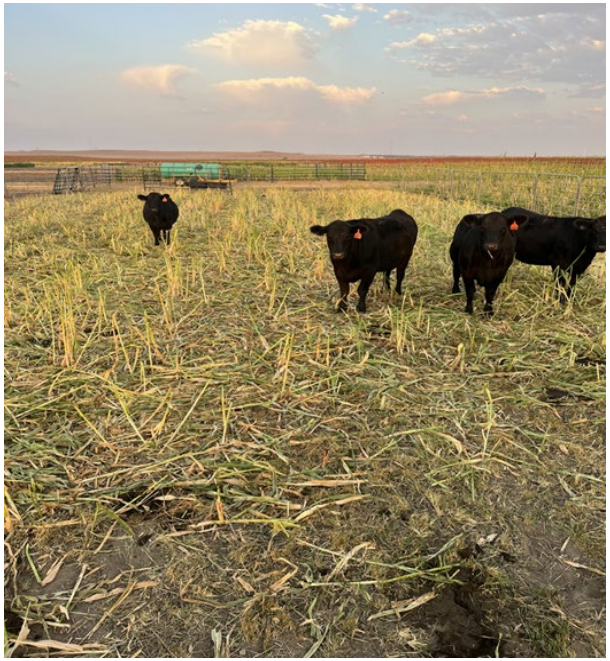
Incorporating Annual forages in Dryland Rotations



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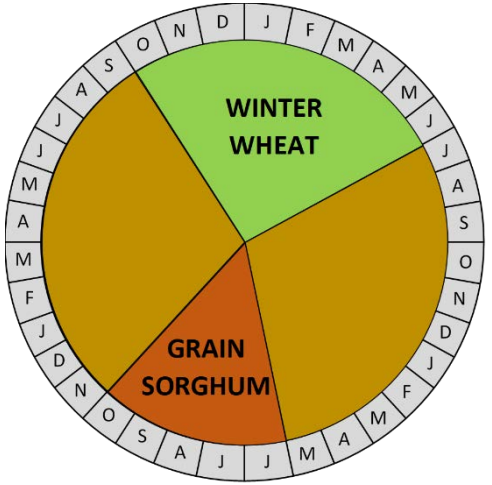
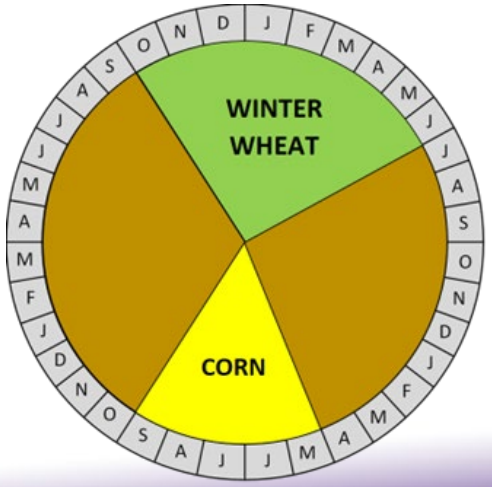
Dryland cropping systems in the USA Great Plains

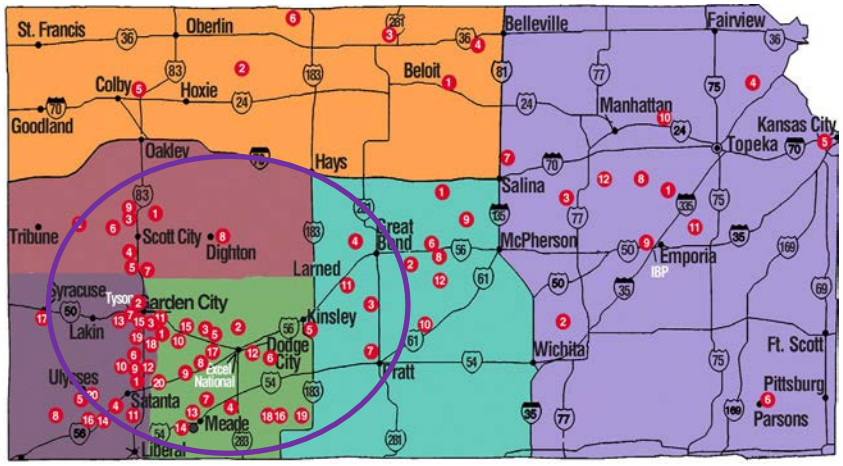
- Highly dependent on soil water storage during fallow periods
- Fallow can increase the stability of crops yields year-to-year though **precipitation storage efficiency is very low (~20-30%)**
- Tillage during fallow decreases residue cover, increases erosion, and degrades soil health
- Even under no-tillage, erosion risk increases when residue levels are low to protect the soil
- Replacing fallow with alternative crops can intensify the crop system





Replacing fallow with forages in drylands

- Important grain & livestock production region
  - **60% wheat production**
  - **96% sorghum**
  - **>75% feedlots** the USA
  - Expansion of dairies in SW Kansas



- Forage (cattle feed) production will diversify cropping systems from corn

- Using **drought-tolerant forage crops**
  - Maintain and enhance the region's ability to ***meet the*** *forage* ***needs of livestock feeders*** in the region as the Ogallala Aquifer continues to decline.
  - Increase efficient use of limited water resources
  - Diversify markets for both grain and forage crops

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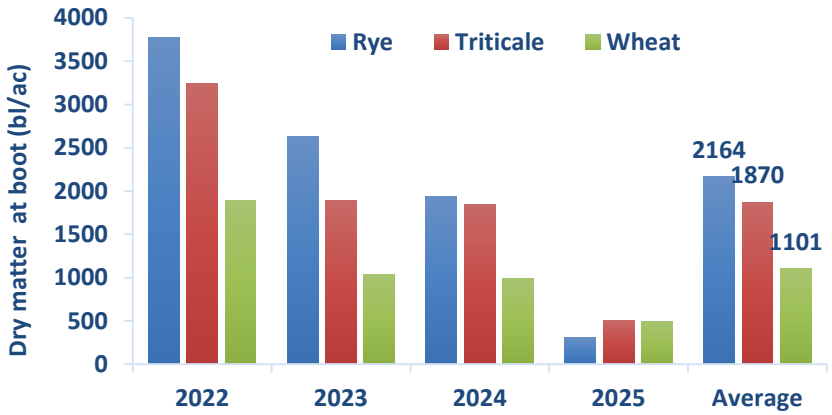
Annual forage crop options in drylands

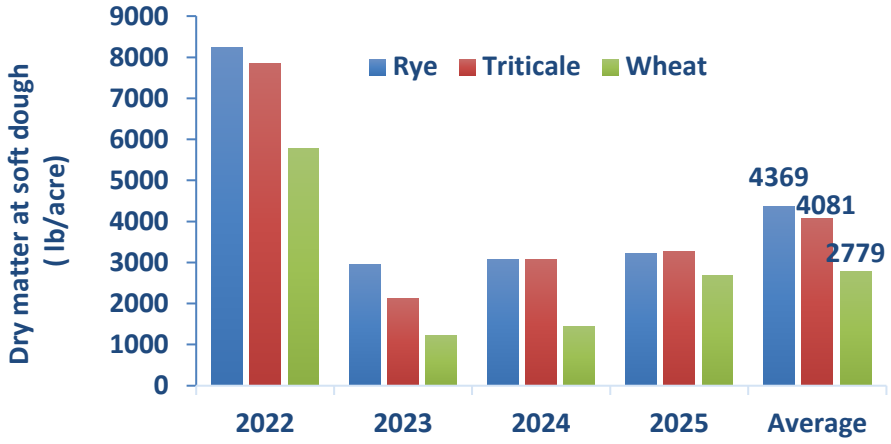
Item	J	F	M	A	M	J	J	A	S	O	N	D
Crop Residue												
Winter Annuals												
Spring Annuals												
Summer Annuals												
Summer legumes												

- Crop residue: grain sorghum, corn
- Winter: dual-purpose wheat, triticale, rye
- Spring: oat, triticale
- Summer: forage sorghum, sorghum-sudan, millet
- Summer legume: cowpea, lablab

Winter wheat, triticale and hybrid rye



- Planted in the September and could be grazed from November to May
  - Haying at soft dough in late may or June provide more yield
- Rye has better tolerance to drought and winterkill
- Triticale, cross between rye and wheat can be grazed harder than wheat
- Rye and triticale are not susceptible to wheat steak
- Crude protein @ boot ~ 20 to 25%
- Crude protein @soft dough 9.5 to 12%



