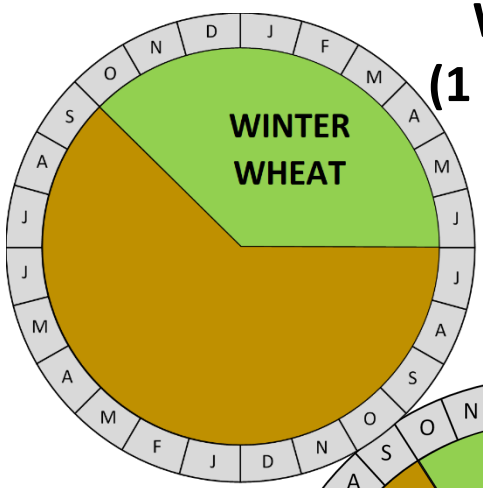
Fitting Cover Crops in Dryland Cropping Systems to Improve Soil Health

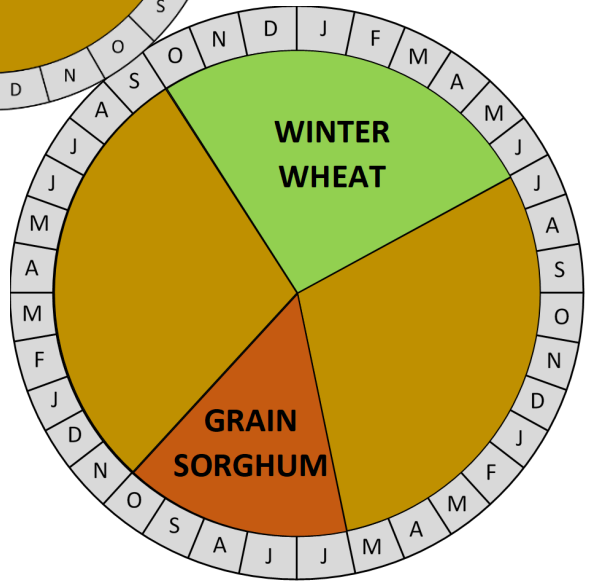
Augustine K Obour, J.D. Holman, L. Simon and S. Johnson
Kansas State University, Western Kansas Agricultural Research Centers
December 6, 2021, Norton, KS

Dryland crop production systems

- Highly dependent on **soil water storage**
- Fallow systems can **increase the stability of grain production**
- **Fallow moisture storage**
  - Depends on fallow management (tillage vs no-till, residue amounts, time of year, etc.)
  - Wheat-Fallow: 12-25% PSE
  - Wheat-Summer Crop-Fallow: 20-30% PSE
- **Tillage and low residue** in fallow systems has **negative effects on soil health and water storage**

Wheat-Fallow
(1 Crop in 2 Years)





Wheat-Sorghum-Fallow
(2 Crop in 3 Years)

