Can increasing sorghum berry size increase its processing and starch digestibility?

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ANIMAL SCIENCE
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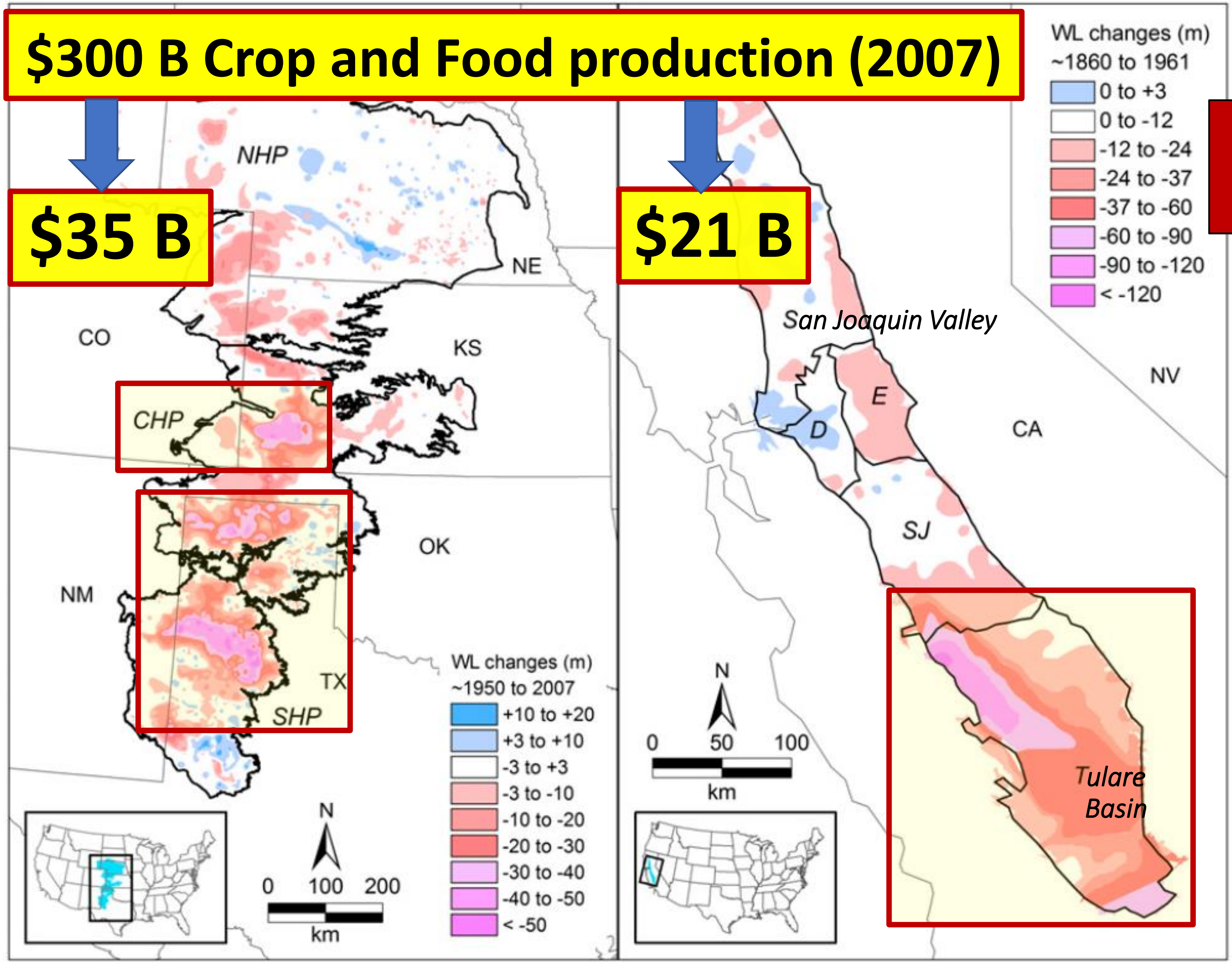
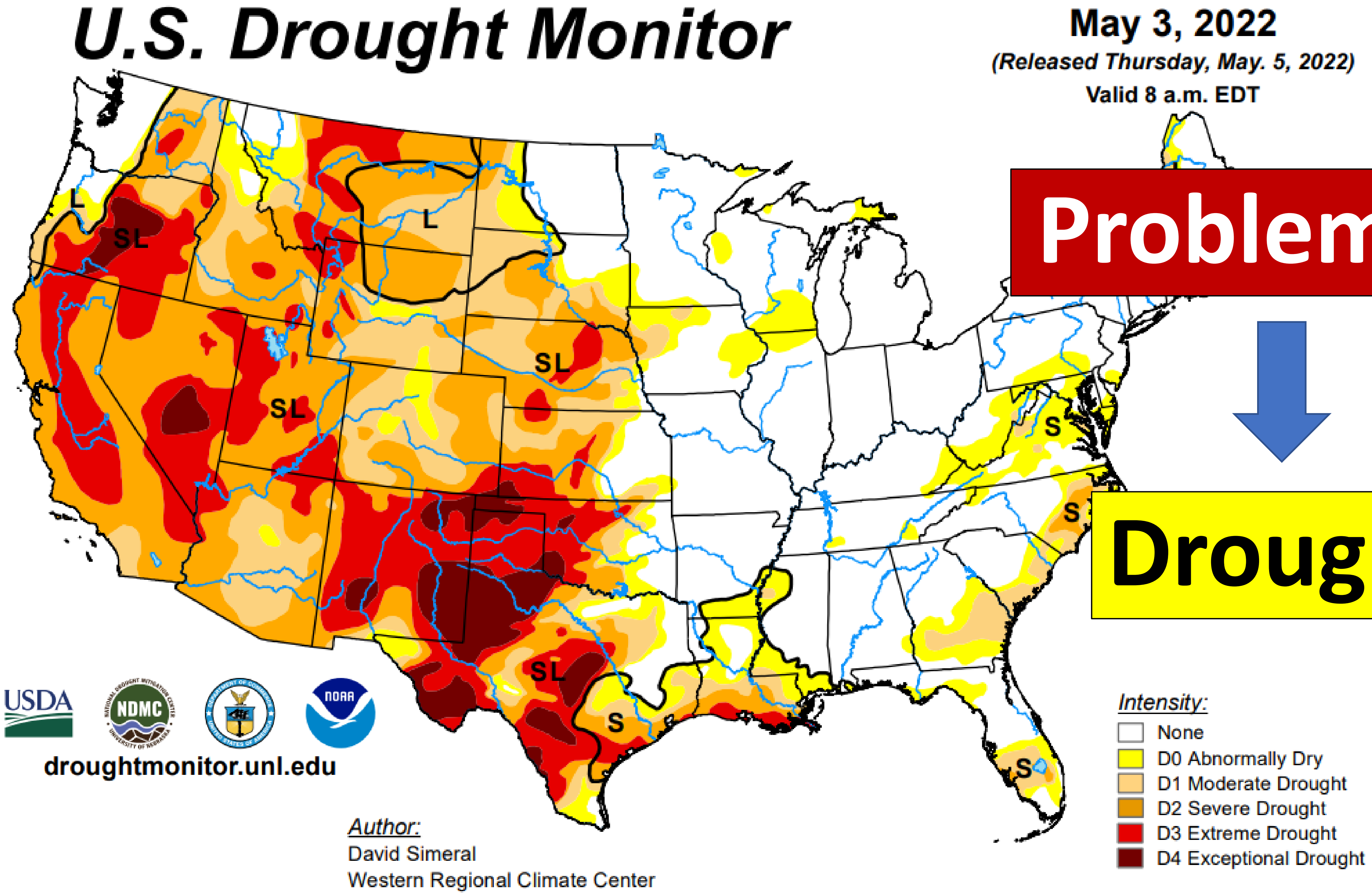