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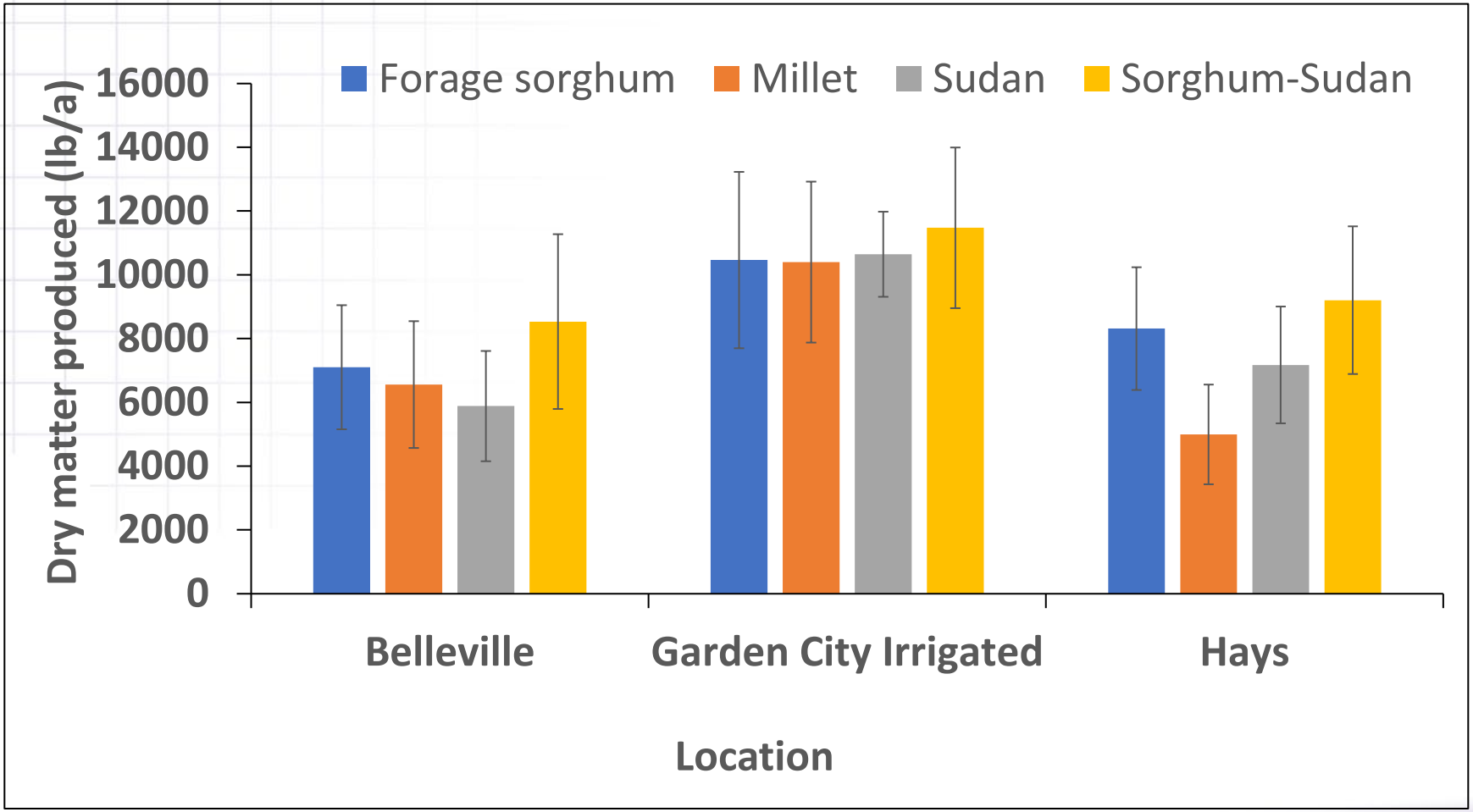
Spring triticale and oat

- Productivity varies by moisture and temperature
- A mixture of oat/triticale tends to yield well
- In Hays, oat yields averaged 3500 to 4500 lb/acre
- Triticale averaged 4000 to 5600 lb/a
- Short grazing window but could be a good hay option
- About 10 to 12% crude protein when harvested at heading or soft dough

Forage sorghums

- Sorghums (forage sorghum, sorghum-sudan, & Sudangrass) are well adapted to dryland environments
- Planted in May or June and can be harvested or grazed in August through November
- Significant regrowth potential
- Nitrate toxicity an issue
- Millets has less prussic acid but yield less than sorghums
- New prussic acid free sorghum hybrid by S & W seeds
- Yields between 6500 to 8500 lb/acre depending on year and hybrid
- Applying about 50 to 60 lb N /acre is adequate

Average dry matter of sorghum hybrids over 10-years across Kansas



Data from hybrid trials led by J. Holman et al.

Sorghums have good regrowth for grazing in the fall

August 2025

December 2025

Cattle grazing prussic acid free sorghum in Ford County, KS. Photos by Dr. J. Holman

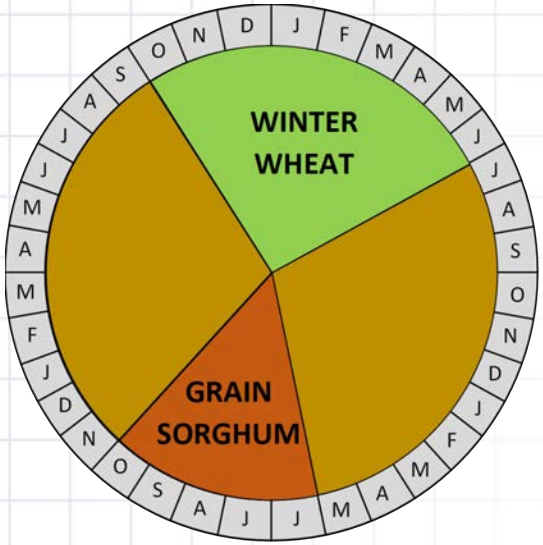
Sorghum/corn residue

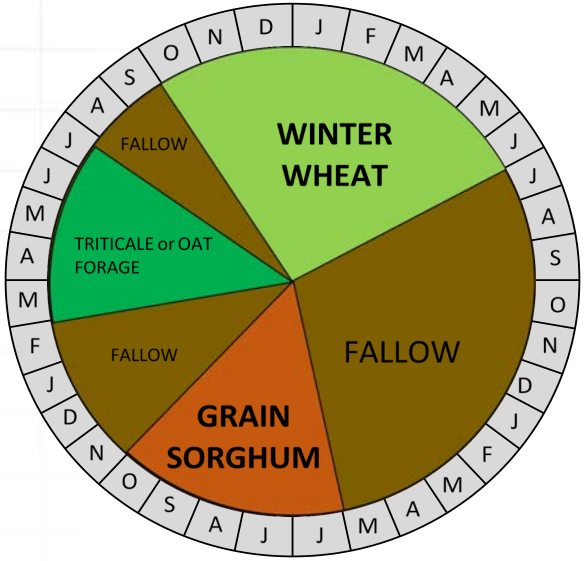
- Residue per year in Kansas
  - ✓ 70,000 tons of sorghum residue
  - ✓ 10 million tons of corn residue
- Good grazing resource
- Cautious about grazing stalks with lots of down heads and ears with grain
- Goal is to leave at least half of the crop residue on the field
- Grazing helps with nutrient cycling

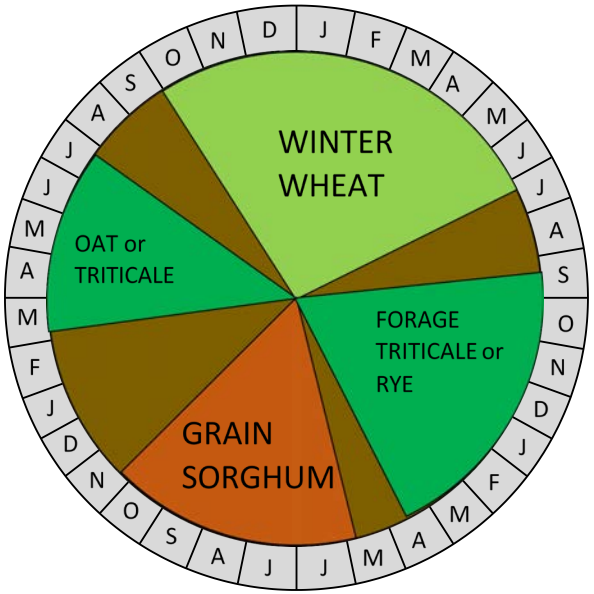
Summer legume alternatives

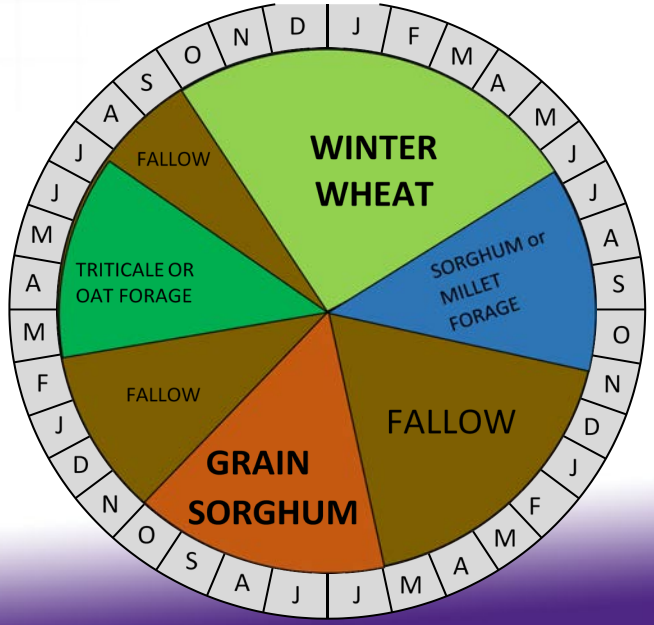
- Cowpea and lablab shows promise as alternative forage legumes for dryland
- Can be planted in May through June
- 2025 varieties harvested in October
- Cowpea yields ranged 1000 to 4000 lb/acre
- Lablab yields ranged 5000 to 6000 lb/acre
- Seed quality and availability is an issue