K-STATE Research and Extension

Knowledge for Life

Replacing fallow with cover crops

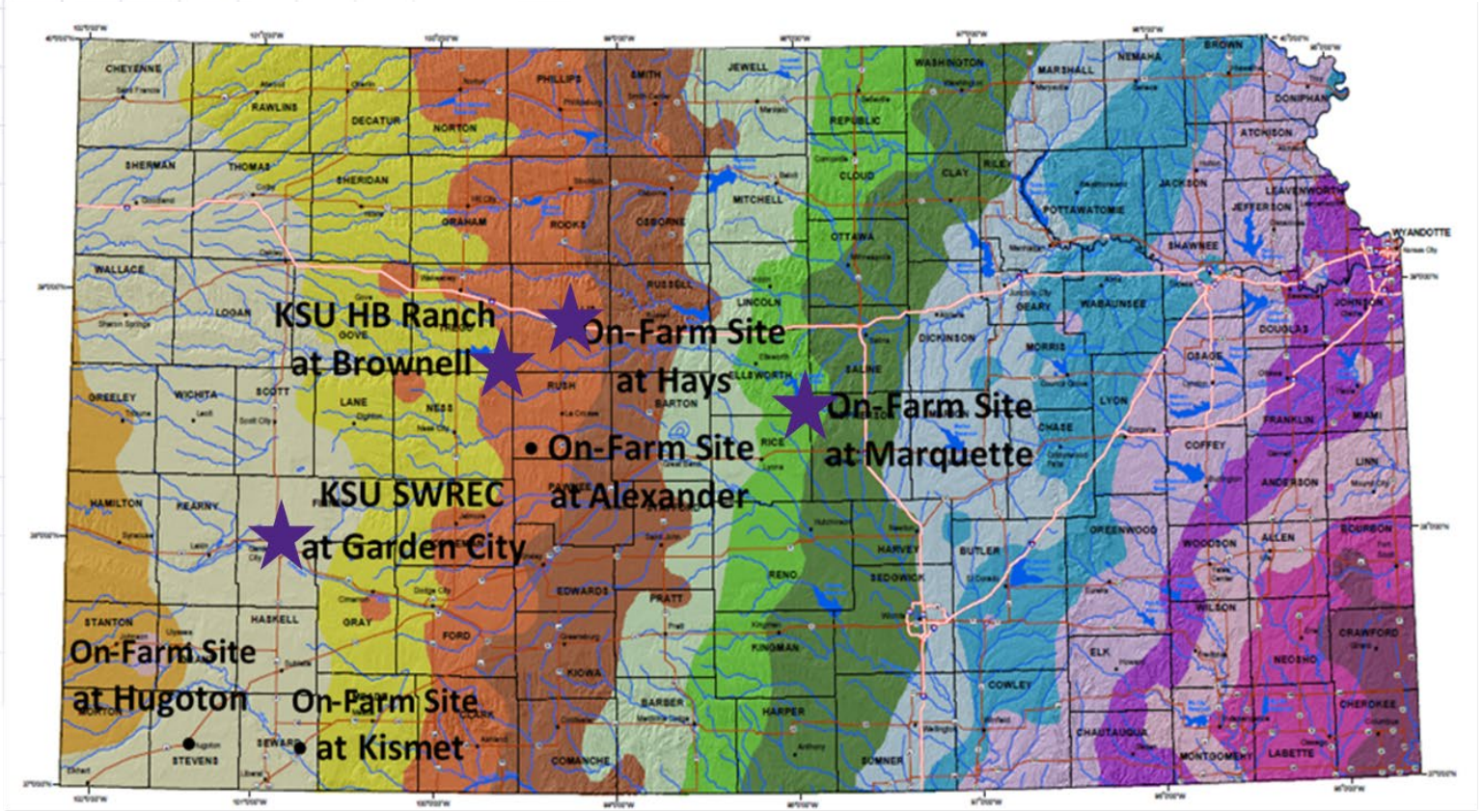
- Cover crop benefits
  - Provide residue cover to protect the soil
  - Reduced erosion
  - Improve soil organic matter & soil structure
  - Weed suppression
  - Forage for livestock
- But cover crop uses water that may affects subsequent crop yields

- Using cover crops for forage will provide economic benefits
- Developing efficient dryland cropping systems with livestock integration in crucial because of declining irrigation water levels