Problem 1:

Aquifer levels severely declined

Scanlon et al., 2012



Problem 2:

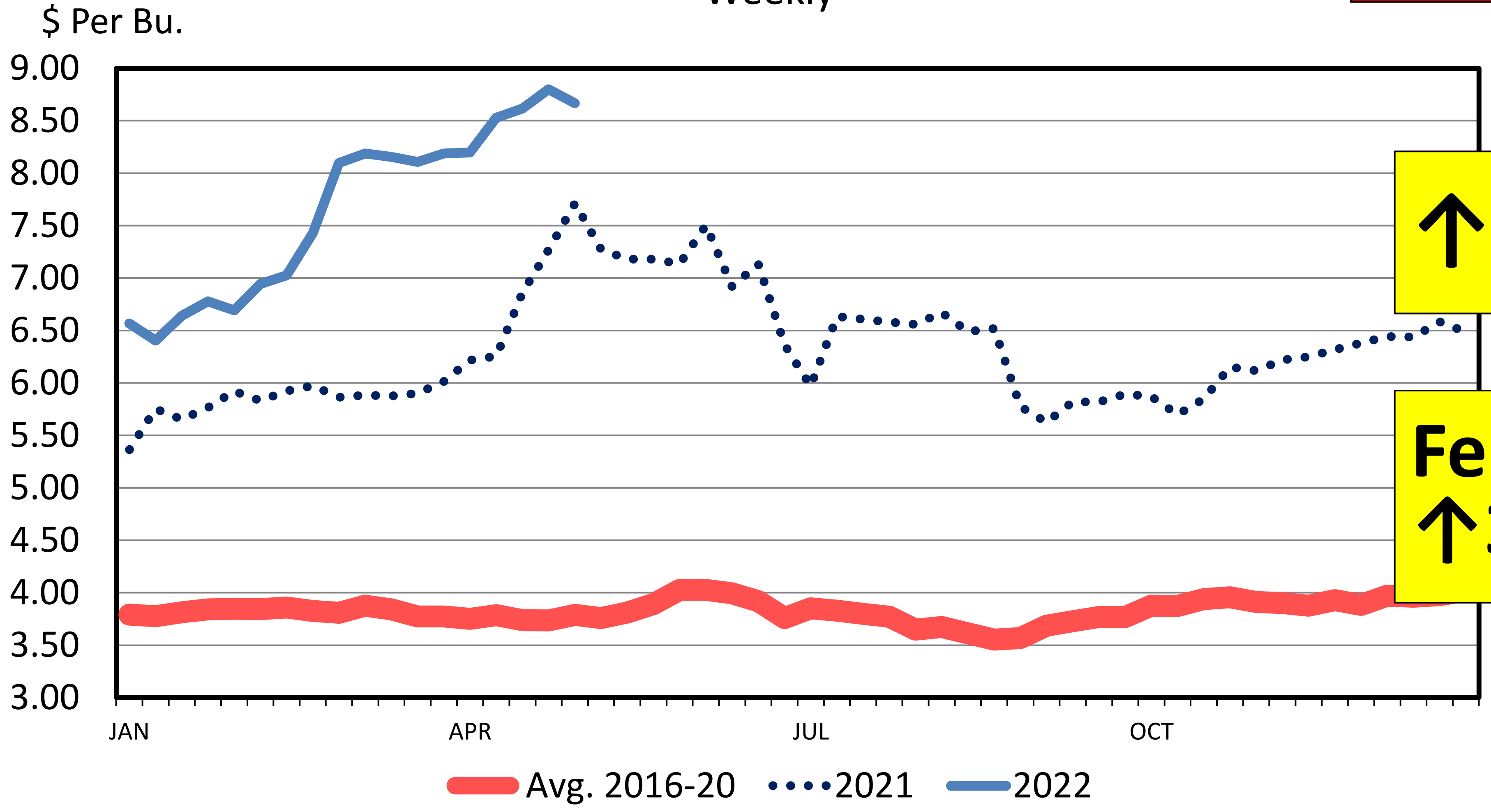
Drought

Problem 3:

↑Input costs

Fertilizer costs ↑38% from '21

SOUTHERN PLAINS CORN PRICES
Weekly



Data Source: USDA-AMS

Livestock Marketing Information Center

Slide courtesy of Dr. Justin Benavidez, TAMU Extension economist.

<u>Sorghum</u> as an Alternative Crop to Corn silage?

- Drought tolerant
- Water efficient
- Lower input costs
  (~10X lower seed costs/acre;
  lower fertilizer & irrigation costs)