Annual forage planting options in drylands









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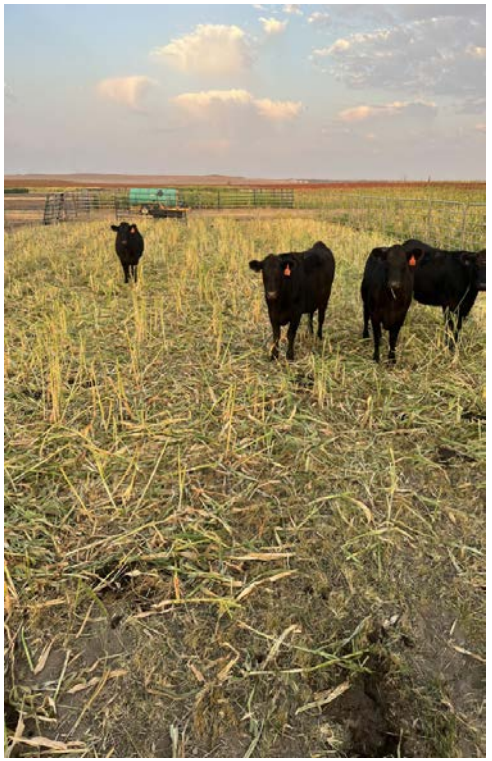
Forages and livestock to diversify wheat-based cropping systems

- Assess how grazed and hayed annual forages and sorghum stalks affect soil properties when integrated into a W-GS-F rotation
- Monitor grain crop yield response and profitability to integrating annual forages and livestock dryland rotations



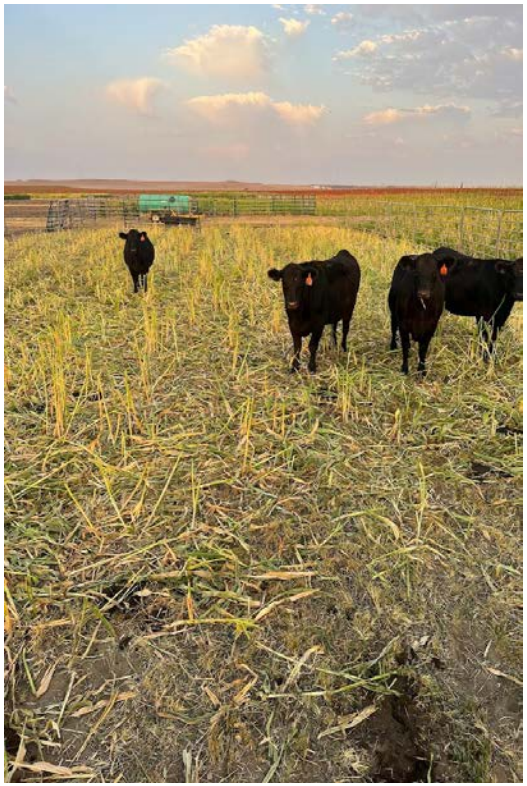
Annual forage study treatments

1. **Year 1: winter wheat; Year 2: grain sorghum; Year 3: fallow**
2. **Year 1: winter wheat; Year 2: grain sorghum (graze stalks); Year 3: fallow**
3. **Year 1: winter wheat/ sorghum-sudan (grazed); Year 2: sorghum-sudan (graze); Year 3: fallow**
4. **Year 1: winter wheat/ sorghum-sudan (hayed); Year 2: sorghum-sudan (hayed); Year 3: fallow**

METHODS (continued)

- Forage harvesting and grazing occurred at or near heading
- Before and after grazing, biomass determined using two 2ft x 3ft quadrats per plot.
- Stocking rate ranged from 3 to 5 AUM/acre depending on available forage (approx. 50% of biomass removed)
- Before Haying biomass was determined using the same quadrants, then harvested using a Carter forage harvester

- Grazing sorghum stalks occurred in November each year



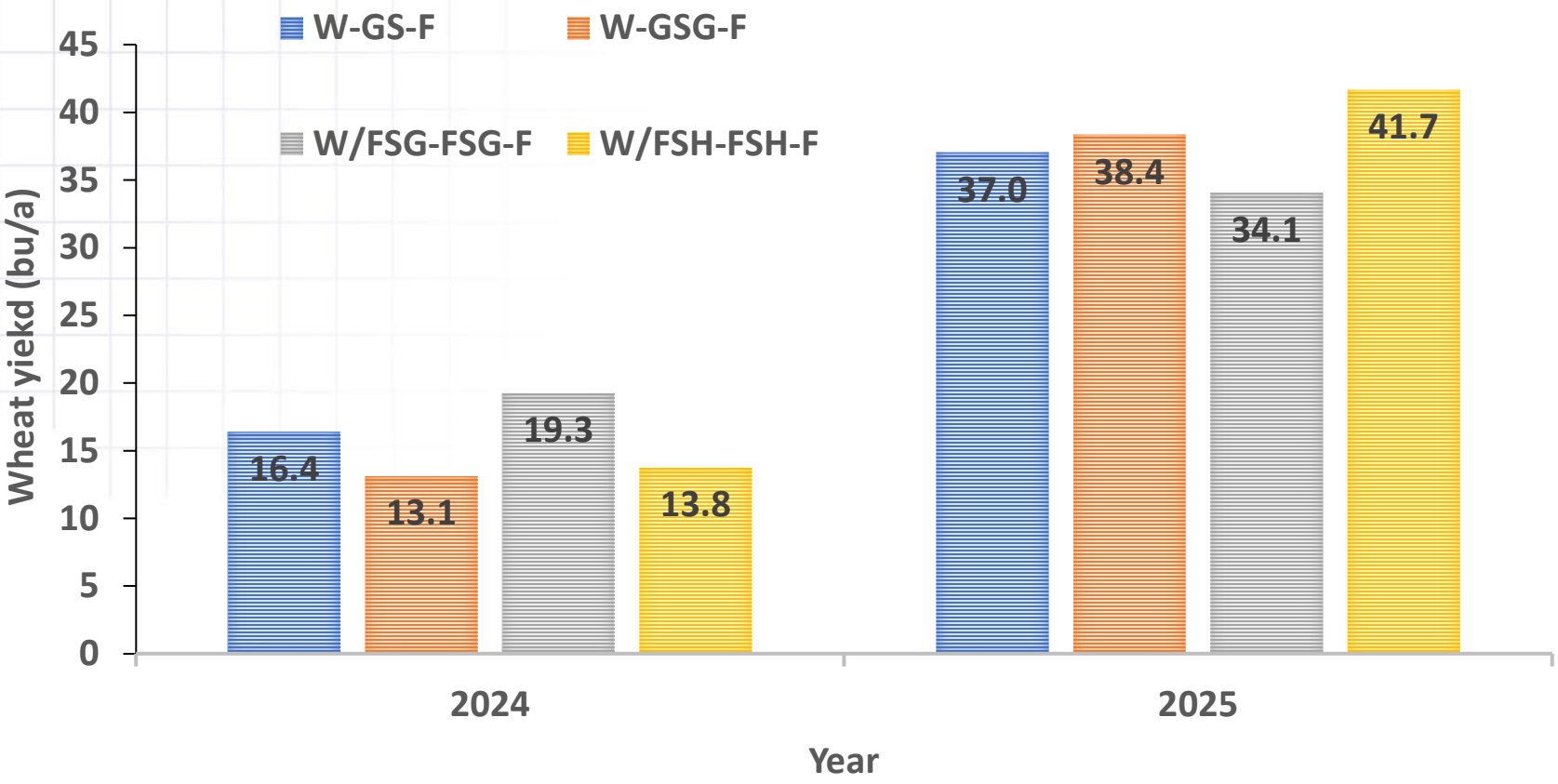
Available forage-2021 to 2025

	Full-Season	Post-Wheat
Treatment	kg ha^{-1}	
Grazing	6933a†	2951a
Haying	7338a	2898a
Year		
2021	7250ba	2997c
2022	5733b	831e
2023	6123b	1527d
2024	8254a	5067a
2025	8319a	4201b
Test of fixed effects		
Harvest Type (HT)	0.556	0.7477
Year (Y)	0.0701	<.0001
HT × Y	0.3185	0.1077