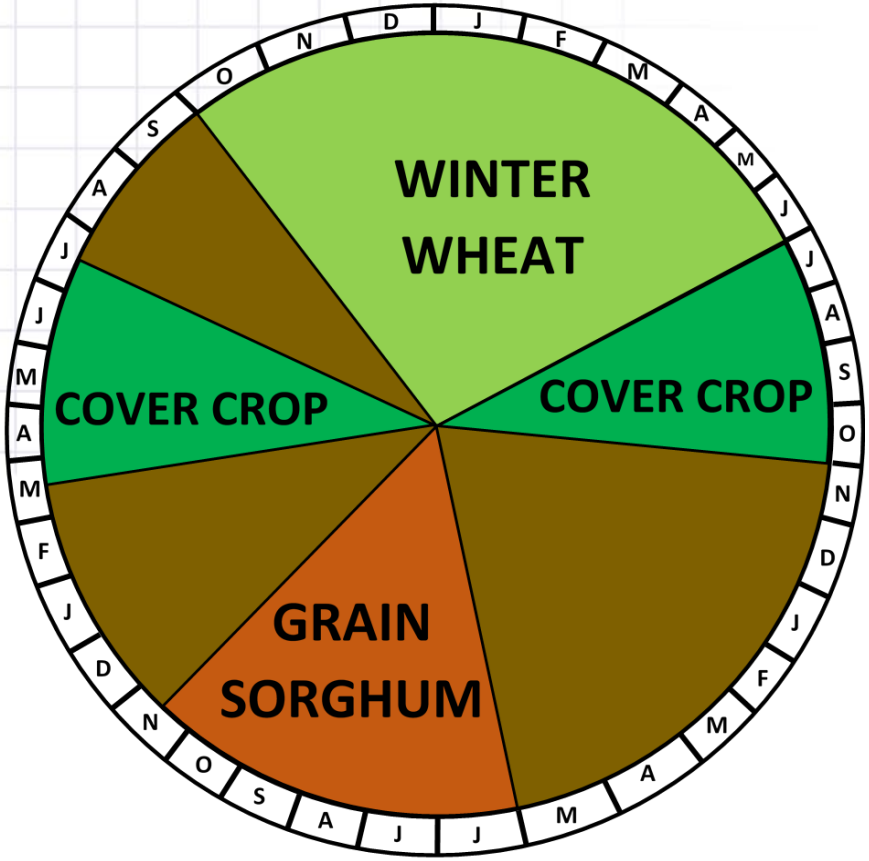
Research objectives

- Determining the forage **production potential** of cover crops in western Kansas
- Evaluating the impacts of cover crop management strategies on **soil health**
- Determining the effects of cover crop management strategies on weed suppression and cash crop yields
- Determine overall system profitability with grazing cover crops

Research sites across western Kansas



Cover crops in wheat-sorghum-fallow



Western Kansas (Alexander, Brownell & Hays, KS)

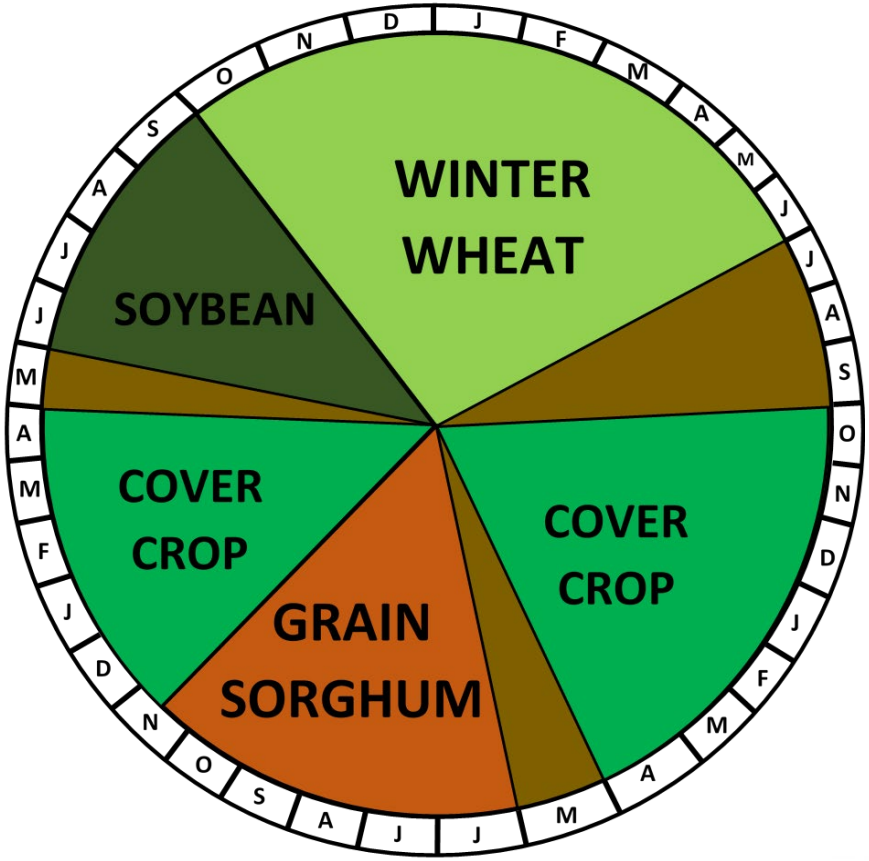
A: Spring-planted cover crop into sorghum stubble