- ↓starch & ↓digestibility
- Higher NDF
- Lower TDN

Research Team

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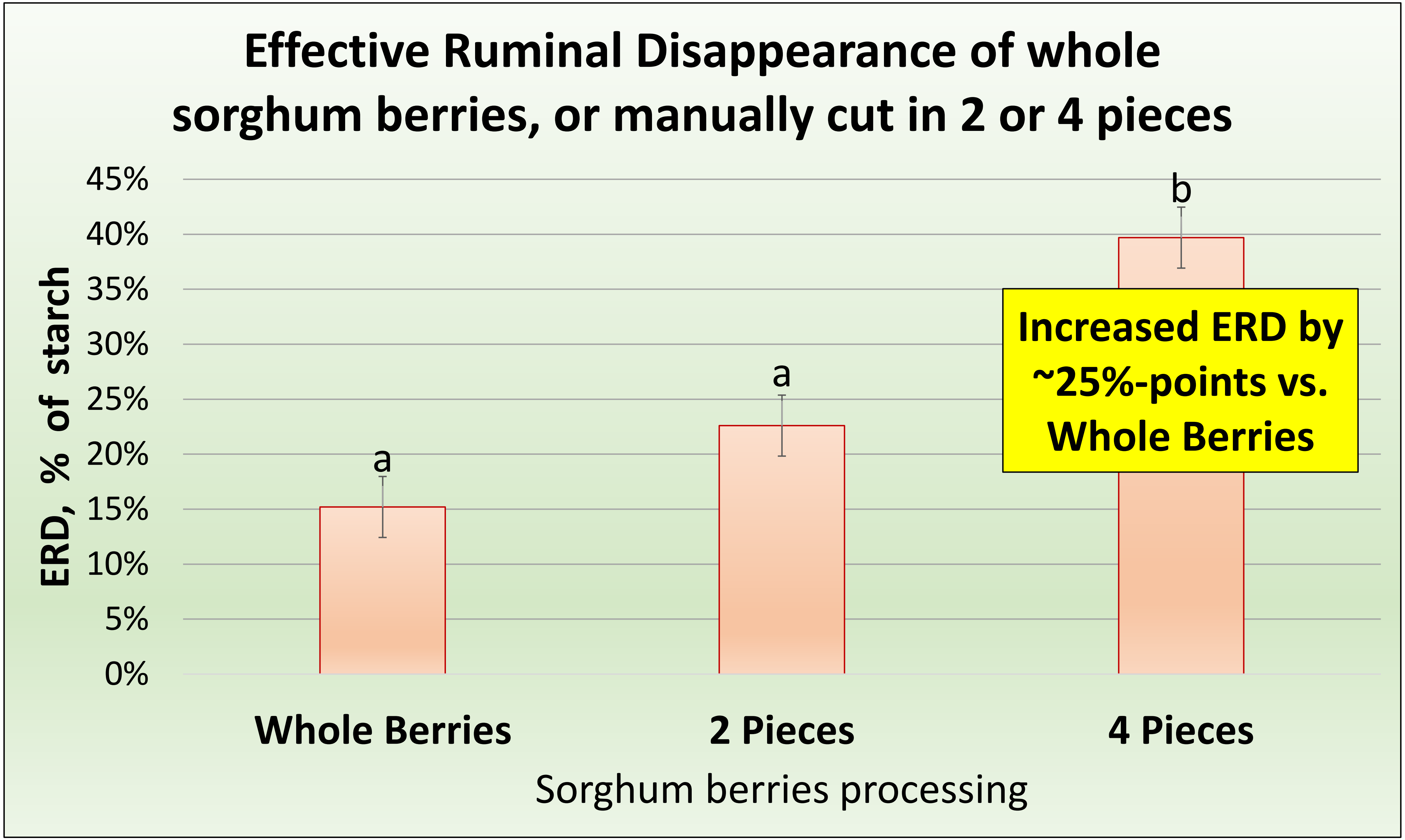
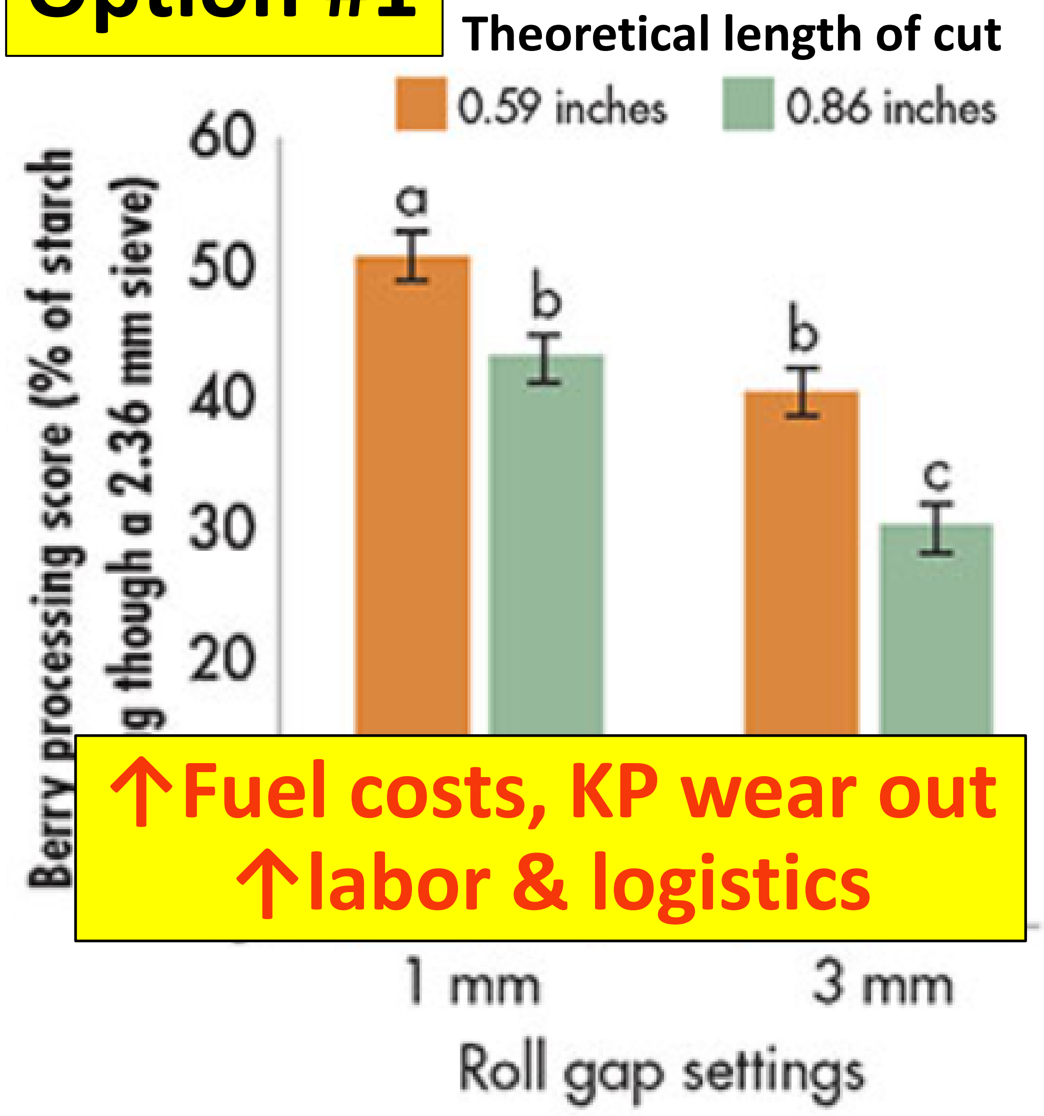


Adapted from McCary, 2019. Strategies to improve whole-plant sorghum silage nutritive value. MSc. Thesis, UF.

Option #1

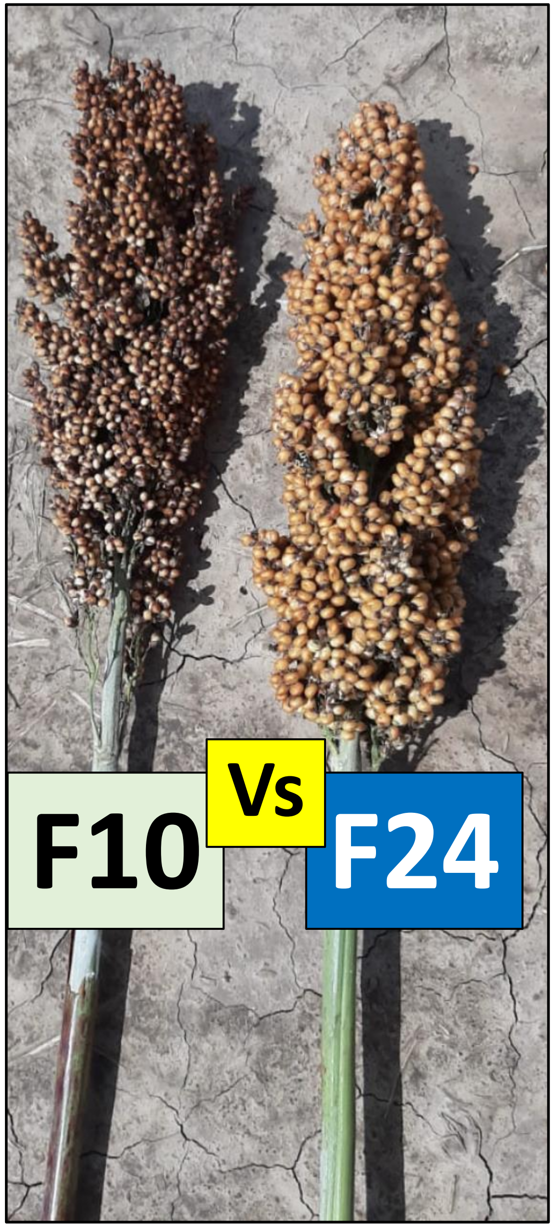


Adapted from McCary and Ferrareto, 2020

Option #2

Pictures courtesy of Diego Druetto, Research Leader at Richardson Seeds

Objectives



- Obj. #1: compare particle size distribution of **intact** and **processed** sorghum berries for hybrids with smaller (F10) and bigger size (F24)