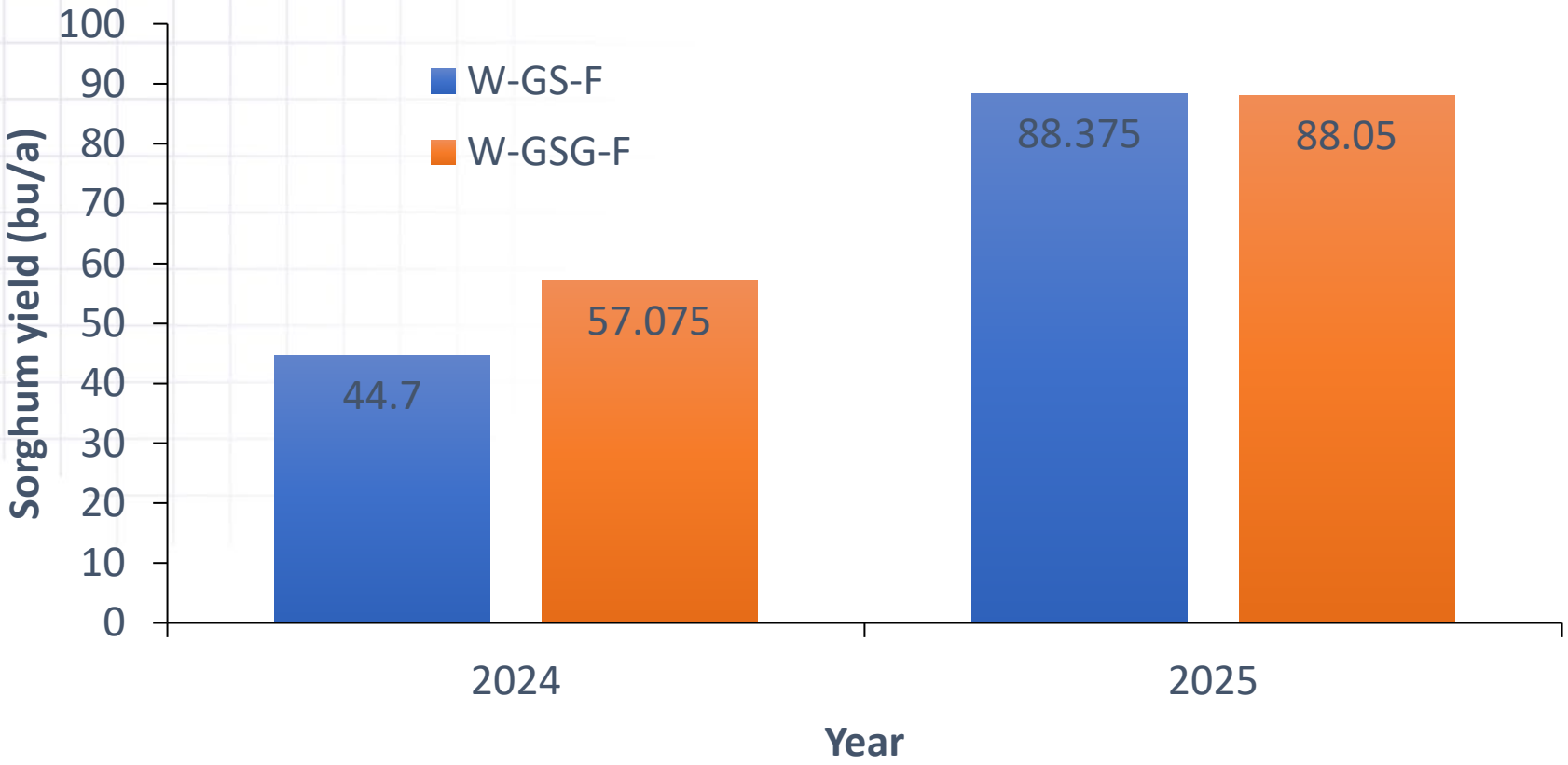
Percent forage remaining after grazing or haying

	Full-Season	Post-Wheat
Treatment	%	
Grazing	50a[†]	60a
Haying	30b	38b
Test of fixed effect		
Harvest Type	0.0035	0.0042

Winter wheat yield



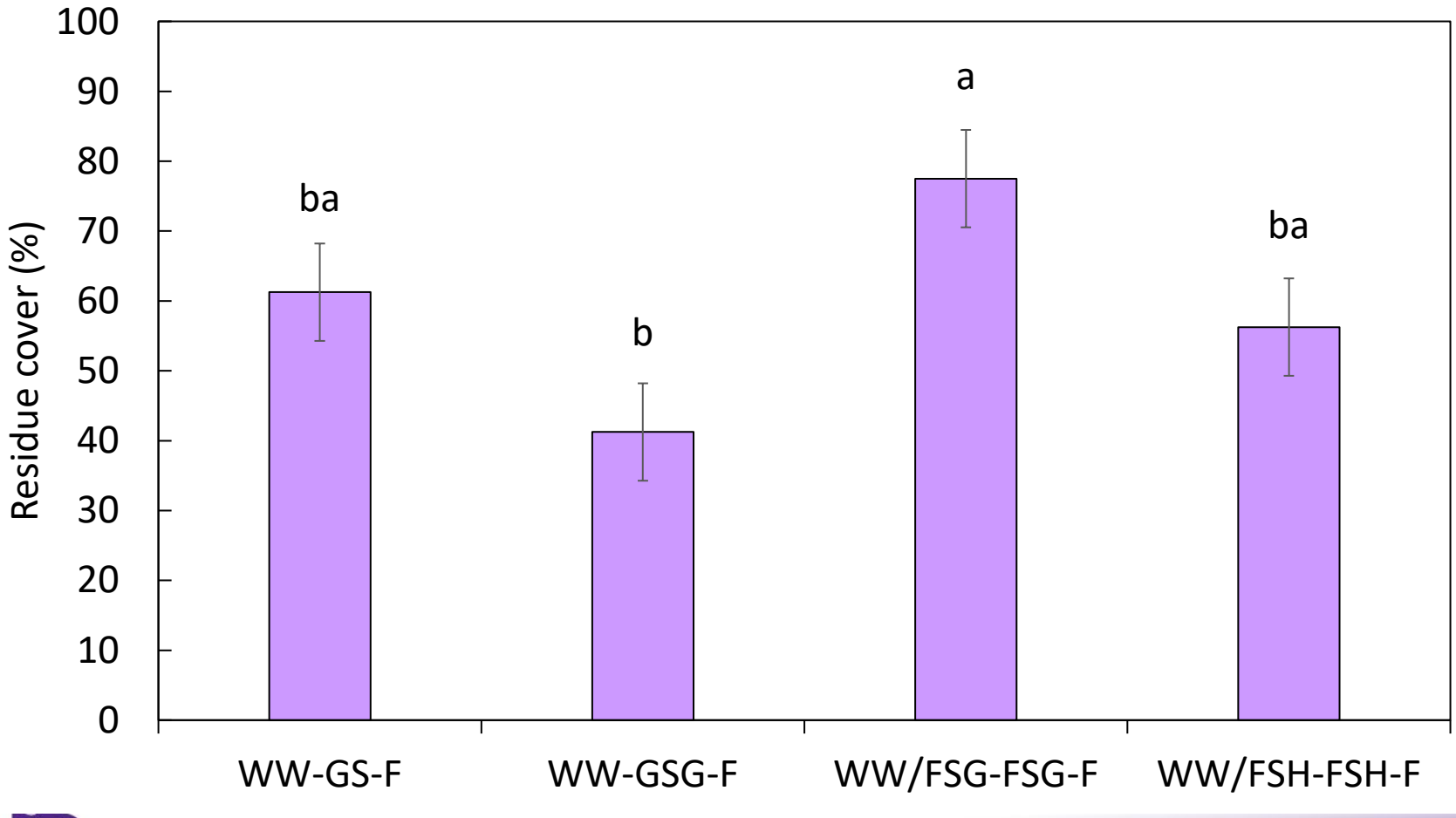
Sorghum yields



Cropping system economic returns

Treatment	2024			2005		
	Total cost	Revenue	Net return	Total cost	Revenue	Net return
	US$/acre					
W-GS-F	383	324	-60b	403	699	296b
W-GSG-F	386	448	62a	403	796	393a
W/FSG-FSG-F	358	423	65a	361	575	213c
W/FSH-FSH-F	534	514	-20b	493	674	181c

Crop residue cover



Using cover crops as a forage resource

- Cover crops can provide immediate economic benefits in the form of high-quality forage
- **Drawbacks may include**:
  - Reduced residue cover and increased exposure to erosive winds and rain
  - Increased soil compaction and decreased water infiltration
  - Reduced soil organic carbon accumulation

Cover crop management research in Western Kansas

- Determine site-specific management options for cover crops in drylands
- Determine forage production potential of cover crops in western Kansas environments and cropping systems
- Evaluating the impacts of grazing and haying cover crops on weed suppression, and crop yields
- Quantify the impacts of grazing cover crops on soil health and cropping system profitability

Dryland cover crop management studies at KSU HB Ranch (Trego County)