B. Summer-planted cover crop after wheat harvest

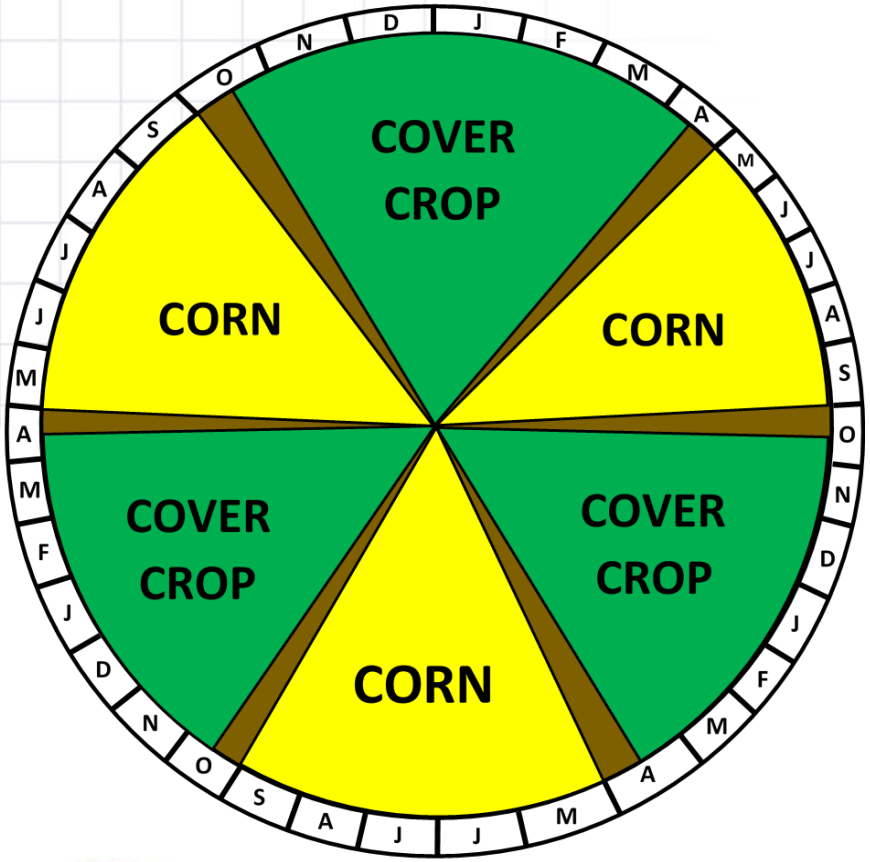
Cover Crops in a wheat-sorghum-soybean

Central Kansas, Rainfed

A: Fall-planted cover crops into wheat and sorghum stubble



Cover crops in continuous corn



Southwest Kansas, Irrigated

A: Fall-planted cover crops in corn stubble

B: Aerial seeding cover crops into growing corn in August

K-STATE Research and Extension

Knowledge for Life

Cover crop management options at HB Ranch near Brownell

Treatments

Fallow

Standing cover crop

Hayed cover crop

Grazed cover crop

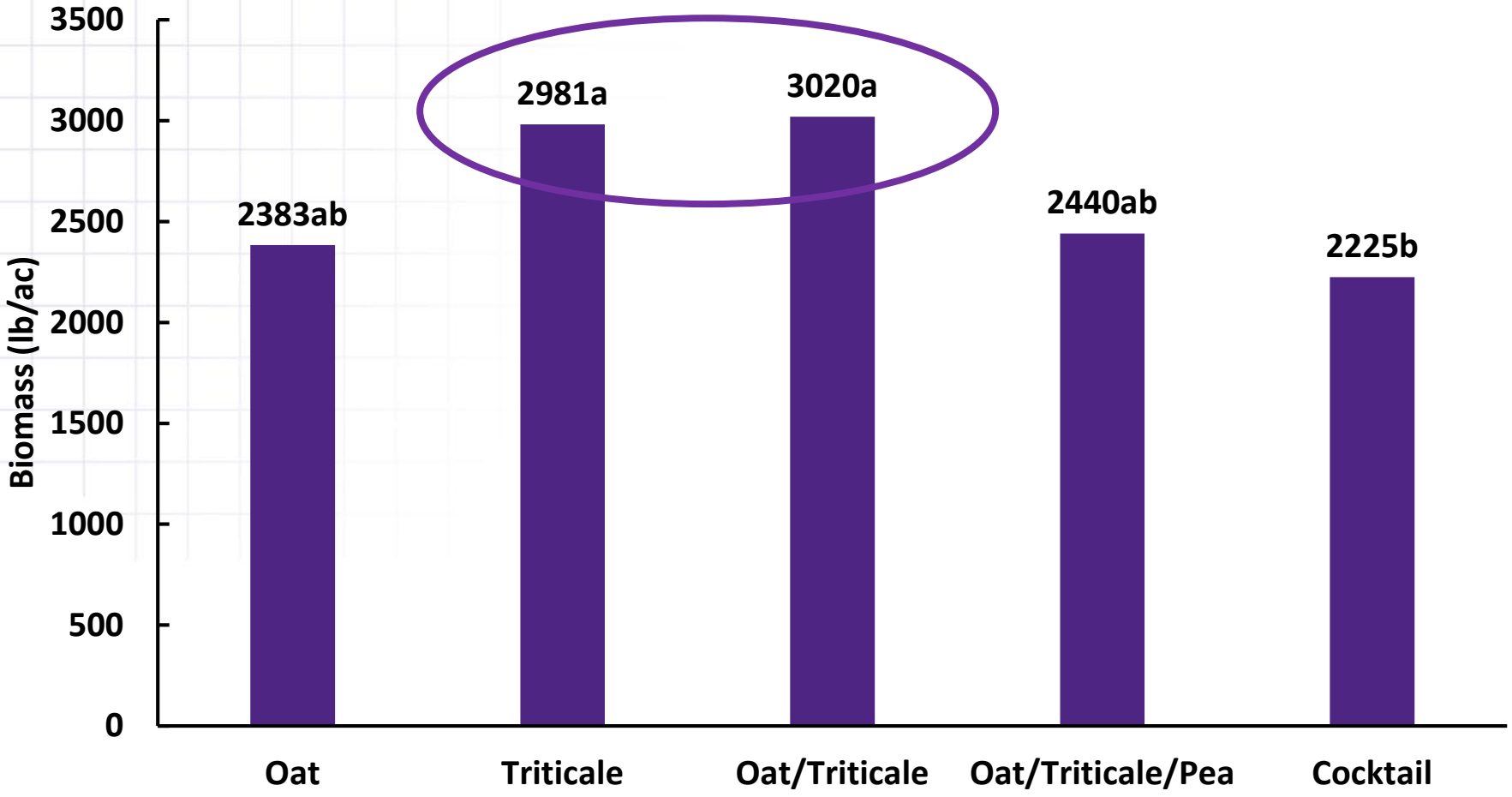
Hayed Cover Crops

- At triticale heading stage
- 15 cm cutting height

Grazed Cover Crops

- Yearling heifers
- ~One week before haying
- 1463 kg live weight ha^{-1} for from four to seven days

