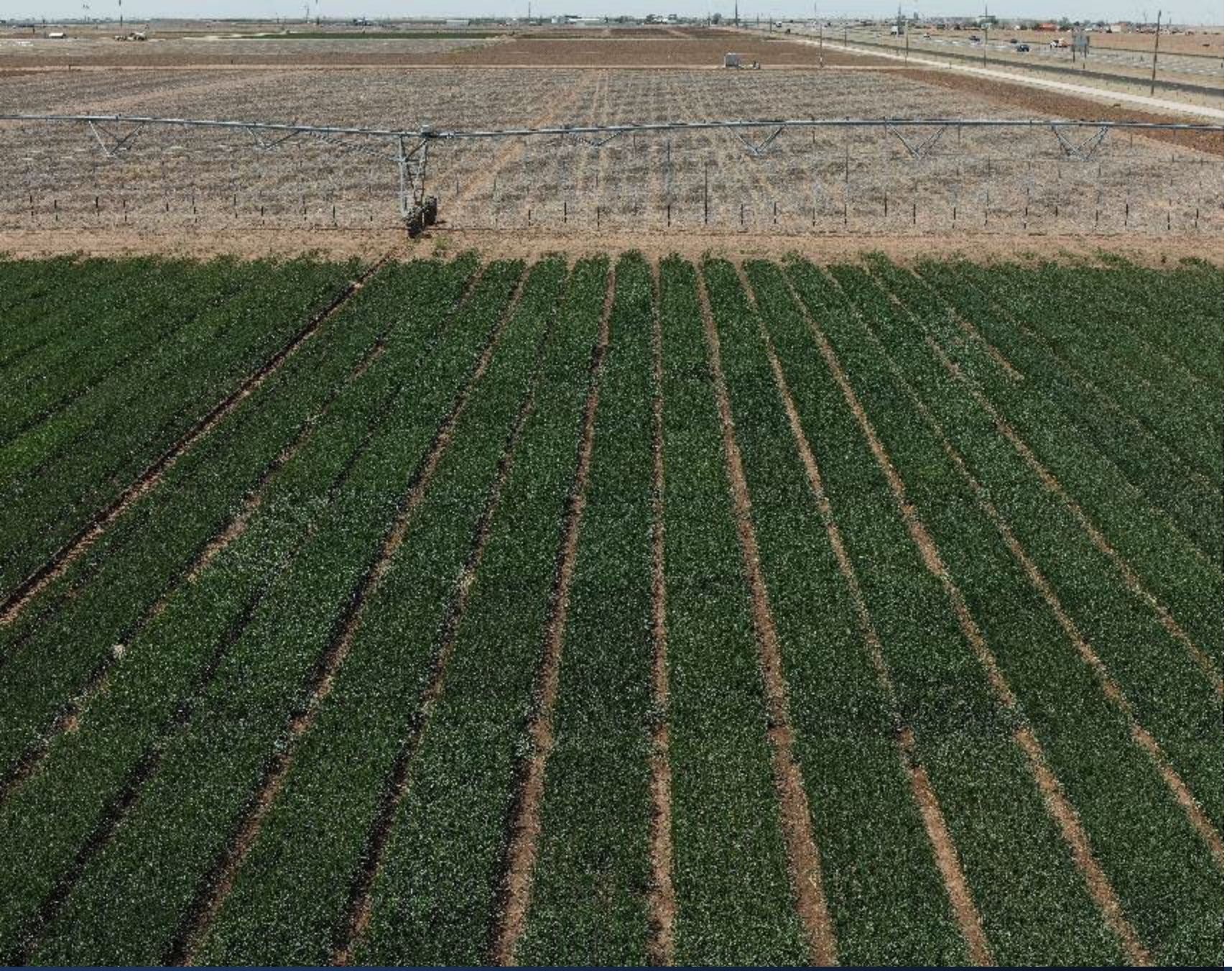
	Average Yield tons/ac	
	DM	65% Moist.
Corn Silage	9.5	27 (22-30)
Sorghum Silage	8.0	23 (20-28)
Wheatlage	5.3	15 (11-22)
		(Range)

*Average Yields for the Texas High Plains Production Region



Boot Harvest Stage - Green Chop

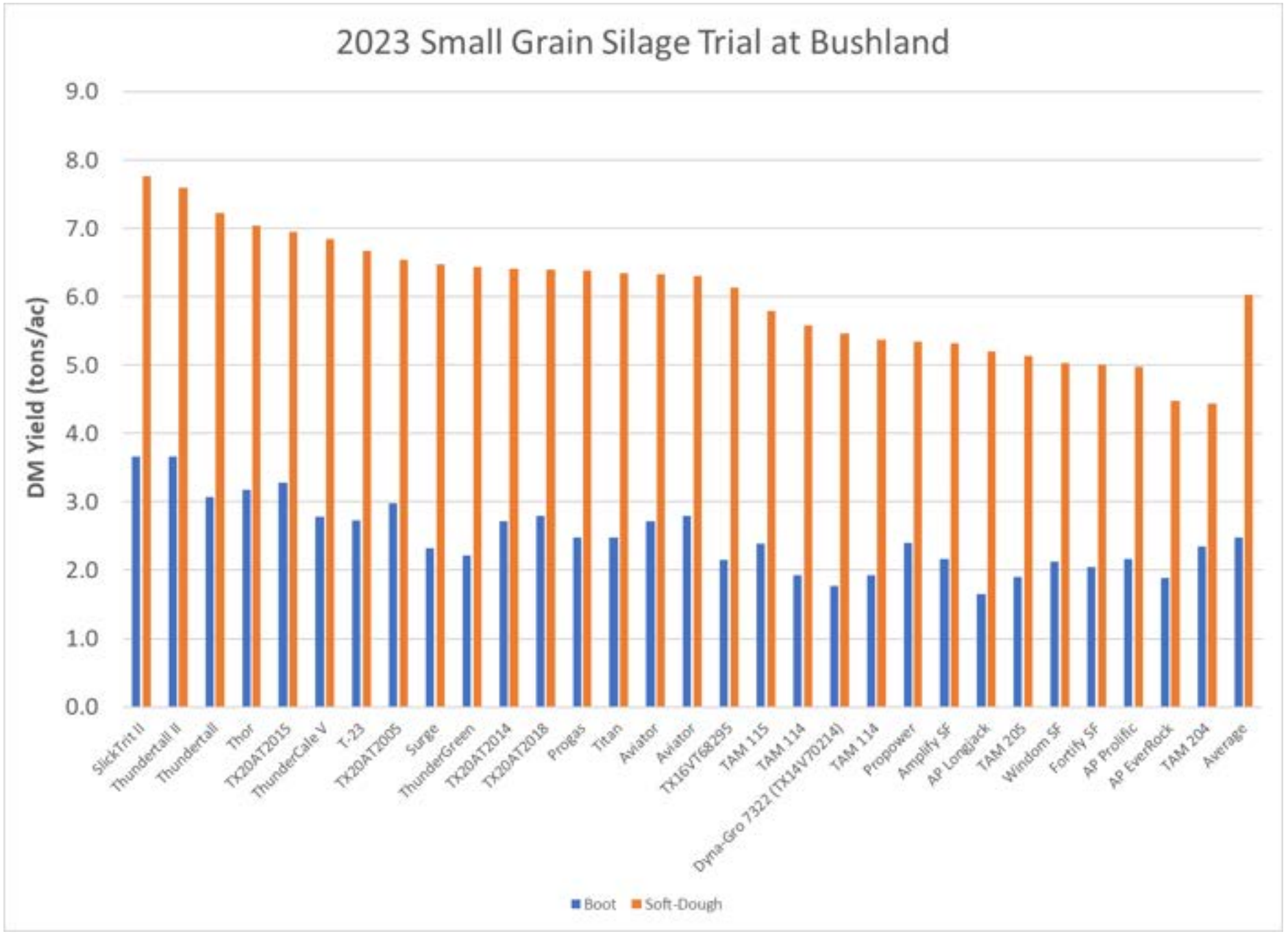
- Directly fed or wilted prior to ensiling
- Optimize forage quality
- Less yield but less water