Planted in Wheat-Sorghum- Fallow rotation

Treatments

1. Chem-Fallow
2. Standing cover crop
3. Hayed cover crop
4. Grazed cover crop
5. Flex-hayed cover crop

Hayed Cover Crops

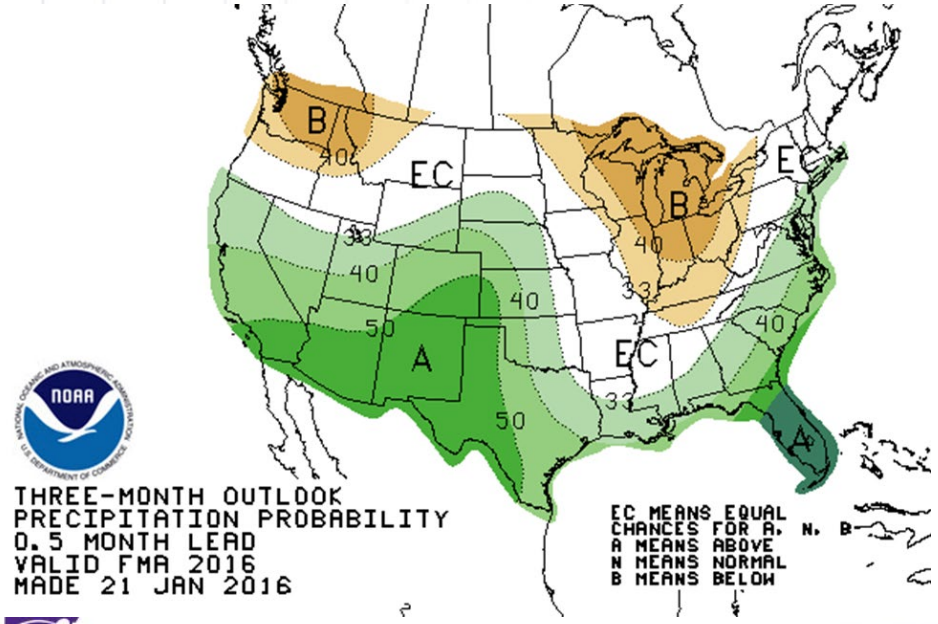
- At grass species heading stage
- 6 inches cutting height

Grazed Cover Crops

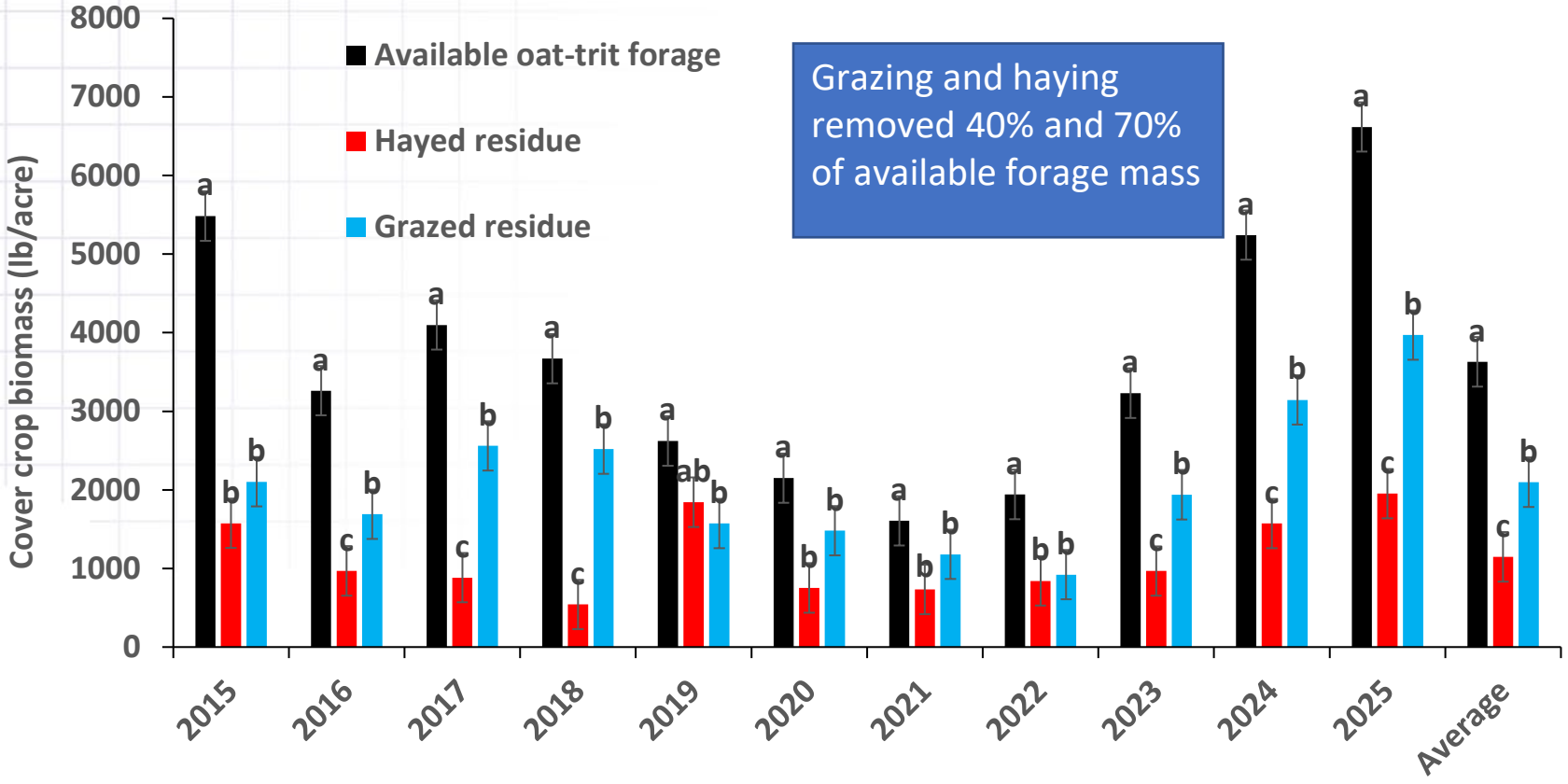
- Yearling heifers
- Generally, one week before haying takes place
- 1300 lb live weight per acre for four to seven days

Flex-Fallow Concept

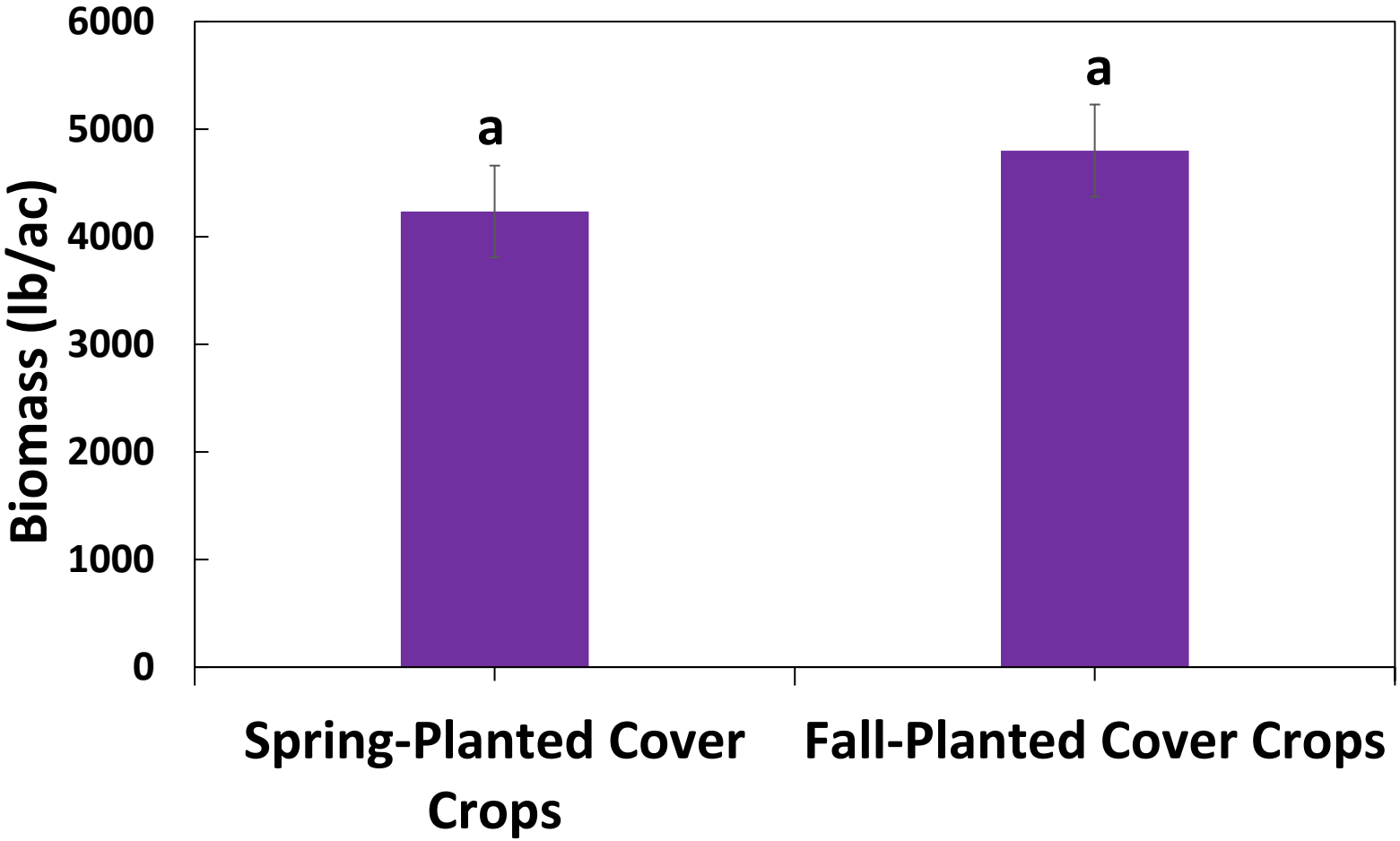
- At CC planting measure soil moisture with Paul Brown Probe
- Plant if >12” of soil moisture & Precipitation Outlook is neutral or favorable
- Otherwise implement fallow
- Trying to reduce losses and take advantage of wet years