H_1: Compared to F10, F24 will have:

1) more intact berries >3.35 mm

2) more starch passing through a 2.36 mm sieve

- Obj. #2: compare nutrient composition and in-situ starch digestibility of sorghum hybrids with smaller (F10) and bigger berry size (F24)

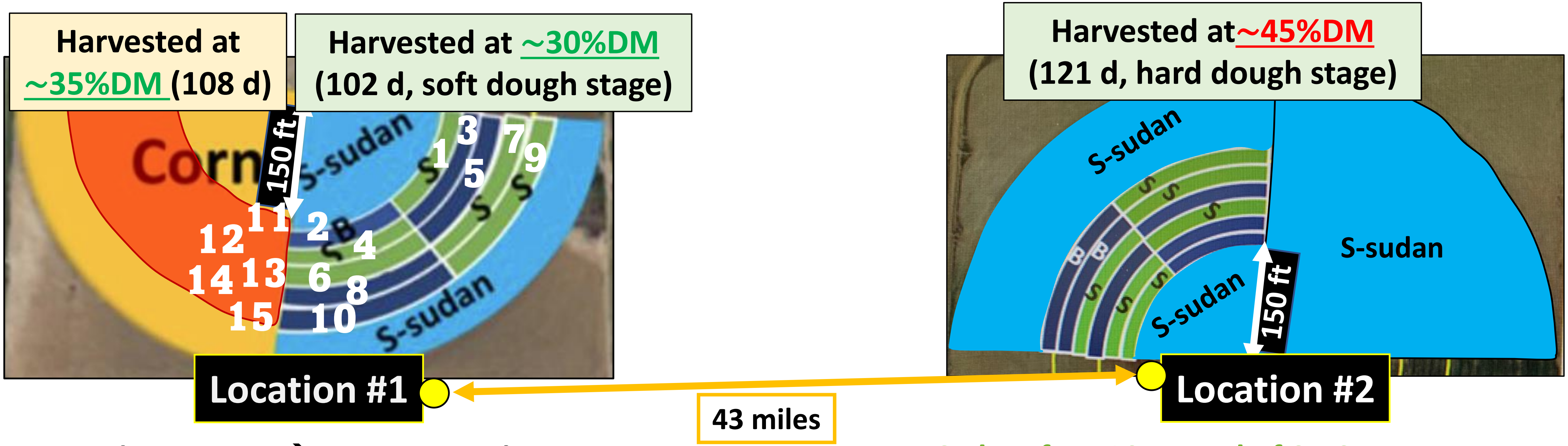
H_1: Compared to F10, F24 will have:

1) higher starch content

2) higher rumen in-situ starch digestibility

Materials and Methods

- Two commercial dairies in the TX South Plains with plots under center pivot irrigation



1st randomization → corn W, sorghum E

Randomization 10 plots (blocked by irrigation)

5 plots for F10 (smaller berry) = Total of 2.11 acres

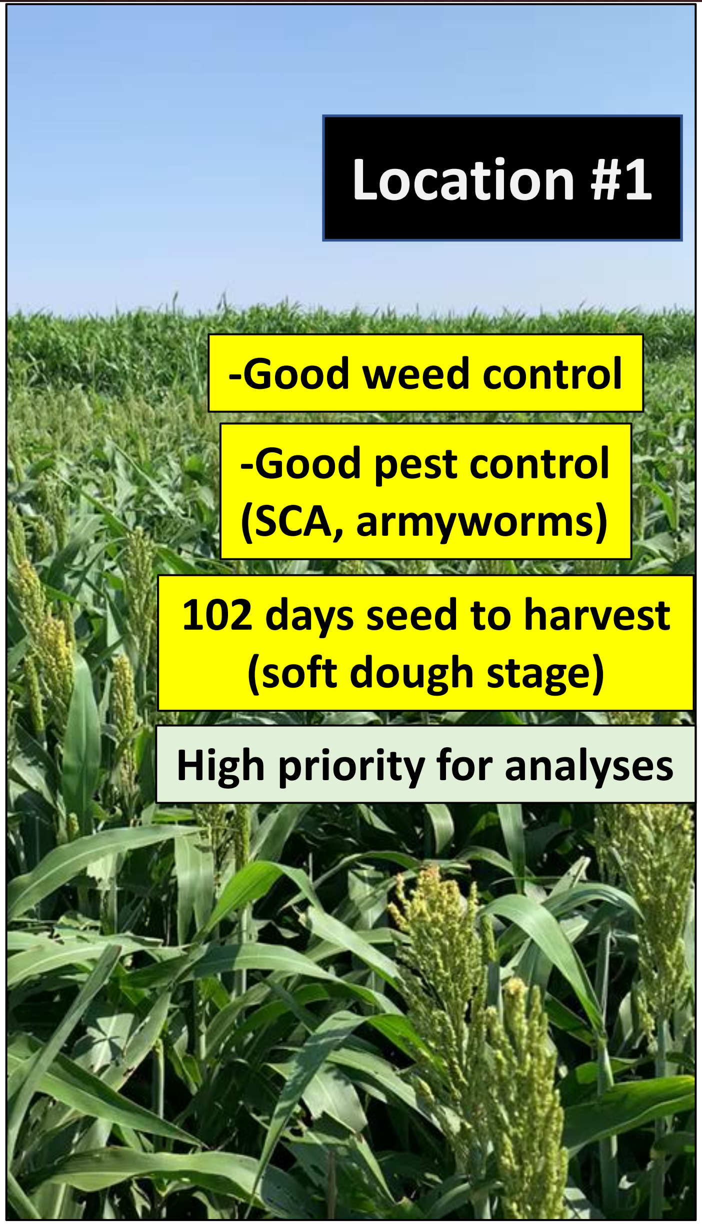
5 plots for F24 (bigger berry) = Total of 2.09 ac.