Spring cover crop biomass- Brownell, KS

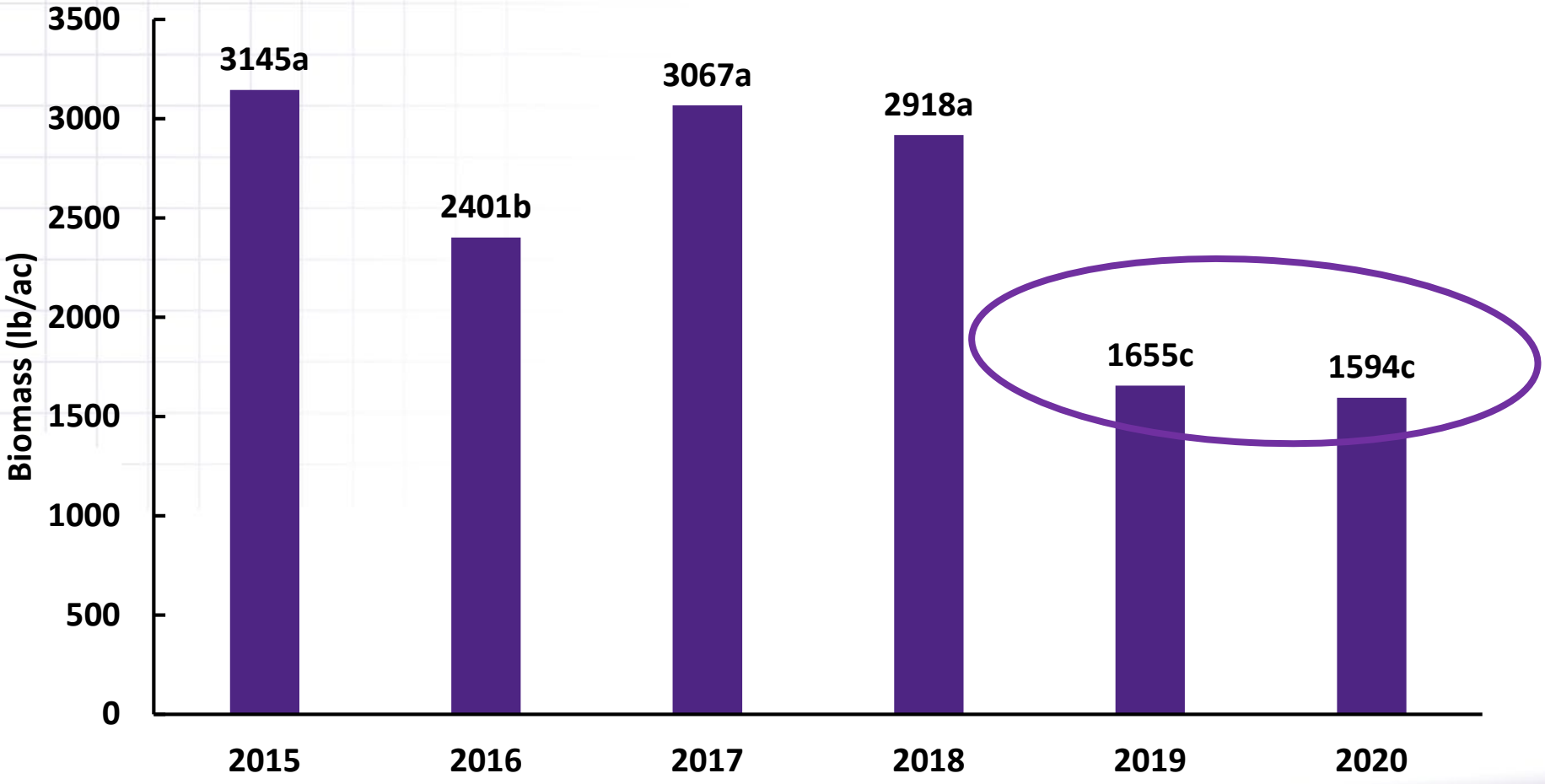


Cocktail: oat/triticale/pea/radish/turnip/buckwheat

Forage quality 2 or 3-way mixtures (average of four-site years)

Cover crop	CP	ADF	NDF	IVDMD
		%		
Oat/triticale	12.3 b	37.1 a	63.4 a	72.7 b
Oat/triticale/pea	14.4 a	36.2 b	60.2 b	74.6 a

High variability in cover crop biomass across years at Brownell