2022-2023 Small Grain Silage Trial at Bushland

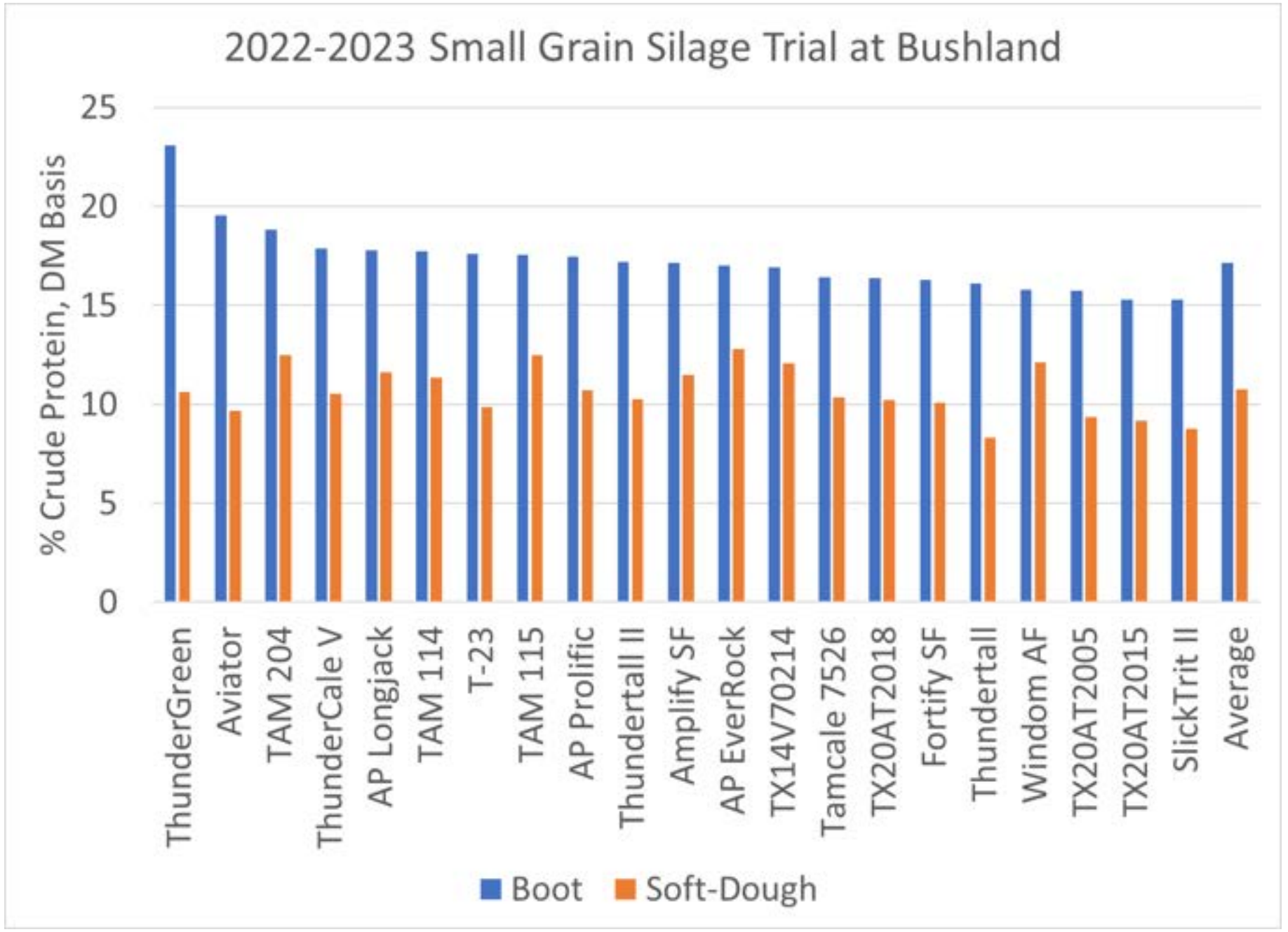
- April 21, 2023
- Image from Shannon Baker

	Boot	Soft-Dough
Triticale	2.9	6.8
Rye	2.5	6.1
Wheat	2.1	5.1
Average	2.5	6.0



Boot – Green Chop

Soft Dough – Wheatlage



Boot – Green Chop

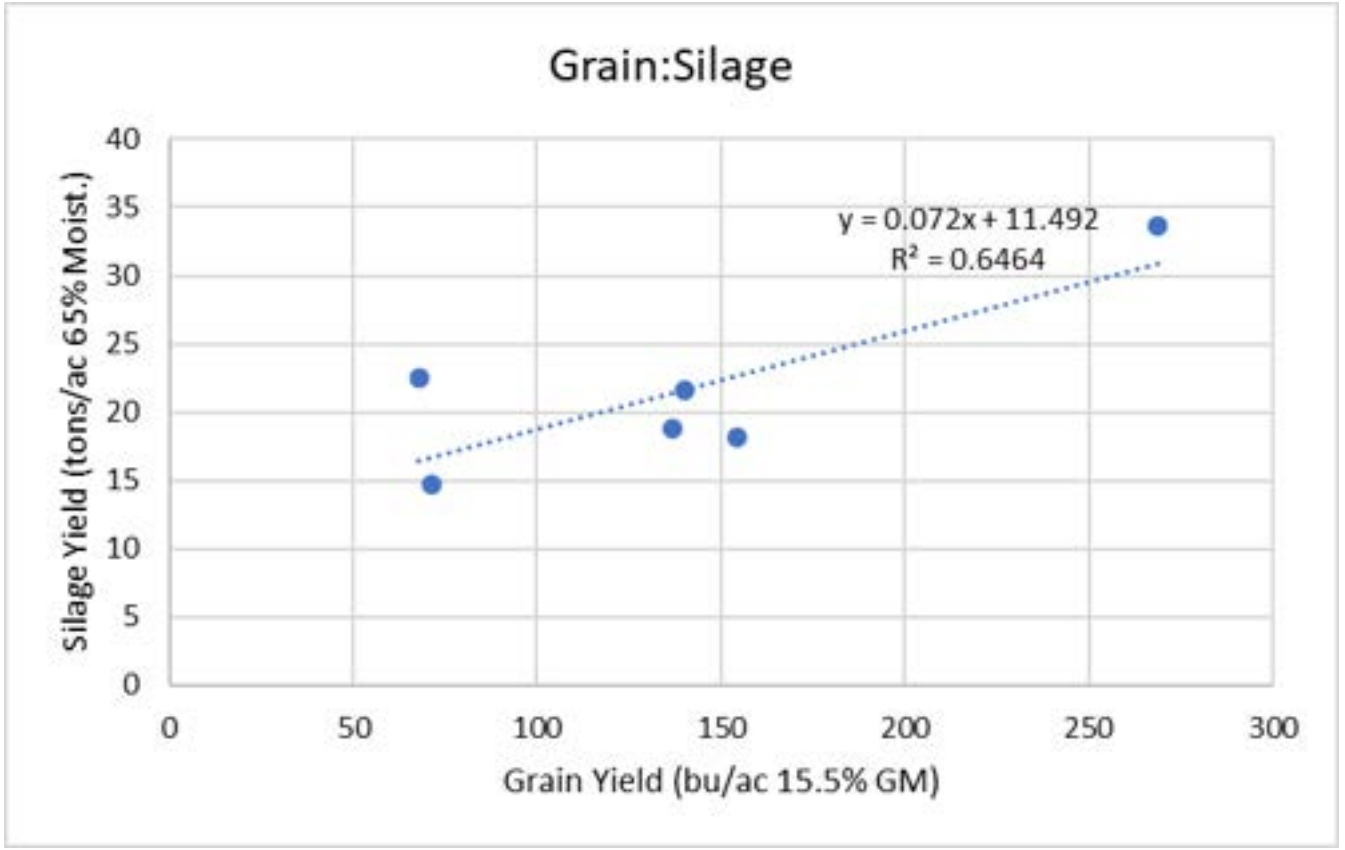
Soft Dough – Wheatlage

Corn silage increases production risks in limited water environments….

Corn Silage – Grain:Silage Ratio

- ROT: 9 to 10 tons/bushel
- This is under IDEAL conditions
- If you do not have the water for grain, you will not have the water for tonnage.

Grain Yield (bu/ac)	Silage Yield (Tons/ac)	Ratio
150	22.3	6.7
200	25.9	7.7
225	27.7	8.1
300	33.1	9.1



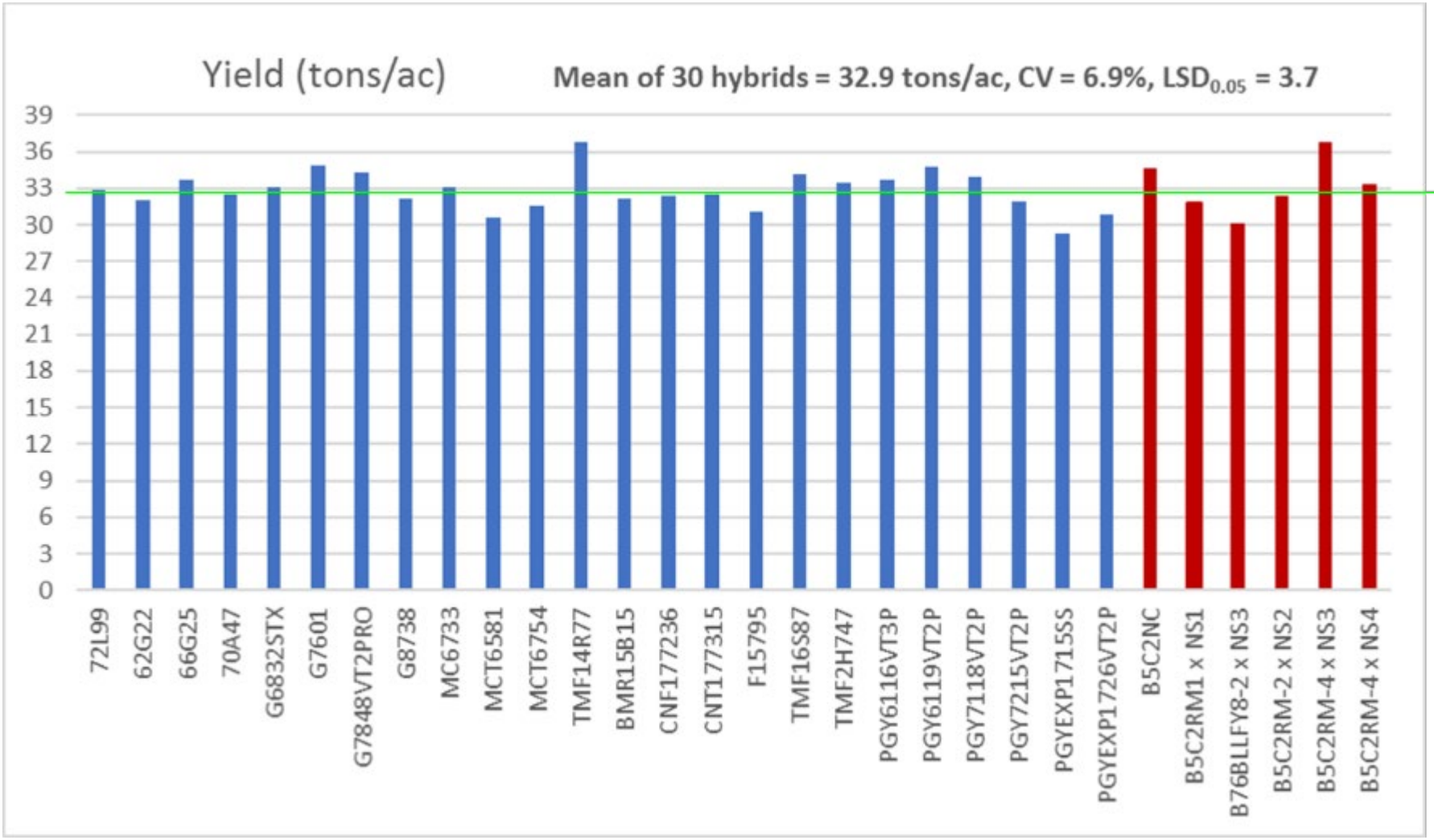
Corn Silage:
Traditional Silage of Choice