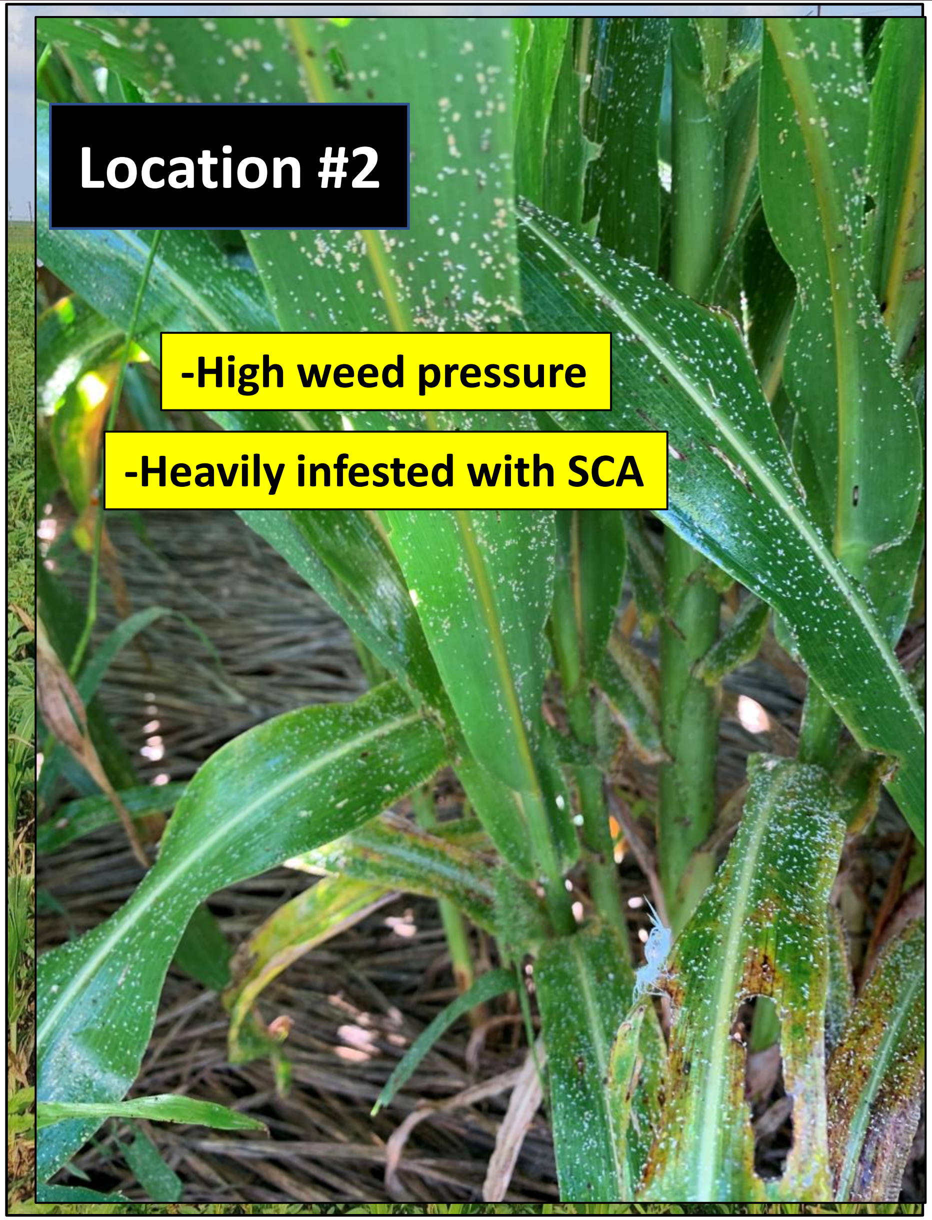
6 plots for F10 = Total of 2.49 acr

6 plots for F24 = Total of 2.58 ac.

Randomization 12 plots (blocked by irrigation)