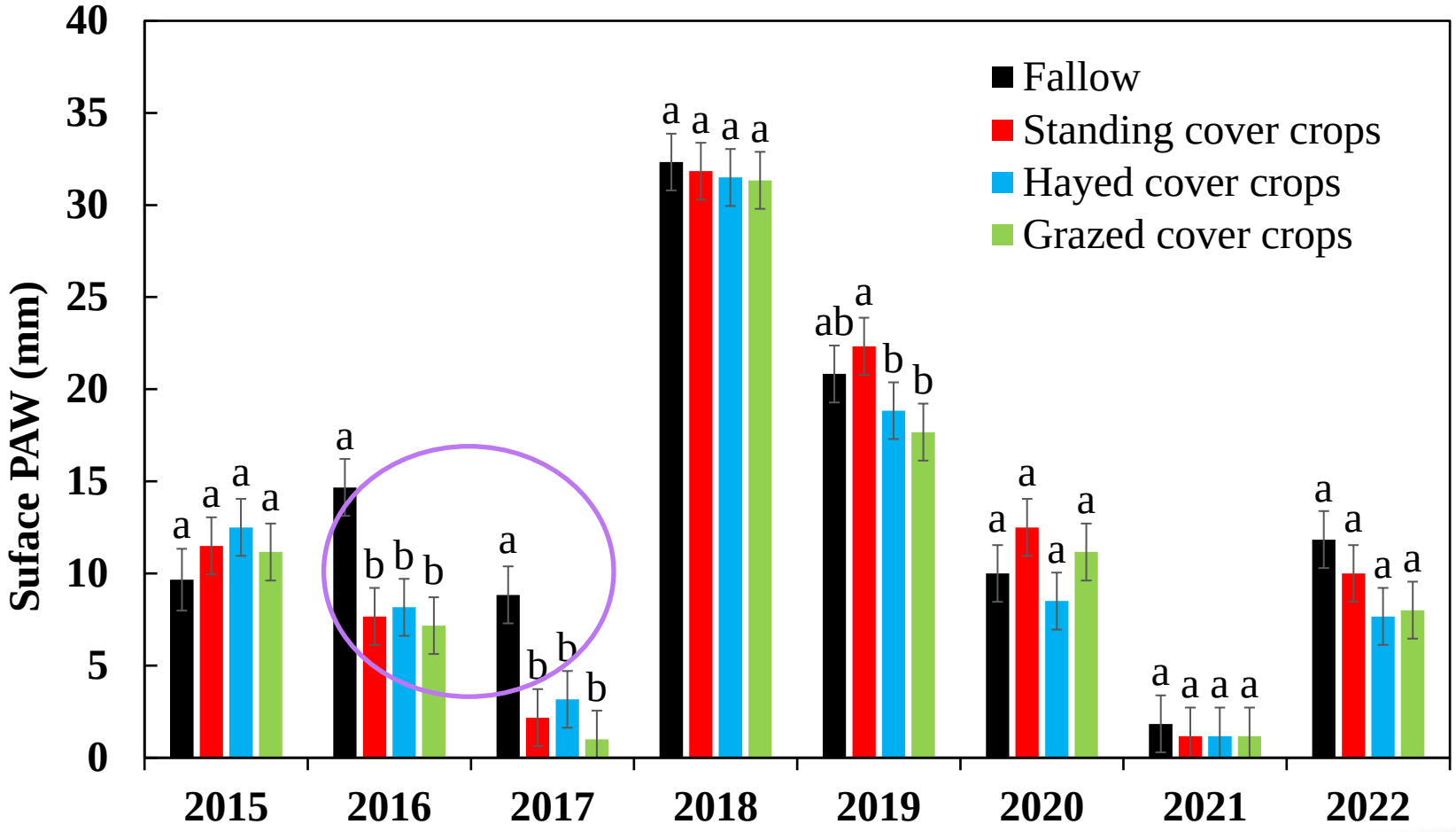
Cover crop forage mass and residue amounts



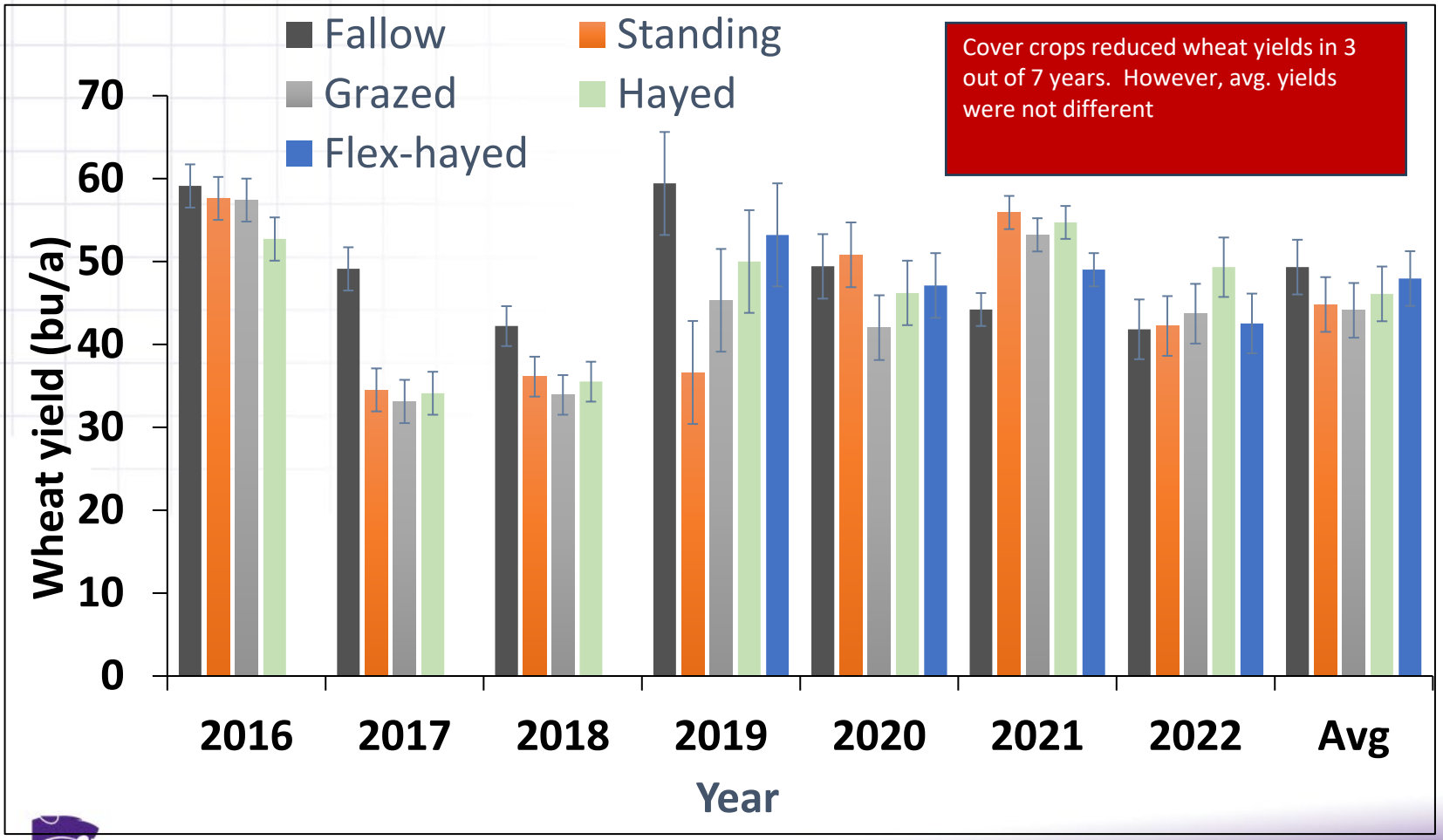
Spring vs fall planted cover crops after sorghum (2023-2025)