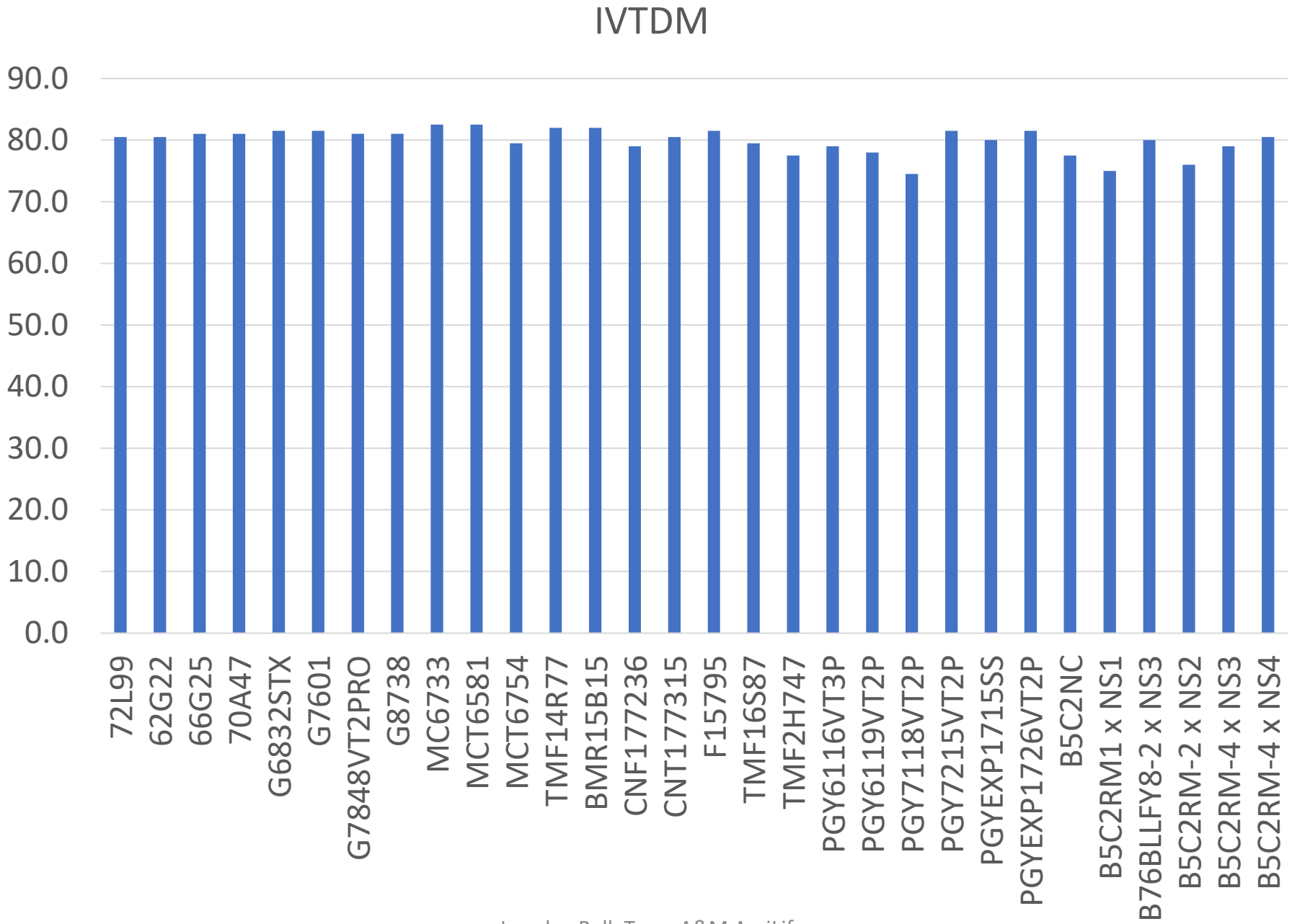
- Belief: Corn silage is ALWAYS higher in energy.
  - Grain content AND stover digestibility affect energy level
  - If you do not have grain, overall forage quality decreases
- Belief: Corn always has a higher yield potential
  - New forage sorghums hybrids produce greater yields in stressed environments
- Under water stress, corn silage quality is reduced
  - Corn silage quality is related the amount of grain produced and quality of the stover

Water Stressed Silage

- Low moisture/ High dry matter: Harvest moisture is critical to silage packing
  - Moisture varies with packing method, but 65% is average
- Were labeled pesticides used?
- Potential Nitrate Poisoning
  - Water stressed forages accumulate nitrates
  - Heavy rates of N fertility and manure
  - Nitrates will partialize dissipate during fermentation – but don’t assume they will all be gone
  - Raise cutting bar (~6 inches)

2017 State Silage Corn Performance Test at Halfway, TX. 24 commercial entries and 6 experimental hybrids from Texas AgriLife Research in Lubbock. Wenwei Xu Corn Breeder



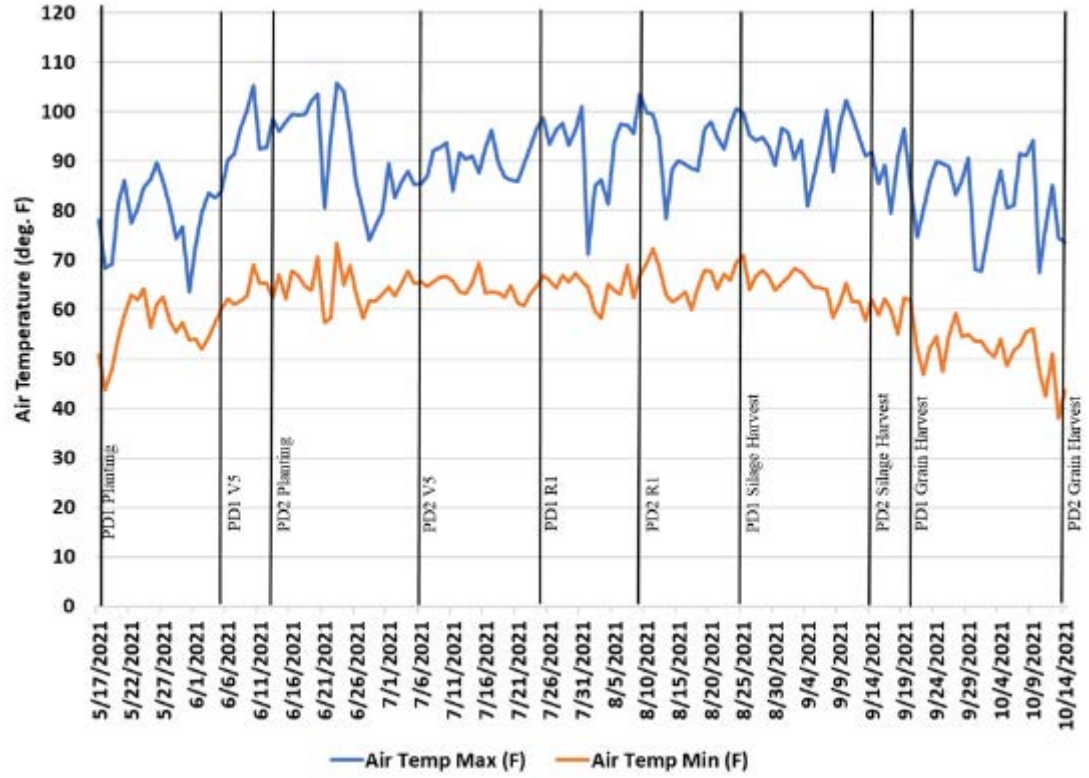

IVTDM
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
72L99
62G22
66G25
70A47
G6832STX
G7601
G7848VT2PRO
G8738
MC6733
MCT6581
MCT6754
TMF14R77
BMR15B15
CNF177236
CNT177315
F15795
TMF16S87
TMF2H747
PGY6116VT3P
PGY6119VT2P
PGY7118VT2P
PGY7215VT2P
PGYEXP1715SS
PGYEXP1726VT2P
B5C2NC
B5C2RM1 x NS1
B76BLLFY8-2 x NS3
B5C2RM-2 x NS2
B5C2RM-4 x NS3
B5C2RM-4 x NS4

Drought Damaged Corn Silage

- Poor ear development
- Decreased tonnage
- Increased shrinkage in the silage pit due to high DM
- High DM can create issues with fermentation losses
- Reduced quality and quantity of forage … harvested and packed

Message to producers: If there is a risk for drought damaged corn, consider forage sorghums.