Materials and Methods





Materials and Methods

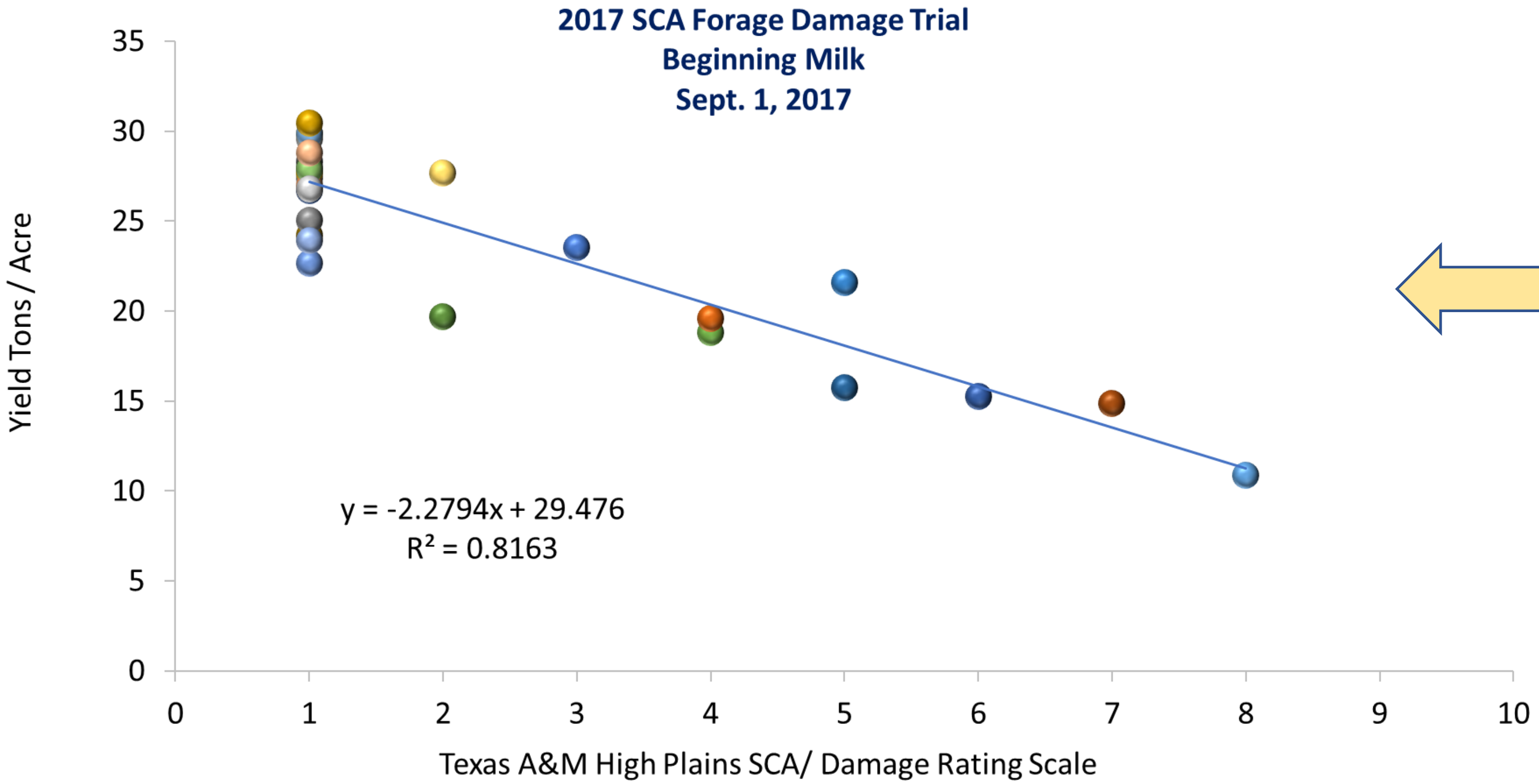
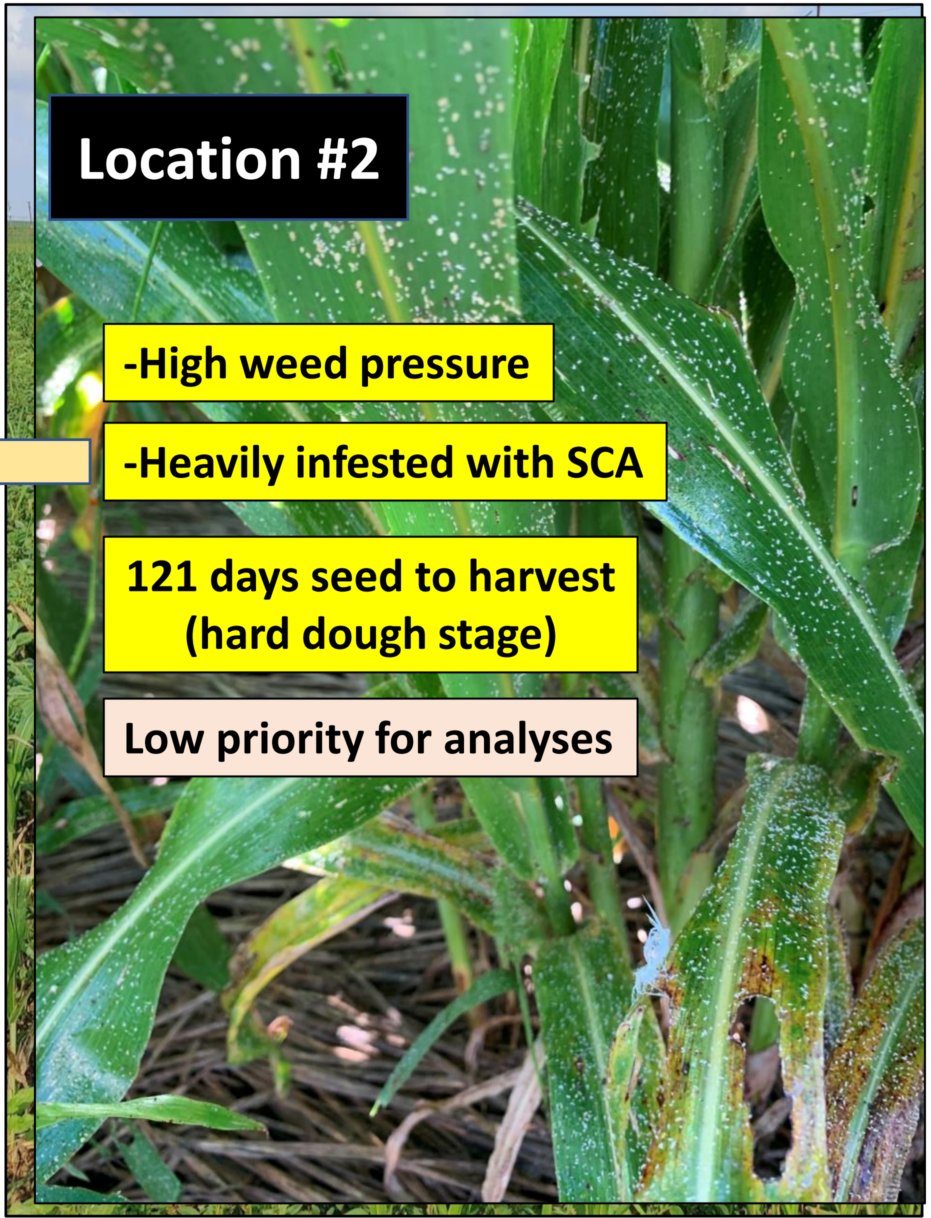
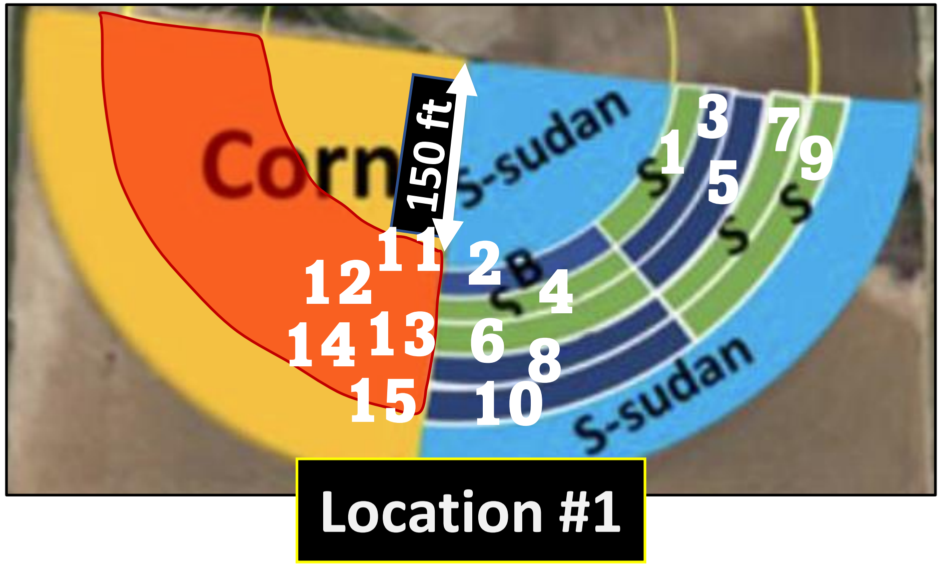


Image courtesy of Dr. Jourdan Bell,
TAMU Extension agronomist.



Materials and Methods



5 plots for F10 (smaller berry) = Total of 2.11 acres

5 plots for F24 (bigger berry) = Total of 2.09 acres

1st randomization → low pop. corn W, sorghum E

Randomization for 10 plots (blocked by irrigation)

6 plots for F10 (smaller berry) = Total of 2.49 acres

6 plots for F24 (bigger berry) = Total of 2.58 acres

Randomization for 12 plots (blocked by irrigation)


Corn
S-sudan-millet
F24
F10
S-sudan-millet

LOCATION #1

Crop Management

Seeding rates

- **Sorghum**: 5 lbs/acre **of F24 and F10 seeds** (80K plants/ac)
- **Corn**: 20,000 plants/acre (low pop.)
- **S-Sudan-millet**: 15 lbs/acre (10 lbs S-sudan, 5 lbs millet)

Herbicides

- After triticale harvest, roundup. Dual and Atrazine (Pre)
- **Sorghum**: Dicamba [F24 and F10 seeds treated with concept]
- **Corn**: Post-emergence: Dicamba, Lauidis, Atrazine.

LOCATION #1

Crop Management

Pesticides

- Sprayed for fall armyworm once [Vantacor, 1.5oz + 0.25% MSO].
- Sprayed for SCA once [flupyradifurone (Sivanto Prime, 7oz)].

Irrigation

- Well capacity 4.6 gal/min/acre. Running all summer unless it rained. They had only 1 in. of rain last 12 mo.

Fertilizer

- **Corn**: 80 gal/ac of 28-0-0-5
- **Sorghum**: 48 gal/ac of 28-0-0-5 **↓%40**

LOCATION #1

Data collection

1- Pre-harvest (10 plants, 1 d before harvest)

- ❑ Total plant weight, Pannicle : Leaf+Stems

2- At harvest

- ❑ Plot yield (farm scale)

3- Berry Processing Score

- ❑ In vitro essays

4- Rumen in situ essays in dairy cows

- ❑ Rumen in situ starch digestibility

5- In vitro essays

- ❑ DM, CP, NDF, starch, etc.

Duplicate fresh samples from 15 plots

#1 Pre-harvest

What is the proportion of panicle:leaf+stems?