Available water at the surface affected by cover crops



Winter wheat yields following spring cover crops at KSU HB Ranch



Flex-cover crops not planted in 2018 & 2022 ahead of wheat

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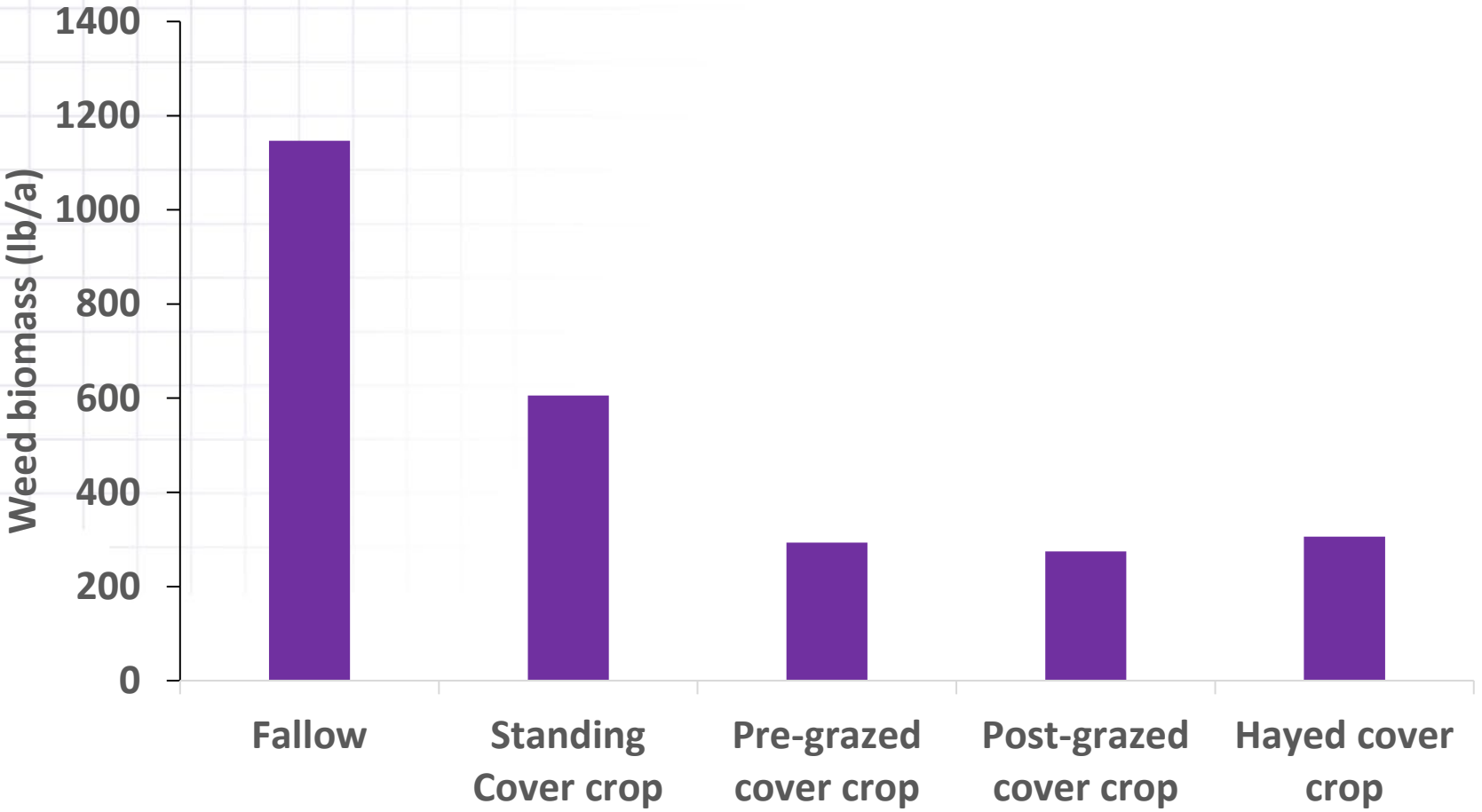
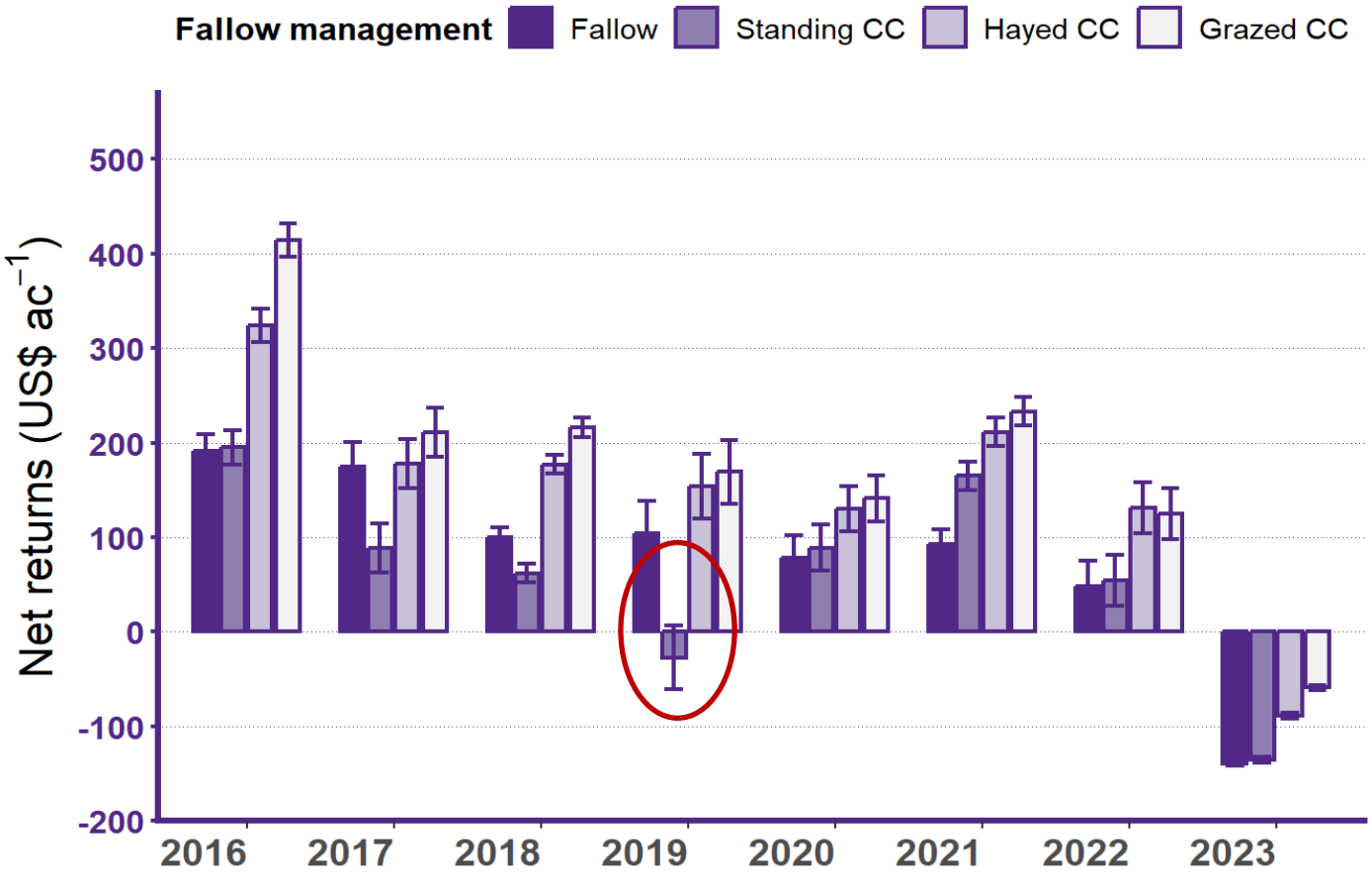
Weed suppression by CC



Cover crops reduce two herbicide applications

Cropping system net return by year



Grazing cover crops at Hays, Alexander, and Marquette, KS (2019 to 2021)

Treatments:

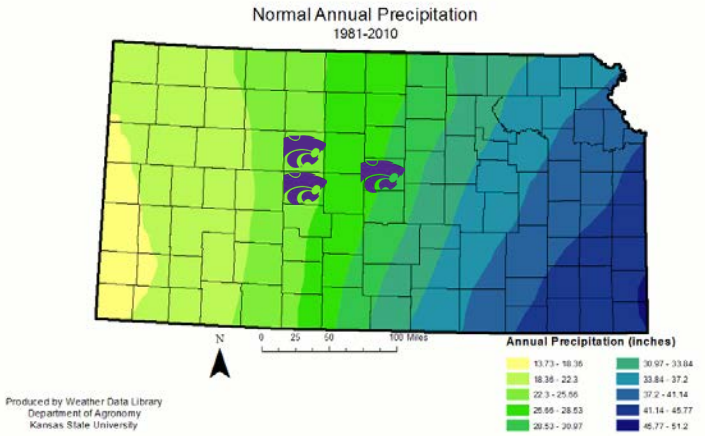
1. Non-grazed cover crop
2. Grazed cover crop

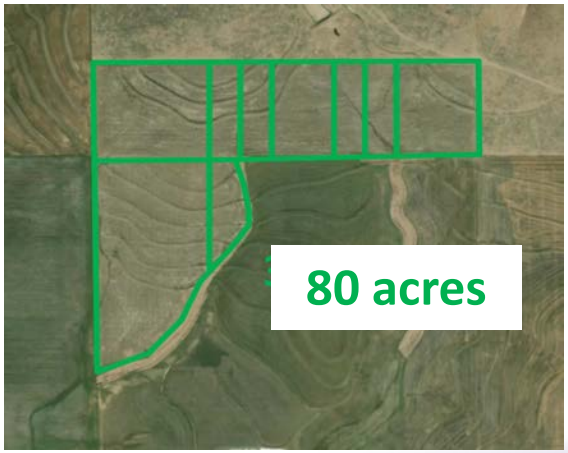
Cover crop species:

- Summer: Forage sorghum, German millet, sunflower, sunn hemp, and radish
- Spring: oat, triticale, barley, radish, sunflower, pea, rapeseed
- Winter: triticale, rapeseed, radish

Cover crop grazing:

- Cow-calf pairs at 575 to 1388 lb live weight per acre for 45 days at Hays
- Yearlings at 350 to 575 lb live weight per acre for 30 to 40 days at Alexander
- Yearlings at 550 to 575 lb live weight per acre for 45 to 60 days at Marquette





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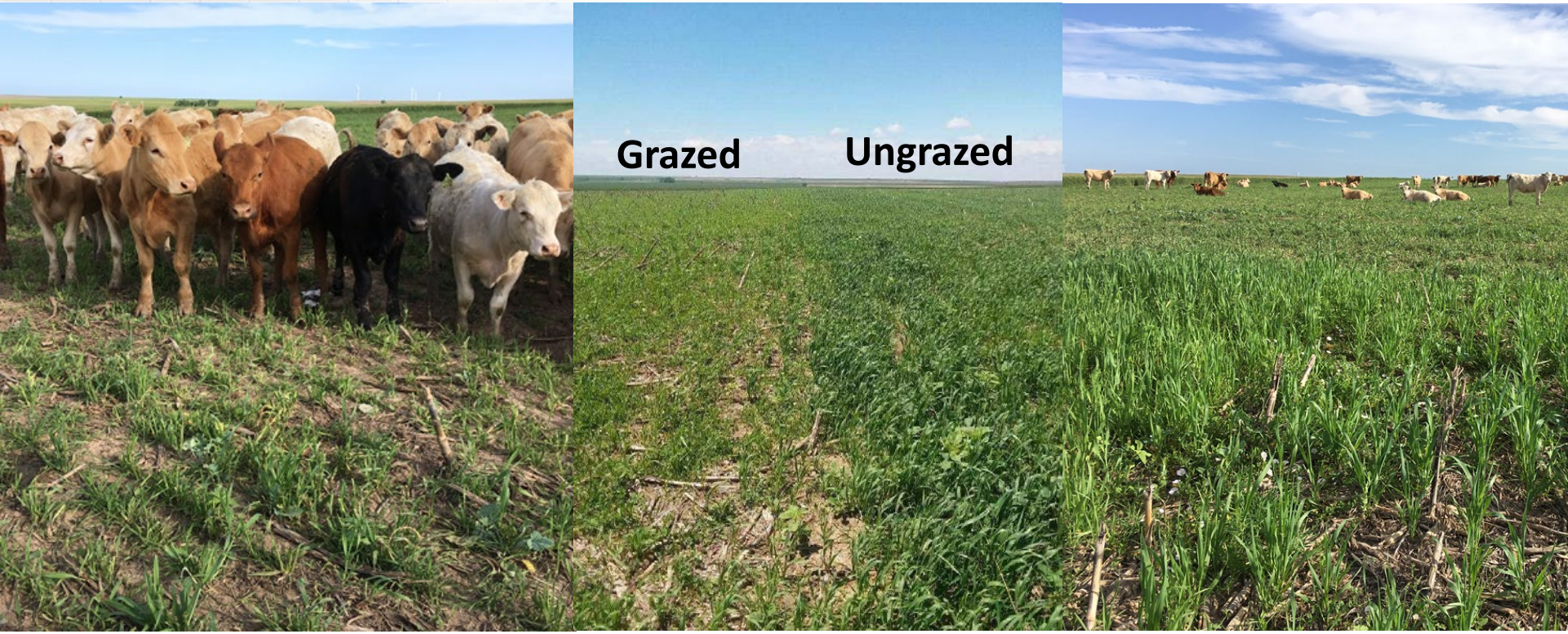
Spring cover crop grazing in 2019 at Alexander



Triticale, Oats, Barley, Pea, Sunflowers; Radish, and Rapeseed

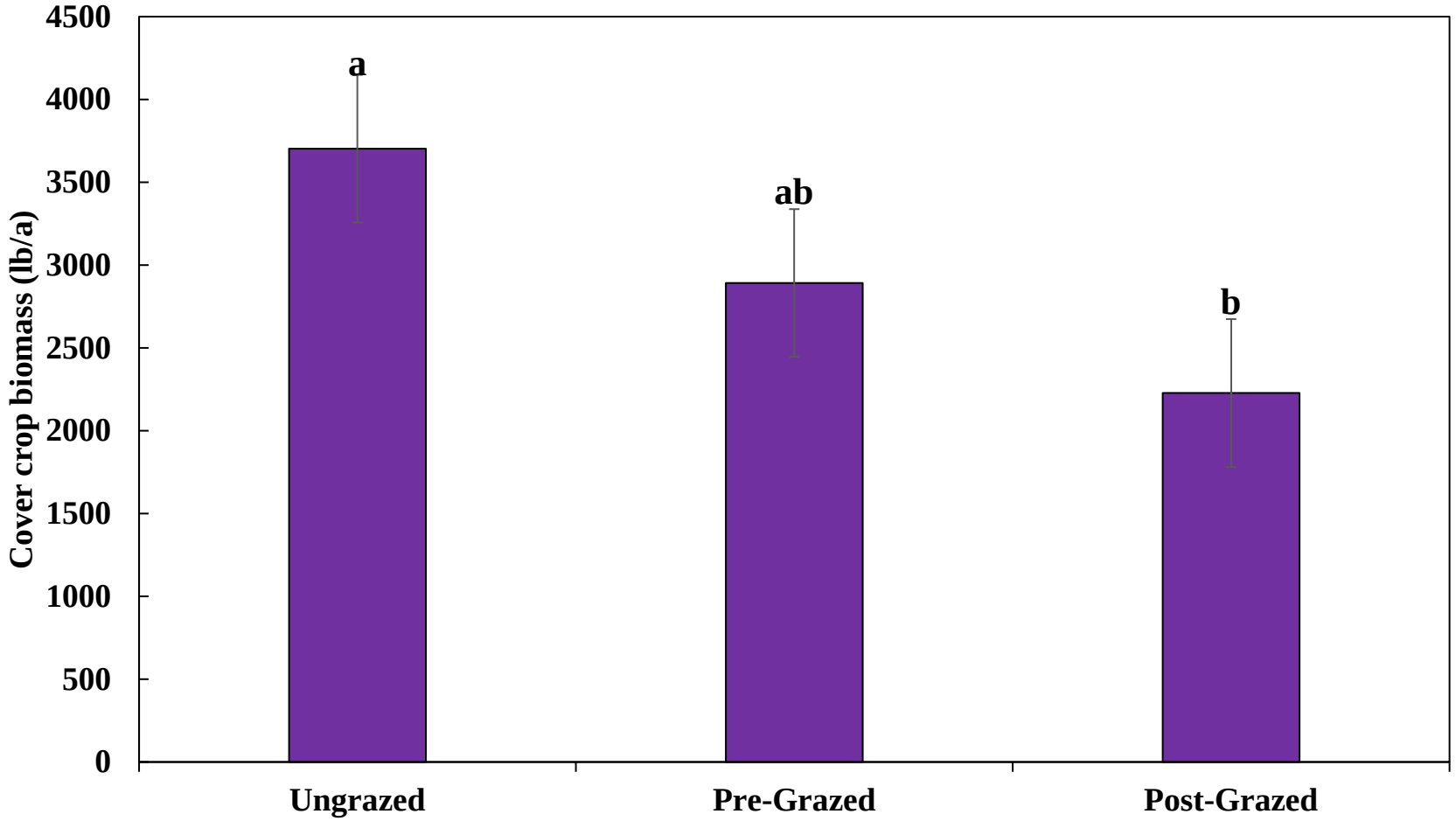
Summer cover crop grazing in 2019 at Hays

06/28/2019

07/25/2019

Sunn hemp, Sunflower, Millet, Sudangrass, Radish, and Rapeseed

On-farm cover crop biomass



Grazing days and animal performance

Location	Crude Protein %	Starting Date	Ending Date	Animal Class	Grazing Days	Average Daily Gains lb/day
Alexander, KS	26	5/14/19	6/14/19	calves	31	3.1
Marquette, KS	19	1/9/20	2/17/20	calves	39	1.2
Alexander, KS	20	8/05/20	09/18/20	heifers	41	1.5

Residue after grazing fall planted cover crops near Marquette in 2019

Residue management is crucial

Conclusions

- Annual forages and cover crop productivity in water-limited environments is highly **variable**
- Dryland biomass production in some years will be insufficient for both forage use and residue cover
- Flex-fallow forages and cover crops to match environmental conditions

Conclusions

- **Grazed or hayed** cover crops can provide similar soil health benefits compared to standing cover crops
- **Residue management** is critical to meeting soil health goals in water-limited farming systems
- **Grain crop yields** after forages or cover crops were often similar or less than fallow
- Incorporating forages or grazing cover crops increased profitability of the cropping system

Funding and Contact Info

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