Deficit Irrigated Corn Silage (Bell, Xue, Marek, Xu, Heflin)



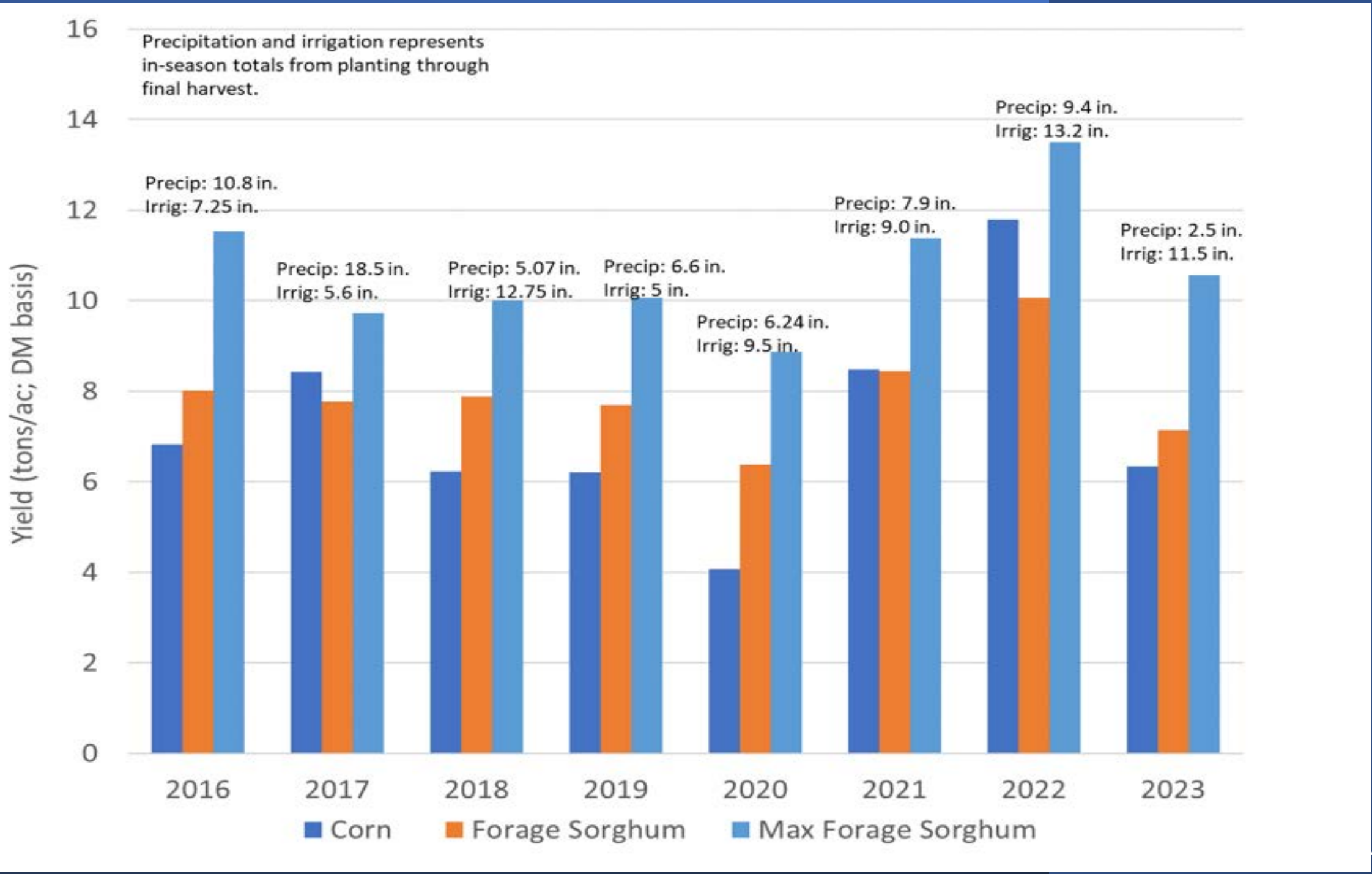
Planting Date	Forage Harvest	Grain Harvest	In-season Irrigation	In-season Precipitation to Silage Harvest	In-season Precipitation to Grain Harvest
			inches		
5/17/2021	8/26/2021	9/21/2021	6.8	8.0	8.7
6/15/2021	9/15/2021	10/14/2021	6.3	7.2	7.2

Corn Silage and Limited Water

PD	Hybrid and Targeted Seeding Rate	Grain Yield	Silage Yield	Grain Price*	Silage Price	Diff.
		bu./ac 15.5% GM	tons/ac 65% Moist.	$/ac		
1	1366Q 22K	133.9	18.0	854.41	1169.85	315.45
1	1366Q 16K	129.7	18.3	827.53	1187.53	360.00
1	DKC70-64 22K	137.1	20.0	874.74	1296.81	422.07
1	DKC70-64 16K	146.4	19.0	934.14	1232.79	298.65
p-value		0.3362	0.2003			
2	1366Q 22K	81.5	14.1	503.81	918.44	414.63
2	1366Q 16K	76.9	14.9	572.35	967.36	395.01
2	DKC70-64 22K	61.1	14.9	415.44	967.28	551.85
2	DKC70-64 16K	66.5	15.0	411.54	977.29	565.75
p-value		0.7023	0.3189			

*Corn grain price calculated using the Jan. 2022 cash price at $6.38/bu; Corn silage price calculated using $65/ton forage at 65% moisture

Jourdan Bell, Texas A&M AgriLife



Forage Sorghums for Silage

The hybrid must match the water!

TEXAS A&M AGRILIFE RESEARCH | EXTENSION

Sorghum Maturity

Maturity Class	Days to HB
Early	<70
Med-Early	70-79
Medium	80-85
Med-Late	86-90
Late	91-100
PS	>100

High yielding hybrids can have high yield potential, but they have a longer duration of water use.

Sorghum maturity class will drive water use

Hybrid	Forage Type	Harvest Date	Soil Water Use	Precip to Silage Harvest	Irrigation to Silage Harvest	Crop Water Use (in.)	Forage Yield (65% DM, tons/ac)	Grain Yield (bu/ac)	WUE (in/bu)
55VP77	Corn	8/24/16	6.1	4.7	9	19.8	18.2	138	0.9
SP4105	PS SxSu	10/24/16	9.0	7.3	10.8	27.0	22.4	------	0.8

- Photoperiod Sensitive Forage Sorghum harvested 2 months after corn silage resulting in greater water use.
- If water is limited, use an early maturing hybrid to minimize risk.

- Historically forage sorghums had a bad reputation. Why?
- Producers plant a late maturity class without the ability to meet the crop water demand.
- Always optimistic of high yields, but without water yield and quality decline.
- Production functions for forage sorghum (maturity classes x irrigation rate) are needed.

Texas A&M AgriLife Forage Sorghum Program

- Research goal is to address both quality and quantity
- Public Forage Sorghum Silage Trial
  - ~80 entries per year

  https://amarillo.tamu.edu/amarillo-center-programs/agronomy/forage-sorghum/

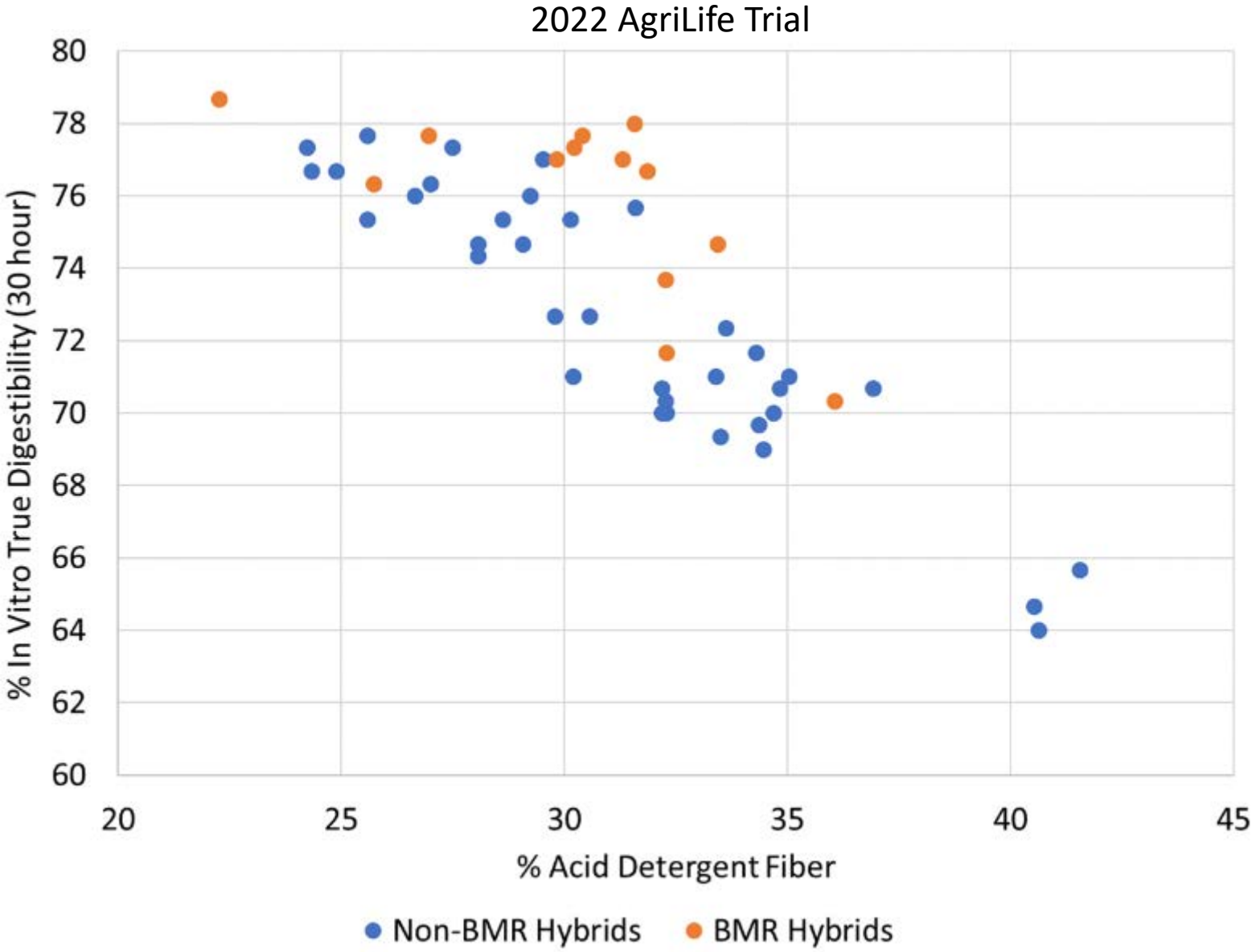
  Google: AgriLife Amarillo Forage Sorghum
- Sorghum harvest timing and berry processing
- Forage sorghum herbicide trial – (Heflin)
- SCA Management in Forage Sorghums
- Sorghum-sudan management