Crop (hybrid)	Total plant weight	Panicle/ear	Leaves+Stems	%Panicle/ear	%Leaves+Stems
Sorghum (F10)	3.0^{a} (± 0.25)	0.89^{a} (± 0.05)	2.14^{a} (± 0.21)	29.4^{a} (± 0.97)	70.6^{a} (± 0.97)
Sorghum (F24)	4.0^{b} (± 0.25)	1.14^{b} (± 0.05)	2.86^{b} (± 0.21)	28.8^{a} (± 0.97)	71.2^{a} (± 0.97)
Corn composite	6.0^{c} (± 0.52)	2.67^{c} (± 0.09)	3.31^{b} (± 0.44)	45^{b} (±	55^{b} (± 2.13)
***P*-value**	0.01	0.0001	0.06	0.005	0.005

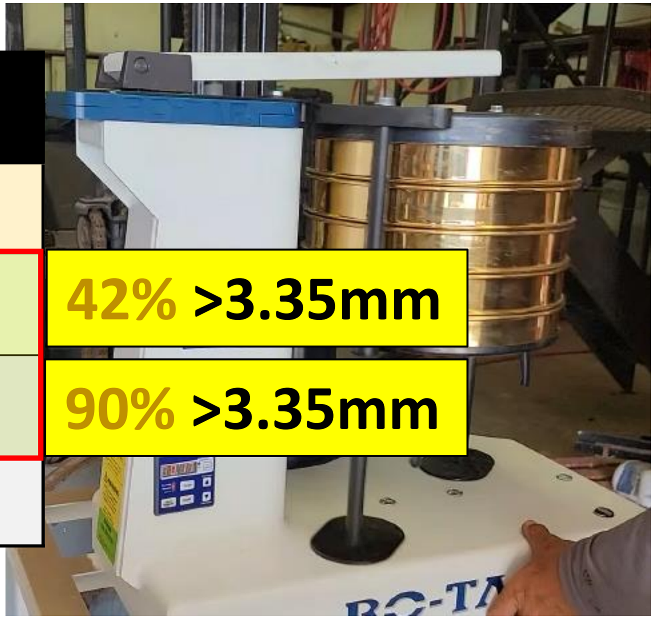
29:71

45:55

#1 Pre-harvest

Are berries from F24 bigger compared to F10?

Particle size distribution of intact sorghum berries			
Sorghum Hybrid	**>4mm, %**	**>3.35, %**	**<3.35, %**
F10	0^{a} (± 2.7)	42 (± 3.9)	58^{a} (± 4.5)
F24	41^{b} (± 2.7)	49 (± 3.9)	10^{b} (± 4.5)
***P*-value**	0.008	0.24	0.017



42% >3.35mm

90% >3.35mm

#2 At harvest

Did F24 yield more than F10?

Hybrid	F10	F24	SEM	P-value
wet_ton/acre	16.8	17.6	1.16	0.55
DM, %	32.0	32.2	0.01	0.87
dry_ton/acre	5.3	5.6	0.27	0.33

Crop	Corn	S-Sudan
dry_ton/acre	6.0	7.2

#3 BPS

Did berry processing score of F24 and F10 differ?

Hybrid	F10	F24	SEM	P-value
Starch above 2.36 mm sc., %	68	75	1.64	<0.001
Starch passing 2.36 mm sc., %	32	25	1.64	<0.001
Starch above 1.7 mm sc., %	84	83	0.90	0.34
Starch passing 1.7 mm sc., %	16	17	→	1/3 in location #2

#4 Rumen in-situ starch digestibility

Did F24 have better starch digestibility than F10, and how do they compare with corn?

Crop	Sorghum (F10)	Sorghum (F24)	Corn	*P*-value
In-situ starch digestibility, % starch	59.5[a] (± 3.03)	59.3[a] (± 3.03)	74.8[b] (± 3.03) ↑25%	0.001

Table 3. In-situ rumen starch digestibility (7 h) of forage sorghum hybrids **F24** and **F10** and **corn** silage.

[a−b]Means within the same row with different superscripts are significantly different.

#5 In-vitro essays

How did nutrient composition vary between F24 and F10?

How do they compare with corn?

Crop	Sorghum (F10)	Sorghum (F24)	Corn		SEM
Starch, % DM	23.9[a]	26.6[b]	31.4[c]	↑24%	1.00
aNDF, % DM	44[a]	44[a]	38[b]	↓14%	0.76
Lignin, % DM	4.4[a]	4.1[b]	3.7[c]	↓13%	0.09
NDFD30, % NDF	44.5[a]	45.5[a]	55.0[b]	↑22%	0.65
CP, % DM	9.9[a]	8.9[b]	9.0[b]		0.12
Milk/ton 2006 T.30h	2850[a]	2870[b]	3130[b]	↑9.5%	44

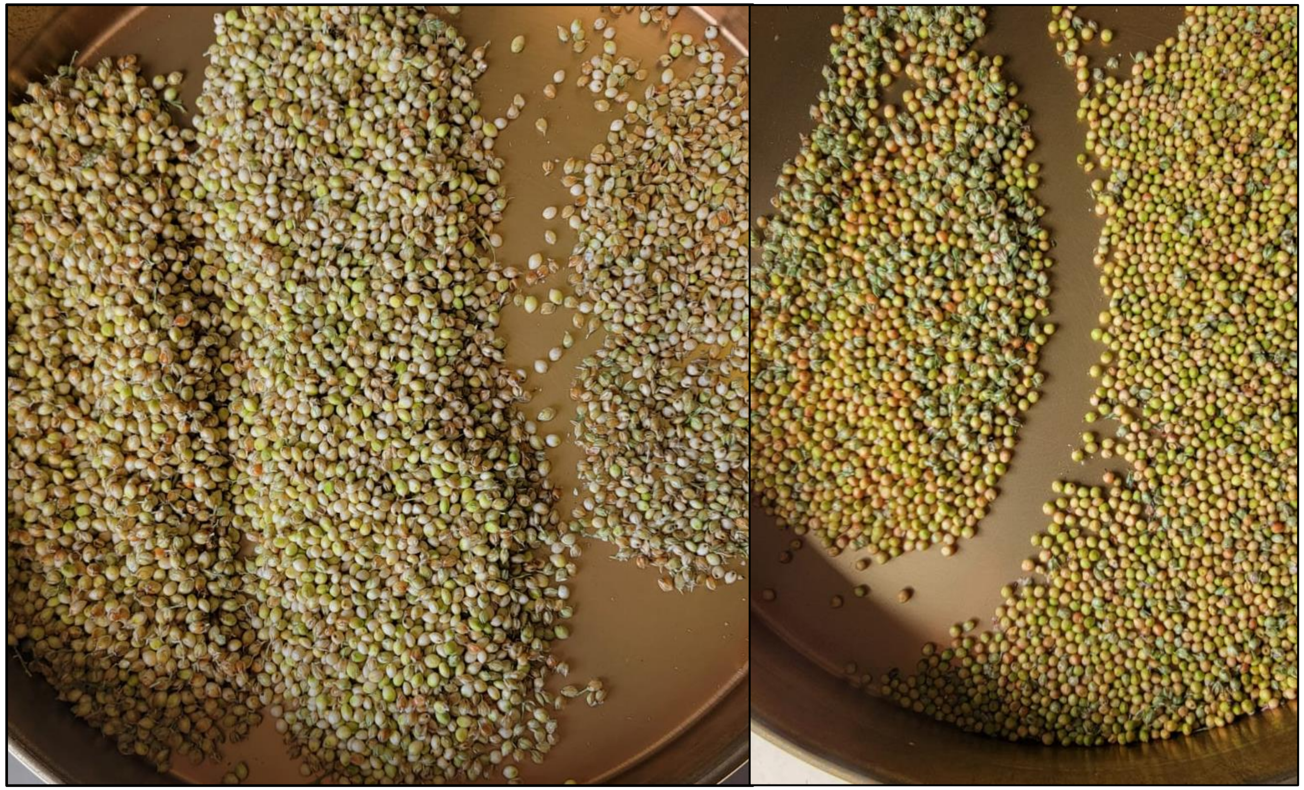
Table 4. Nutrient value of sorghum hybrids F10, F24 and corn.