Grazing cover crops at Hays, KS and Alexander, KS (2019 to 2020

Treatments:

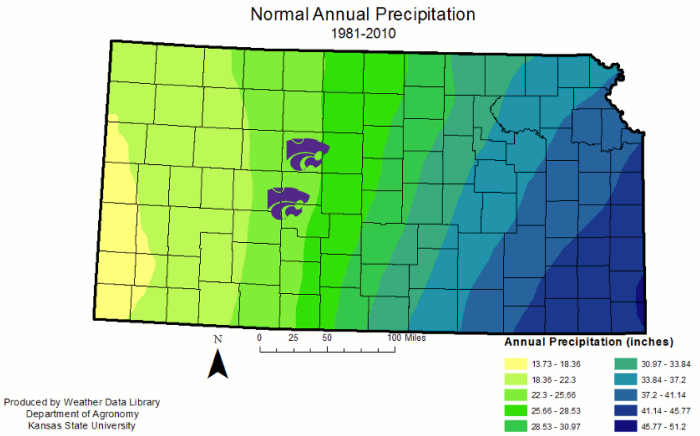
1. Non-grazed cover crop
2. Grazed cover crop

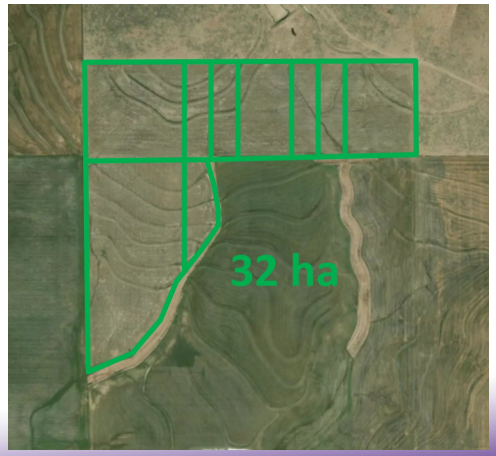
Cover crop species:

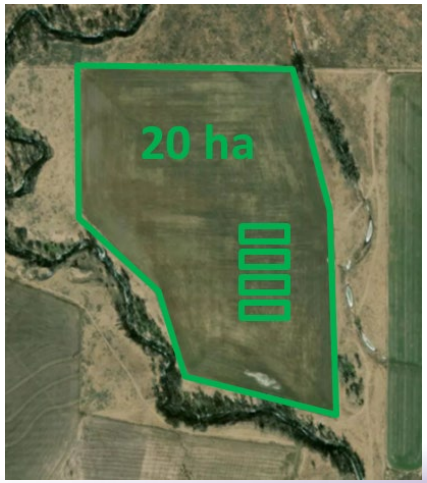
- Summer covers : Forage sorghum, German millet, sunflower, sunn hemp, and radish
- Spring: oat, triticale, barley, radish, sunflower, pea, rapeseed

Cover crop grazing:

- Cow-calf pairs at 312 kg live weight ha^{-1} from 8/24 to 10/10
- Yearlings at 514 kg live weight ha^{-1} from 8/7 to 9/18







On-farm cover crop grazing-Alexander, KS

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

Summer cover crop on producer field at Hays

06/28/2019

07/25/2019

Sunn hemp, Sunflower; millet; Sudangrass, radish, rapeseed

Grazing days and animal performance

Location	CP %	Starting	Ending	Class	Grazing days	Stocking rate, lb/acre	ADG lb/day
Alexander, KS	26	5/14/19	6/14/19	calves	31	354	3.11
Marquette, KS	19	1/9/20	2/17/20	calves	39	552	1.2
Alexander, KS	20	8/05/20	09/18/20	heifers	41	576	1.5

Residue after grazing cover crops at Marquette, KS

<u>Cover crop biomass in the spring</u>

Grazed winter triticale/radish/rapeseed = 1135 lb/a

Ungrazed triticale/radish/rapeseed = 2410 lb/a

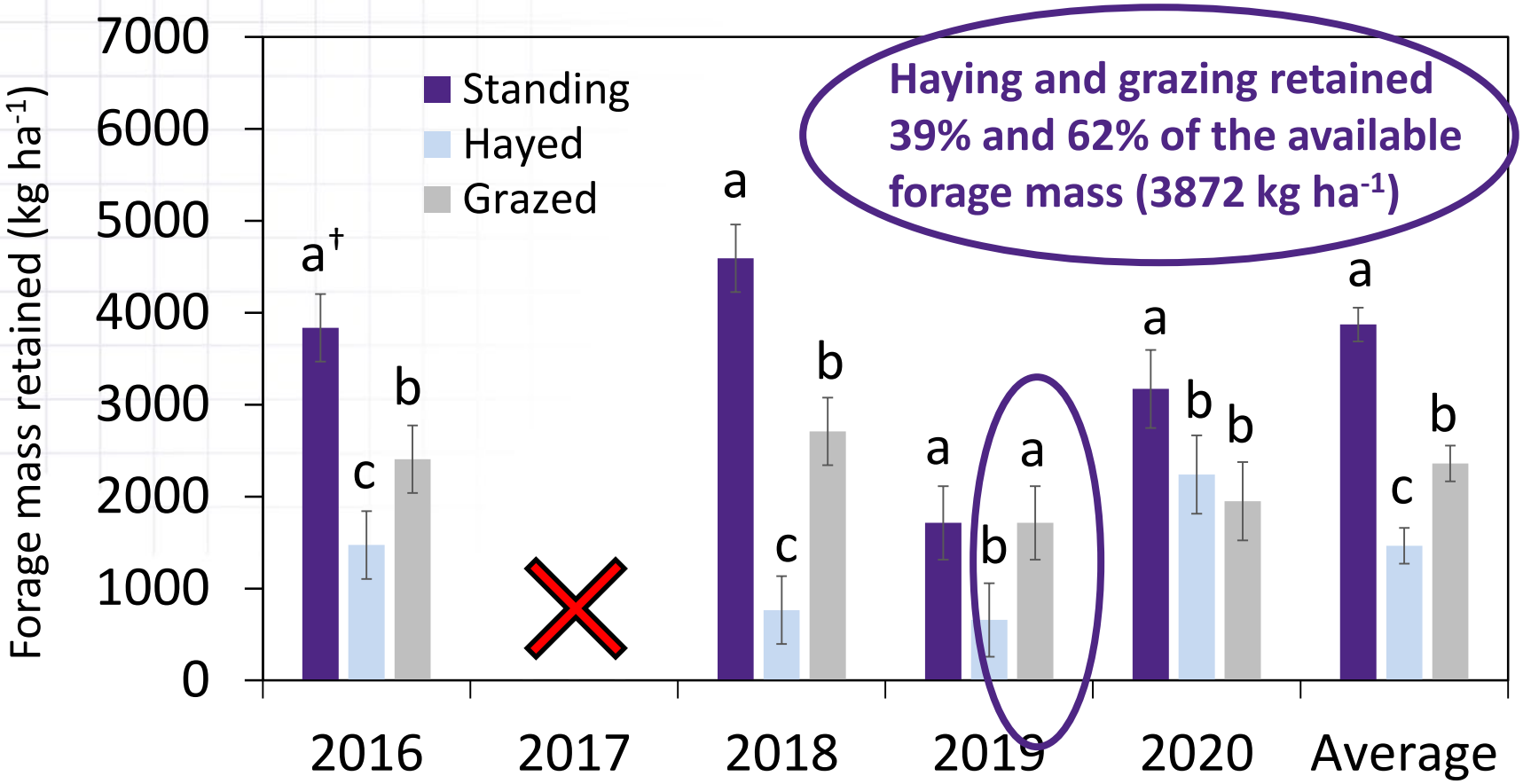
Ungrazed winter triticale cover crop = 3231 lb/a