Quality Forage Sorghum Silage Begins with Hybrid Selection

- Not all sorghum equal
- Evaluate variety trials from multiple locations
- Hybrid should match production system and end-user goals
- Later maturity class hybrids have greater yield potential, but do you have the water to meet the demand?
- Late season hybrids more prone to lodging under late season moisture and high fertility
- Choose hybrid based on hybrid specific characteristics not forage type

Nationwide Confusion about Forage Sorghum Quality

Variety trial data demonstrates differences in forage sorghum hybrids



2023 AgriLife Forage Sorghum Silage Trial - Bushland

Planting Date: June 22, 2023

Forage Sorghum Seeding Rate: 80,000 seeds/acre

Corn Silage Seeding Rate: 32,000 seeds/acre

Fertilizer: Manure pre-wheat

Pre-plant strip-tilled 180 lbs. N/ac and 30 lbs. P_2O_5/ac (6-15-2023)

Herbicides:

Pre-plant: S-metolachlor 1 pt/ac plus Atrazine 1 lb./ac (4-25-2023)

Pre-plant burndown: Quinclorac 8 oz/ac plus Paraquat 2 pt/ac (5-22-2023)

Pre-emergent: Warrant (acetochlor) 48 oz/ac plus Starane Ultra (fluroxypyr) 6 oz/ac plus Buccaneer (glyphosate) 48 oz/ac (6-23-2023)

Post-emergent: Huskie FX 18 oz/ac (pyrasulfotole + bromoxynil + fluroxypyr) plus QuinStar (quinclorac) 32 oz/ac plus Atrazine (1 lb/ac)

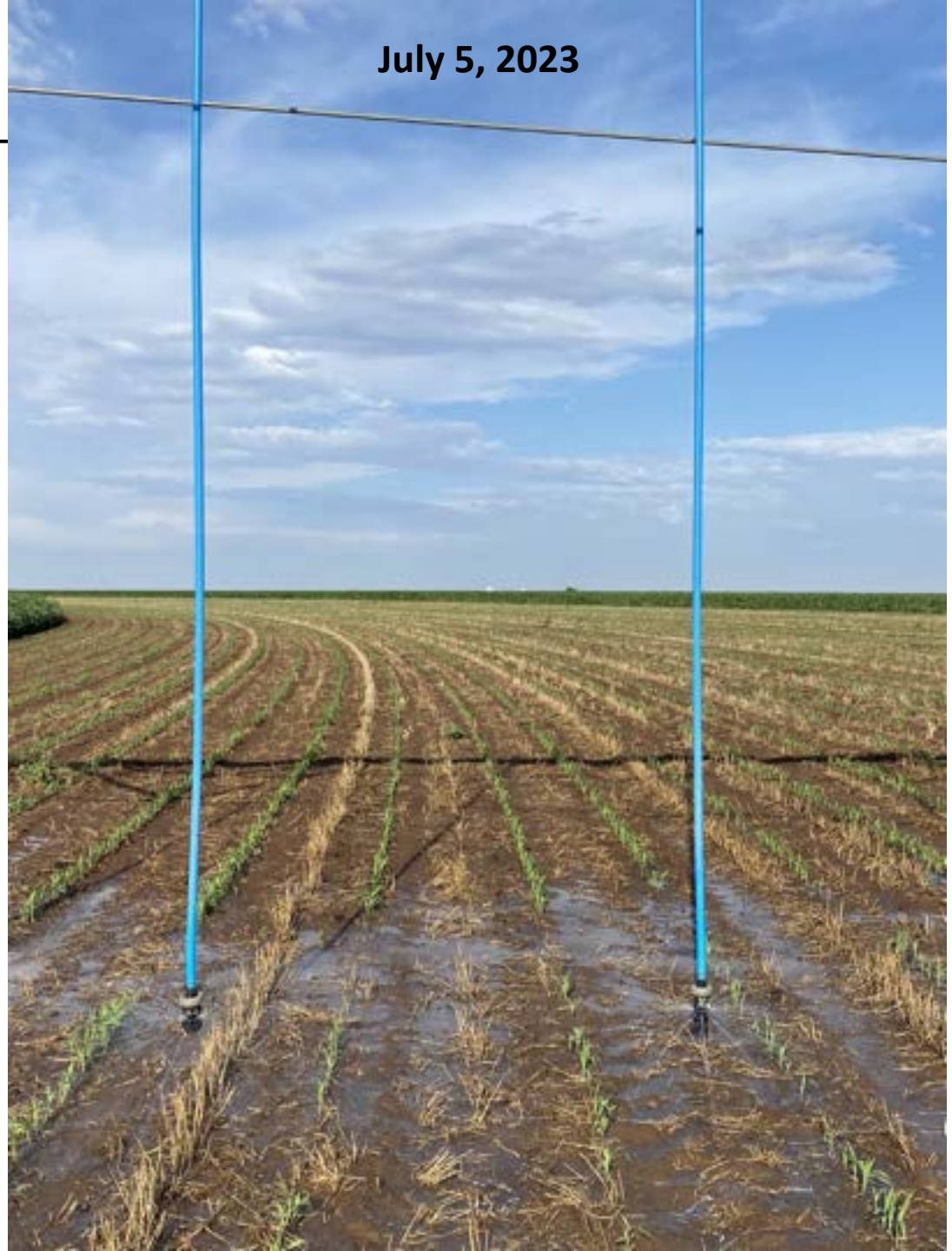
Insecticide: Sivanto 4 oz/ac with pre-plant strip-tilled N (6-15-2023)

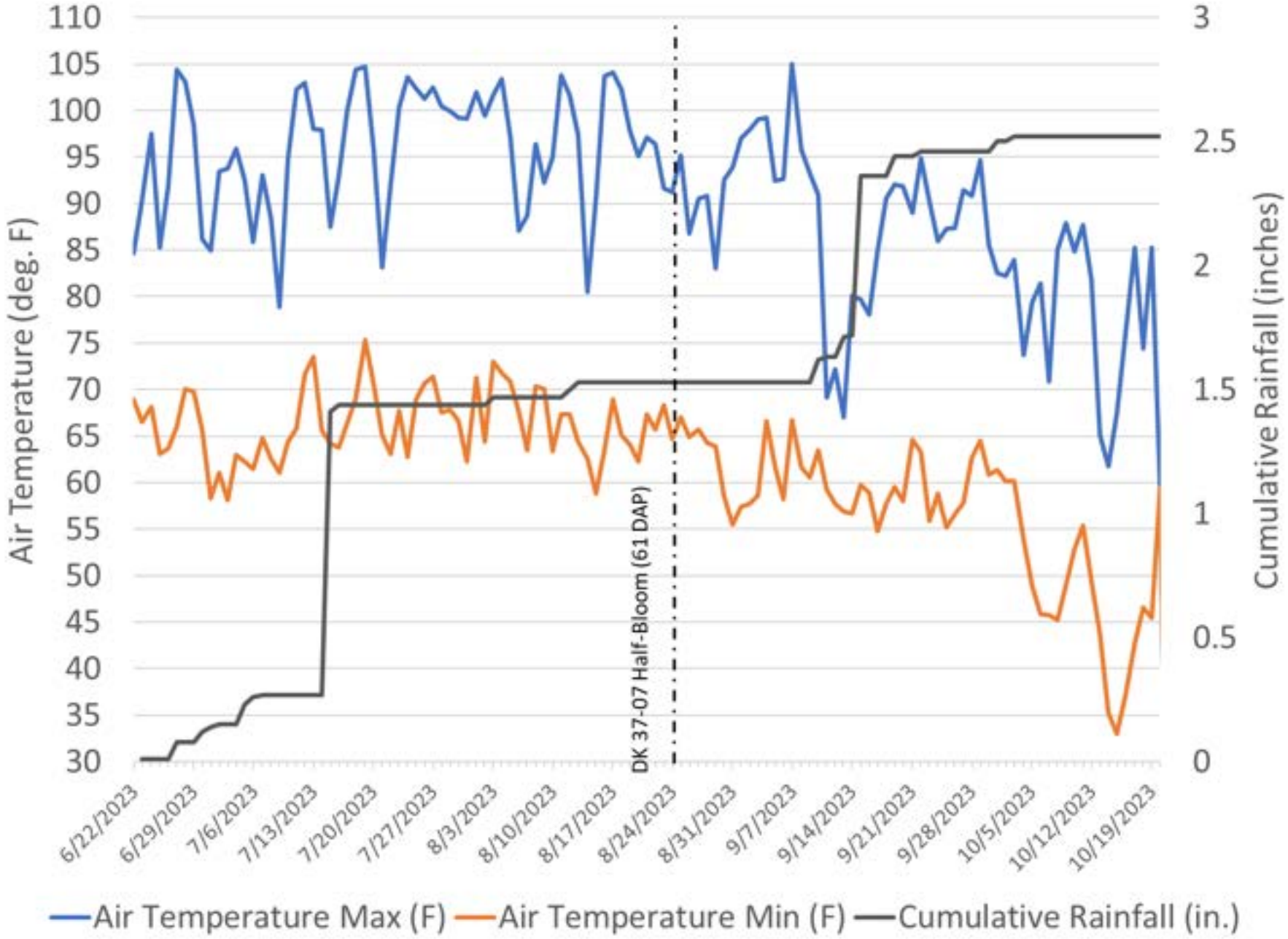
Sorghum aphids (Sugarcane Aphids) identified 7-27-2023