$^{a-c}$Means within the same row with different superscripts are significantly different.

Discussion

- Increasing sorghum berry size, at least for the size difference compared, may not increase in situ starch digestibility.

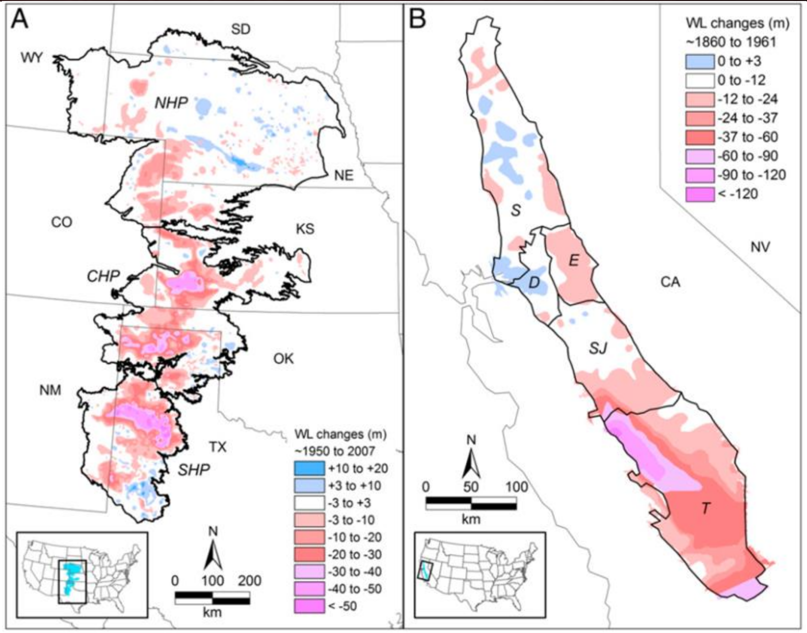
- The increase quality in corn silage vs. sorghum silage may be attributed by the increased grain (starch) content and better processing.

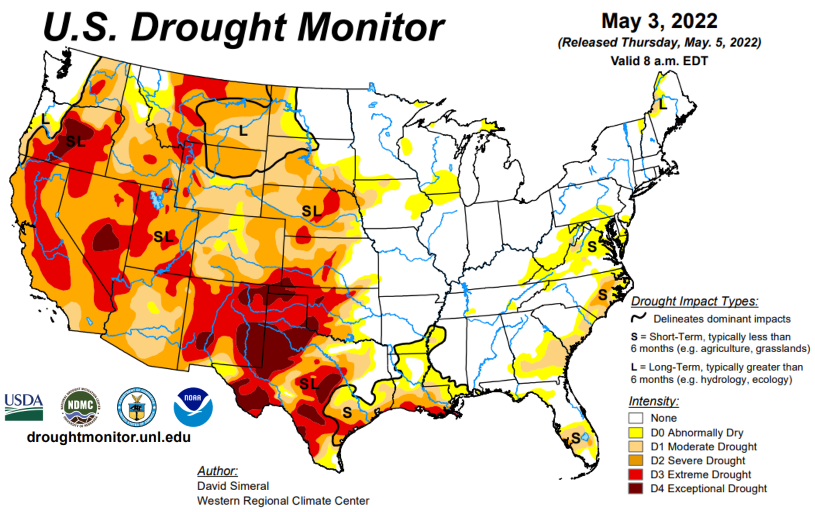


Discussion

- Under drought stress conditions corn loses quality much more quickly than sorghum. If corn does not develop grain, overall quality decreases.

- With water scarcity, sorghum hybrids may be a safer option and may achieve higher yield (Sorghum-sudan) and similar NDFD (BMR hybrids) vs. corn silage while reducing input costs.





Future Directions #1

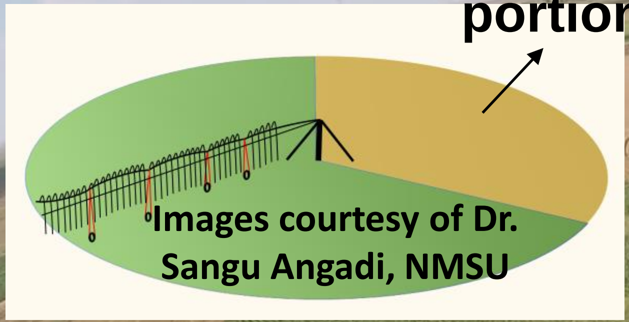
❑ Does sorghum stems+leaves impedes its processing?

- Increase panicle: stems+leaves from 30:70 to 50:50
- Increase fragility of stems using BMR hybrids

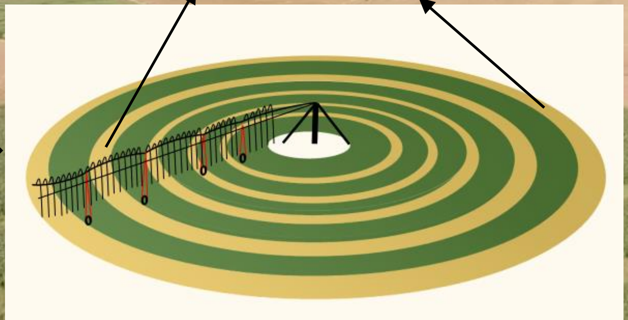
❑ Focus on comparing only forage yield and quality of sorghum hybrids (e.g., male steriles) vs. corn silage

Douglas Duhatschek, DVM,
Graduate Research Assistant

Future Directions #2



Partial pivot



Circular Grass Buffer System

Dr. Sangu Angadi, NMSU

<u>Duplicates</u> water efficiency use and ↑grain yield by >15%

- ↓wind & soil erosion, ↑soil moisture and T
- "ponding effect" blocking rain runoff on/below surface

Herbicide drift (aerial application)

- Pest reservoir (spider mites)
- 1^{st} year irrigation needs

Take home messages

- Groundwater depletion in the HP and CV aquifers threatens future crop production. Increasing water efficiency use will be key to meet forage demand.

- Current strategies to increase water efficiency use include growing water efficient crops, hydroponic systems, and use of buffer strips for forage production

- Sorghum is a drought tolerant, water efficient alternative for corn silage. While berry processing remains an issue, sorghum silage production could be focused on forage yield and quality if starch content in the diet comes from other feeds (DG corn)

Acknowledgements

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Texas Association of Dairymen

Sorghum Checkoff

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Questions?

THANK YOU!