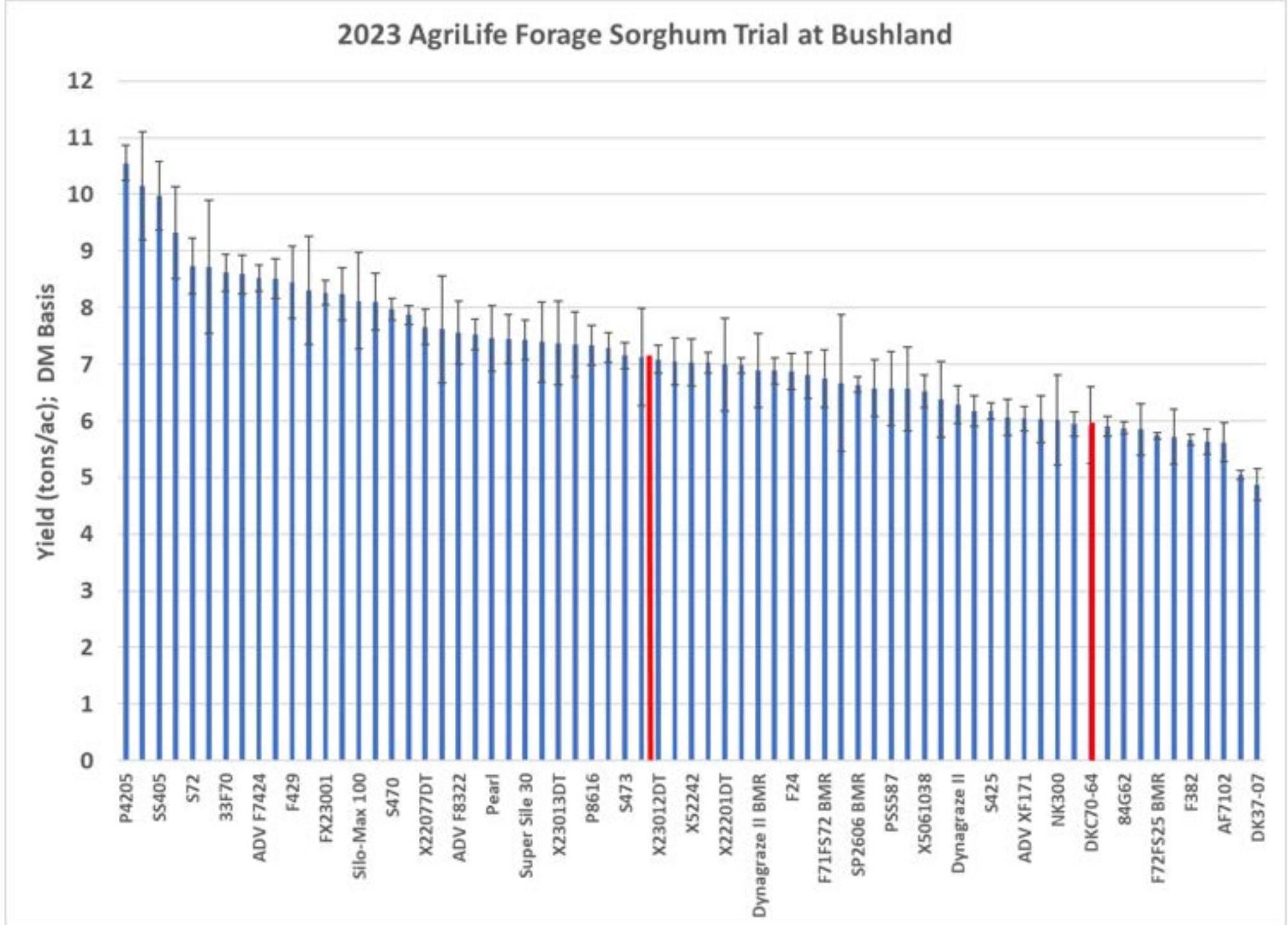
Sivanto 7 oz/ac aerially at 4 gpa (7-29-2023)

Preplant Rainfall (May 1 – June 21): 9.6 inches

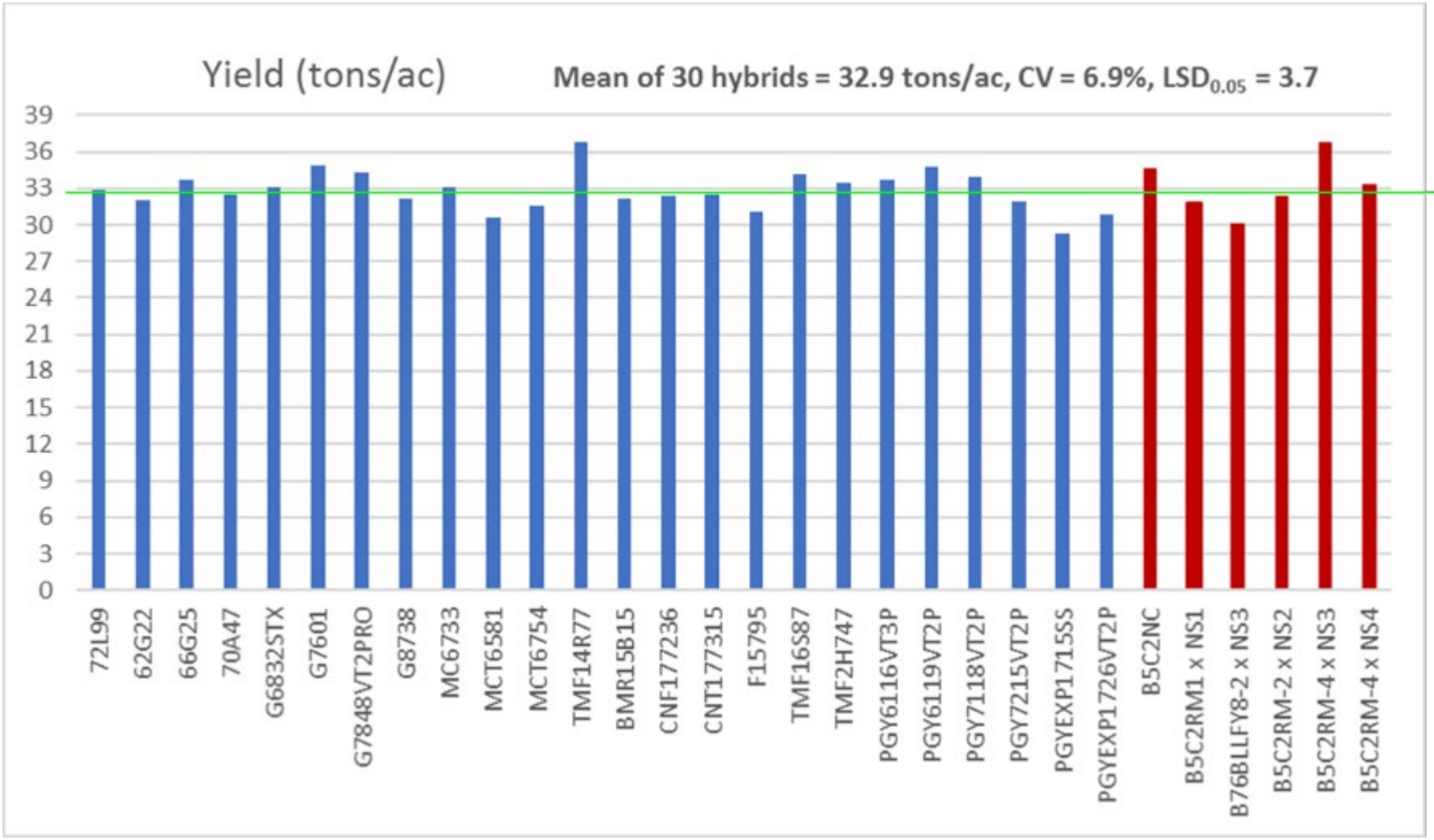
In-season Irrigation: 10 in. (early and med early hybrids) and 11.5 (medium and longer hybrids) and In-season Rainfall: 2.52 in.

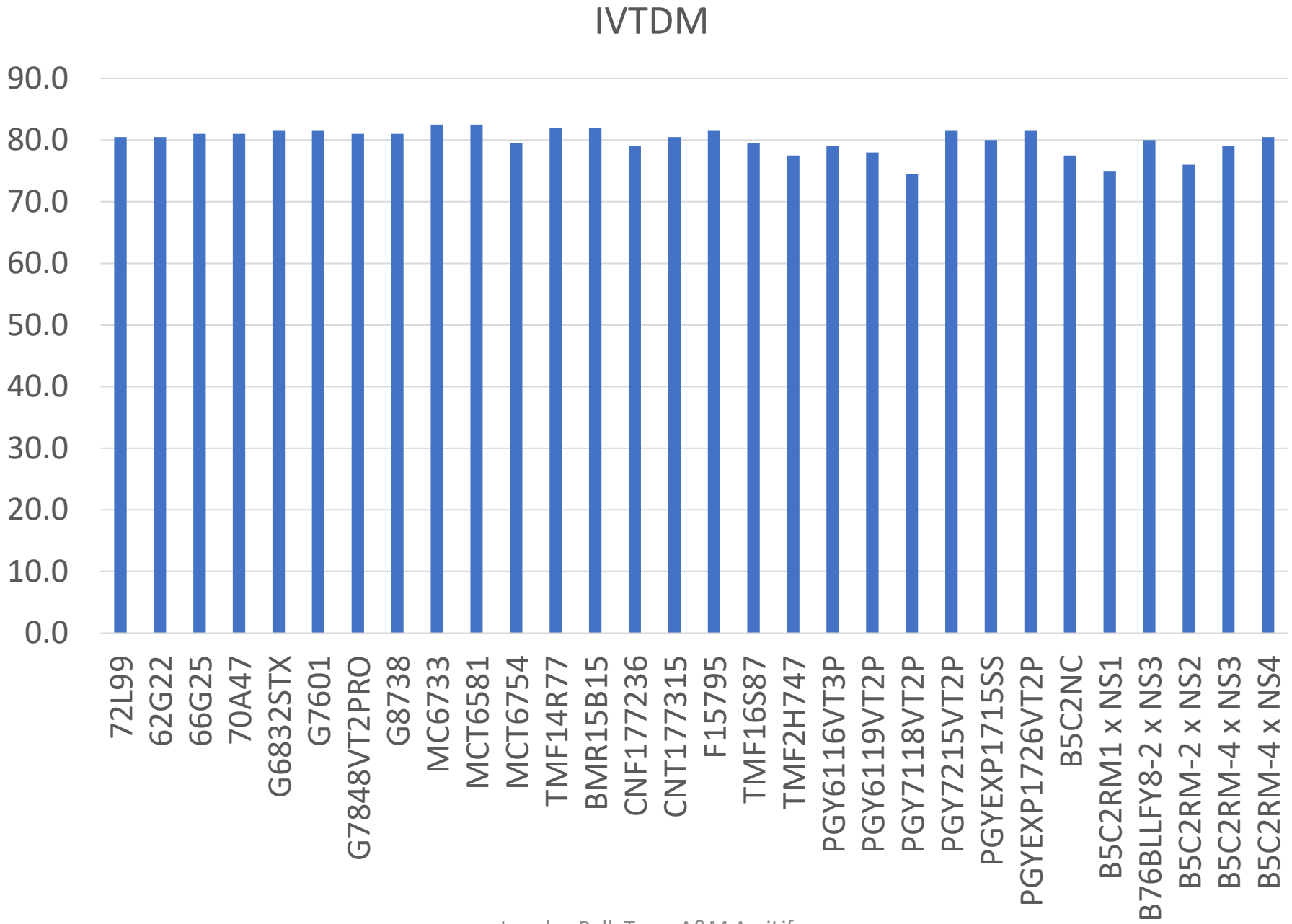



Air Temperature (deg. F)
Cumulative Rainfall (inches)
110
105
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
3
2.5
2
1.5
1
0.5
0
DK 37-07 Half-Bloom (61 DAP)
6/22/2023
6/29/2023
7/6/2023
7/13/2023
7/20/2023
7/27/2023
8/3/2023
8/10/2023
8/17/2023
8/24/2023
8/31/2023
9/7/2023
9/14/2023
9/21/2023
9/28/2023
10/5/2023
10/12/2023
10/19/2023
Air Temperature Max (F)
Air Temperature Min (F)
Cumulative Rainfall (in.)


2023 AgriLife Forage Sorghum Trial at Bushland
Yield (tons/ac); DM Basis
12
11
10
9
8
7
6
5
4
3
2
1
0
P4205
SS405
S72
33F70
ADV F7424
F429
FX23001
Silo-Max 100
S470
X22077DT
ADV F8322
Pearl
Super Sile 30
X23013DT
P8616
S473
X23012DT
X52242
X22201DT
Dynagraze II BMR
F24
F71FS72 BMR
SP2606 BMR
PSS587
X5061038
Dynagraze II
S425
ADV XF171
NK300
DKC70-64
84G62
F72FS25 BMR
F382
AF7102
DK37-07

2017 State Silage Corn Performance Test at Halfway, TX. 24 commercial entries and 6 experimental hybrids from Texas AgriLife Research in Lubbock. Wenwei Xu Corn Breeder




IVTDM
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
72L99
62G22
66G25
70A47
G6832STX
G7601
G7848VT2PRO
G8738
MC6733
MCT6581
MCT6754
TMF14R77
BMR15B15
CNF177236
CNT177315
F15795
TMF16S87
TMF2H747
PGY6116VT3P
PGY6119VT2P
PGY7118VT2P
PGY7215VT2P
PGYEXP1715SS
PGYEXP1726VT2P
B5C2NC
B5C2RM1 x NS1
B76BLLFY8-2 x NS3
B5C2RM-2 x NS2
B5C2RM-4 x NS3
B5C2RM-4 x NS4

Rank	HYBRID	COMPANY	TYPE	Advertised MATURITY	SCA Tol.	BMR	BRACHY TIC	Days to HB†	Harvest Date	Yield (tons/ac) DM Basis
1	P4205	Warner Seeds	Forage Sorghum	Medium Late	Yes	No	No	92	10/19/2023	10.6
2	F465 *Unpollinated MS	Richardson Seeds	Forage Sorghum	Medium	Yes	No	No		9/25/2023	10.2
3	38F80	Wilbur-Ellis	Forage Sorghum	Late	Yes	No	No	90	10/19/2023	10.1
4	SS405	S&W Seed	Forage Sorghum	Medium Late	No	No	No	97	10/19/2023	10.0
5	Super SIle 20	DynaGro	Forage Sorghum	Medium Late	No	No	No	85	10/19/2023	9.3
6	S72	Richardson Seeds	Sorghum Sudan	Late	Yes	Yes	No	107	10/19/2023	8.7
7	ADV F8484IG	Advanta	Forage Sorghum	Late	No	No	Yes	92	10/19/2023	8.7
8	33F70	Wilbur-Ellis	Forage Sorghum	Late	No	Yes	Yes	92	10/19/2023	8.6
9	ADV XS005	Advanta	Sorghum Sudan	PS	Yes	Yes	No	118	10/24/2023	8.6
10	ADV F7424	Advanta	Forage Sorghum	Medium Late	Yes	Yes	Yes	91	10/19/2023	8.5

Perennial Forages Objectives

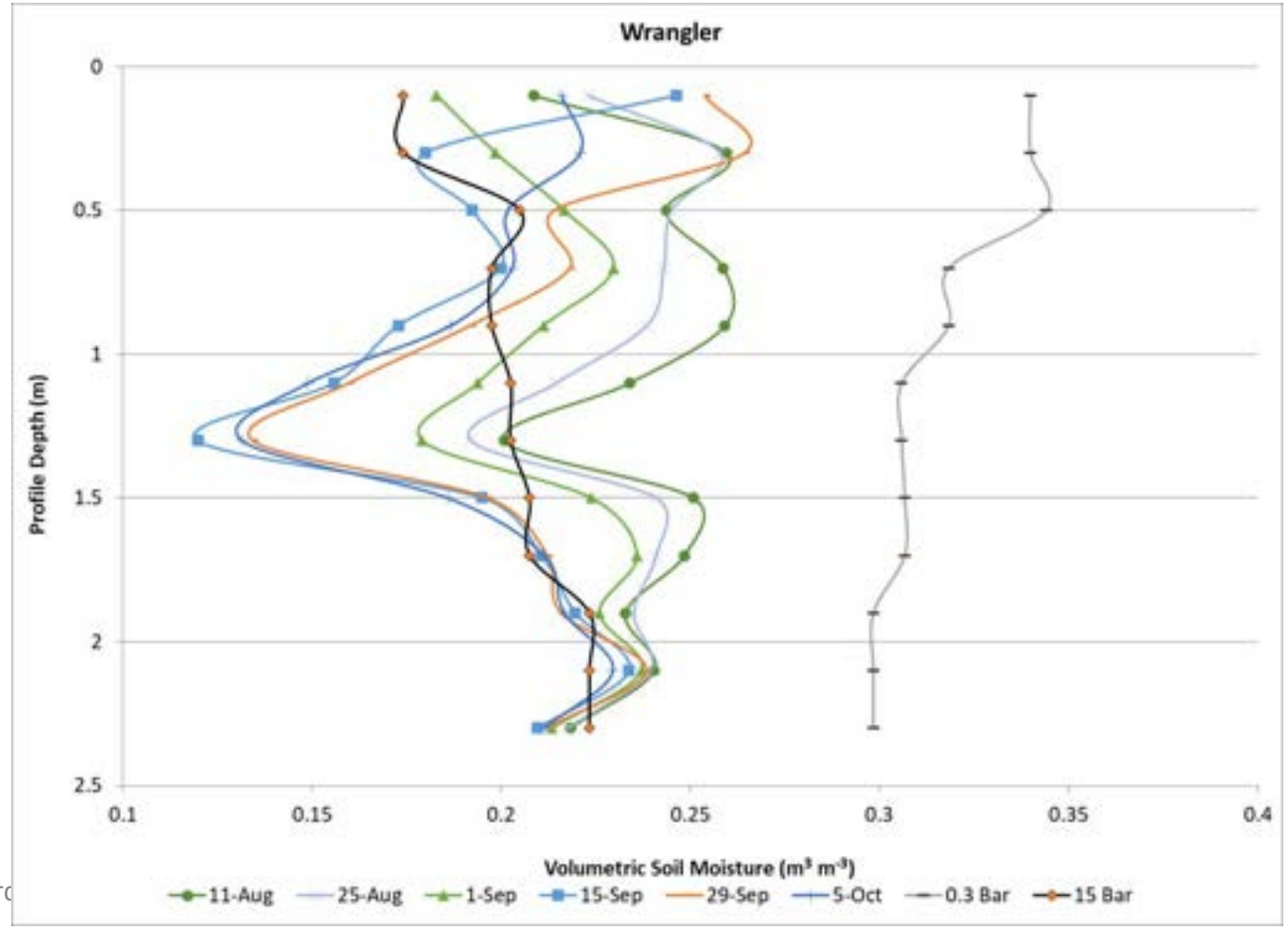
- Alternative option to reduce water withdrawals OR simply optimize the limited irrigation capacity that is available.
- The economic return of native pasture (per acre) is approximately 8% the return on average irrigated croplands (Deines, 2020)
- Improved forages with a higher economic return are essential to sustain the economic viability as crop production declines.

OAP Perennial Forage Project at Bushland

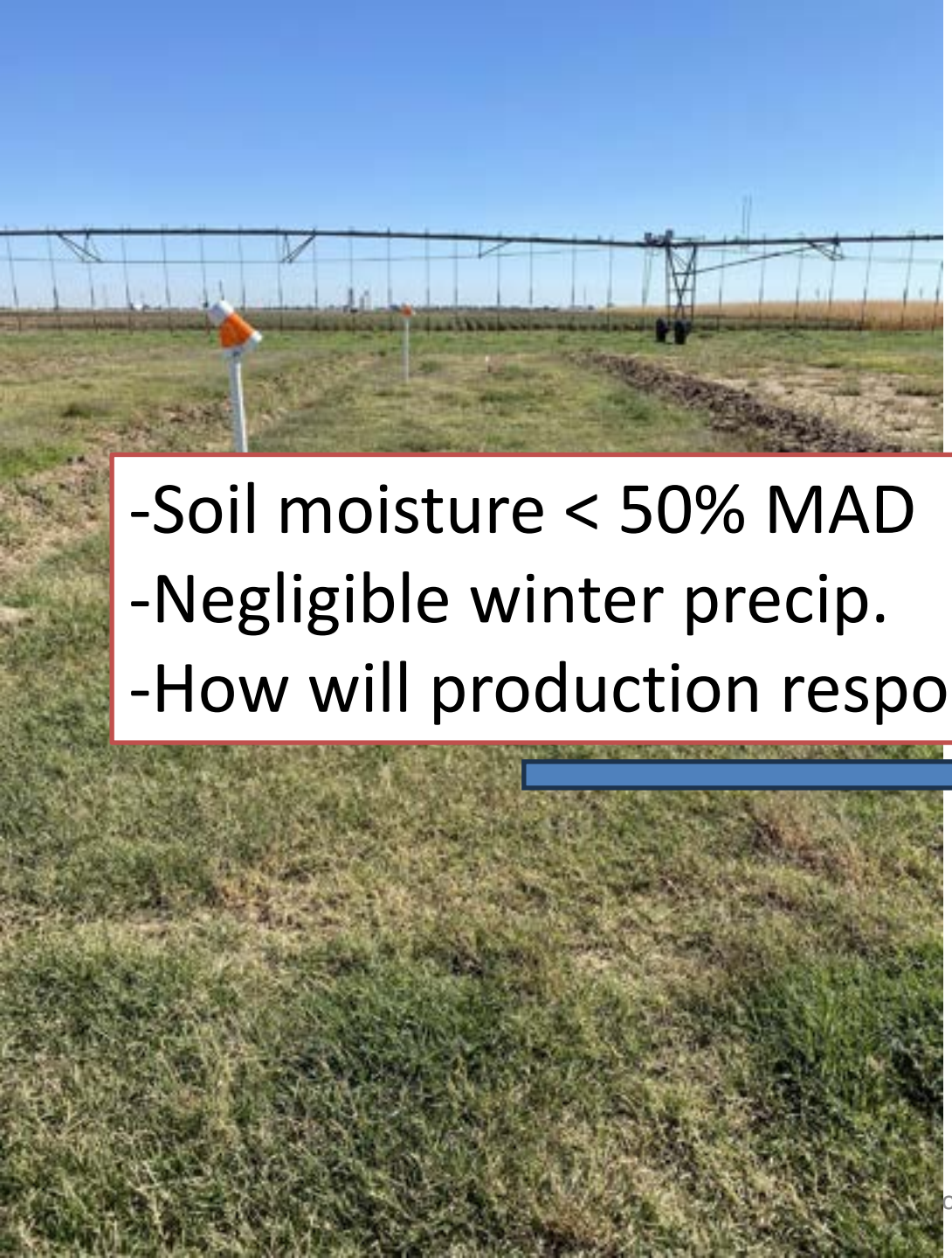
- Reality: perennial forage research is a long-term commitment
- Establishment period: 1-2 years

	Harvest Date			Cumulative Yield
	6/20/2023	8/8/2023	10/18/2023	
Forage	**lbs DM/ac**			
Wrangler	434 ± 135	933 ± 259	773 ± 441	2140
Wrangler + Alfalfa	794 ± 168			794
Cheyenne		1696 ± 348	1350 ± 452	3047
Sorghum Sudan			944 ± 107	944

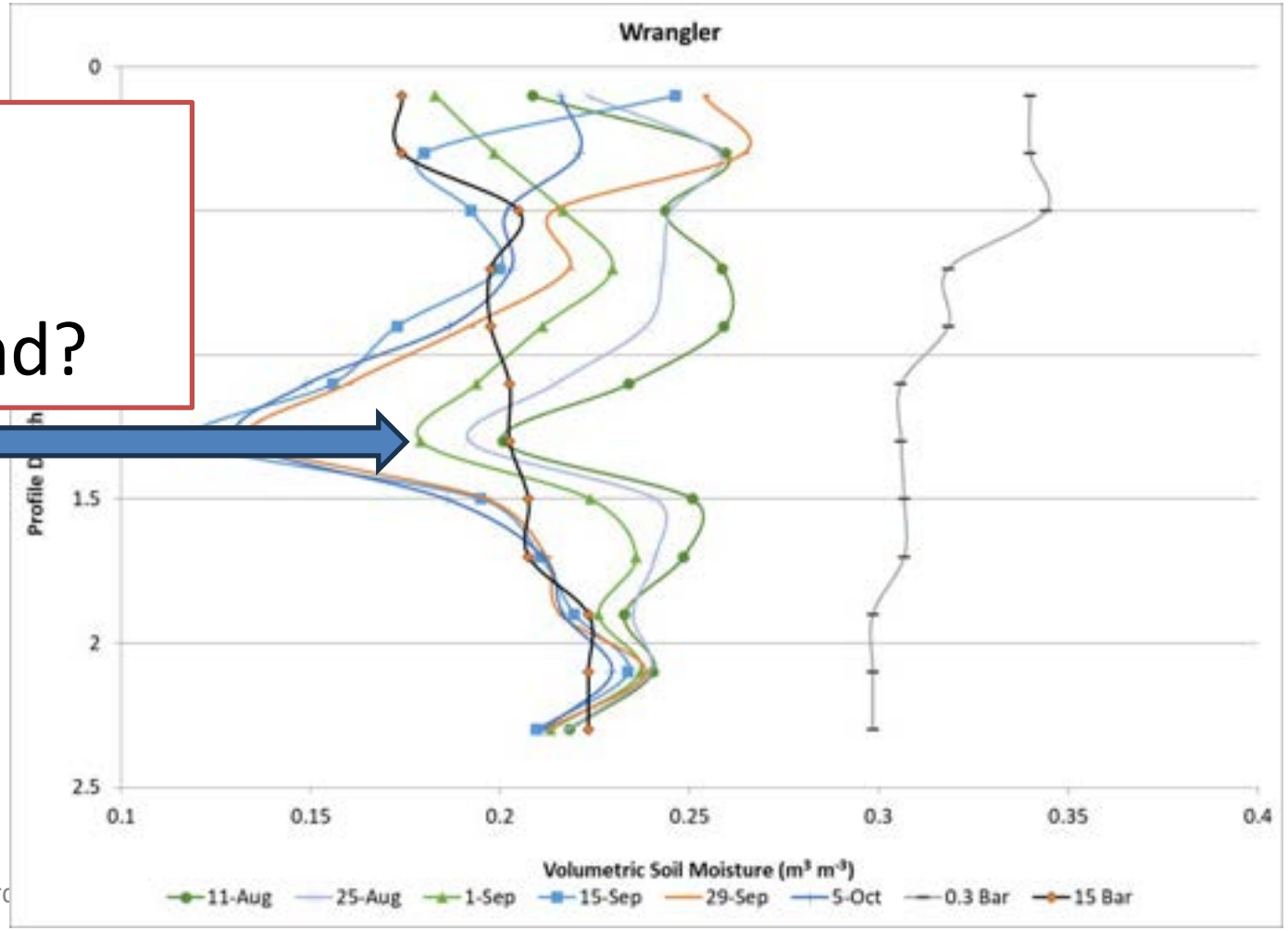
Profile drydown during last cutting growth period



Profile drydown during last cutting growth period



-Soil moisture < 50% MAD
-Negligible winter precip.
-How will production respond?



Summary

- As water declines, forages may be the most economical and VIABLE option.
- Research is needed to optimize production with adapted forages under limited irrigation.
- Production functions are needed for LOW water environments.
- A better understanding about the long-term impact of annual forages to soil is needed.

Thank you!

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