Residue after grazing summer cover crops in Hays, KS

~ 6026 lb/a produced

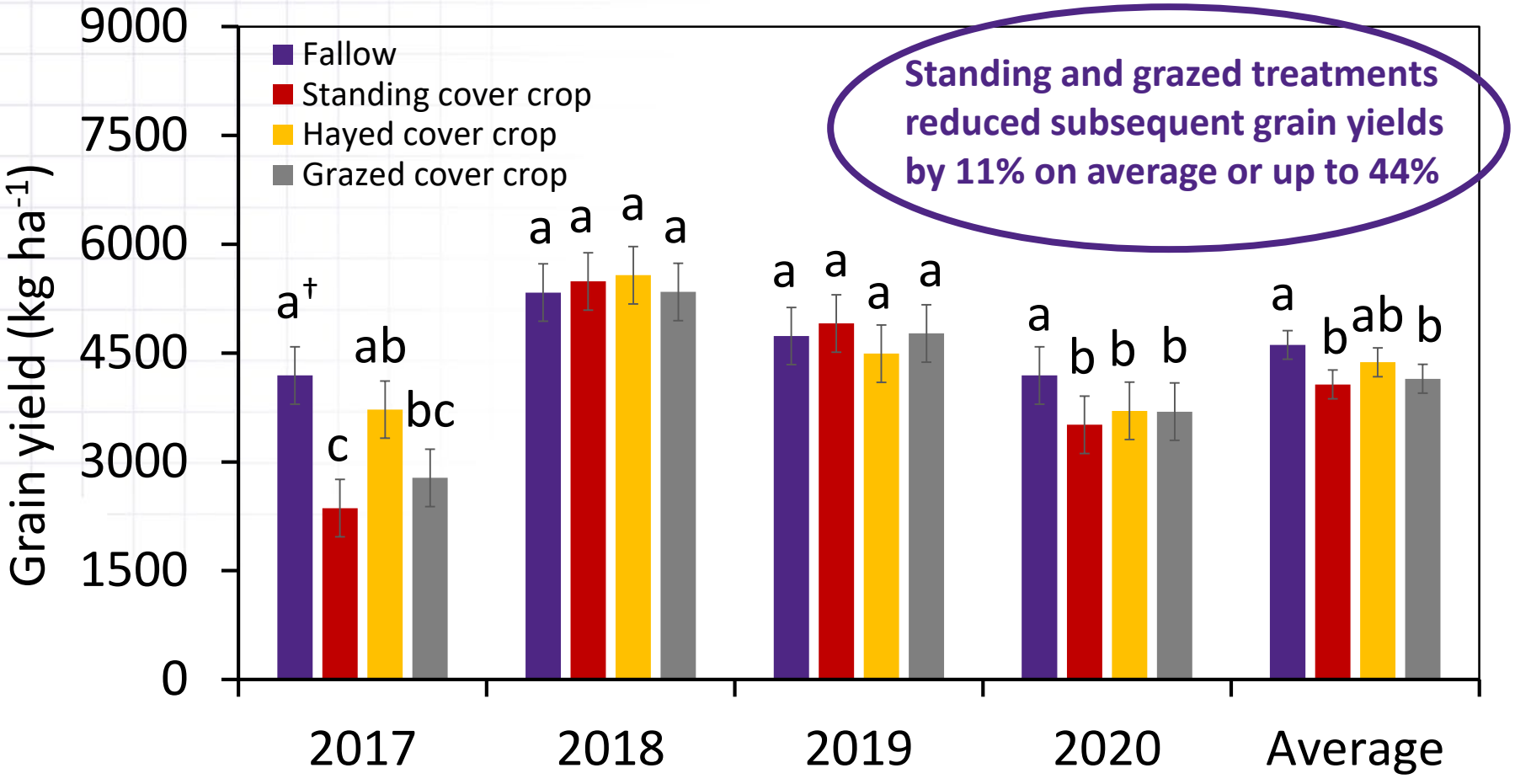
~ 4592 lb/a residue left after grazing

Cover crop residue retained after forage harvest at Brownell, KS



†Error bars indicate standard error (α =0.05) and bars with the same letter are not significantly different (α =0.05) among treatments within the same year.

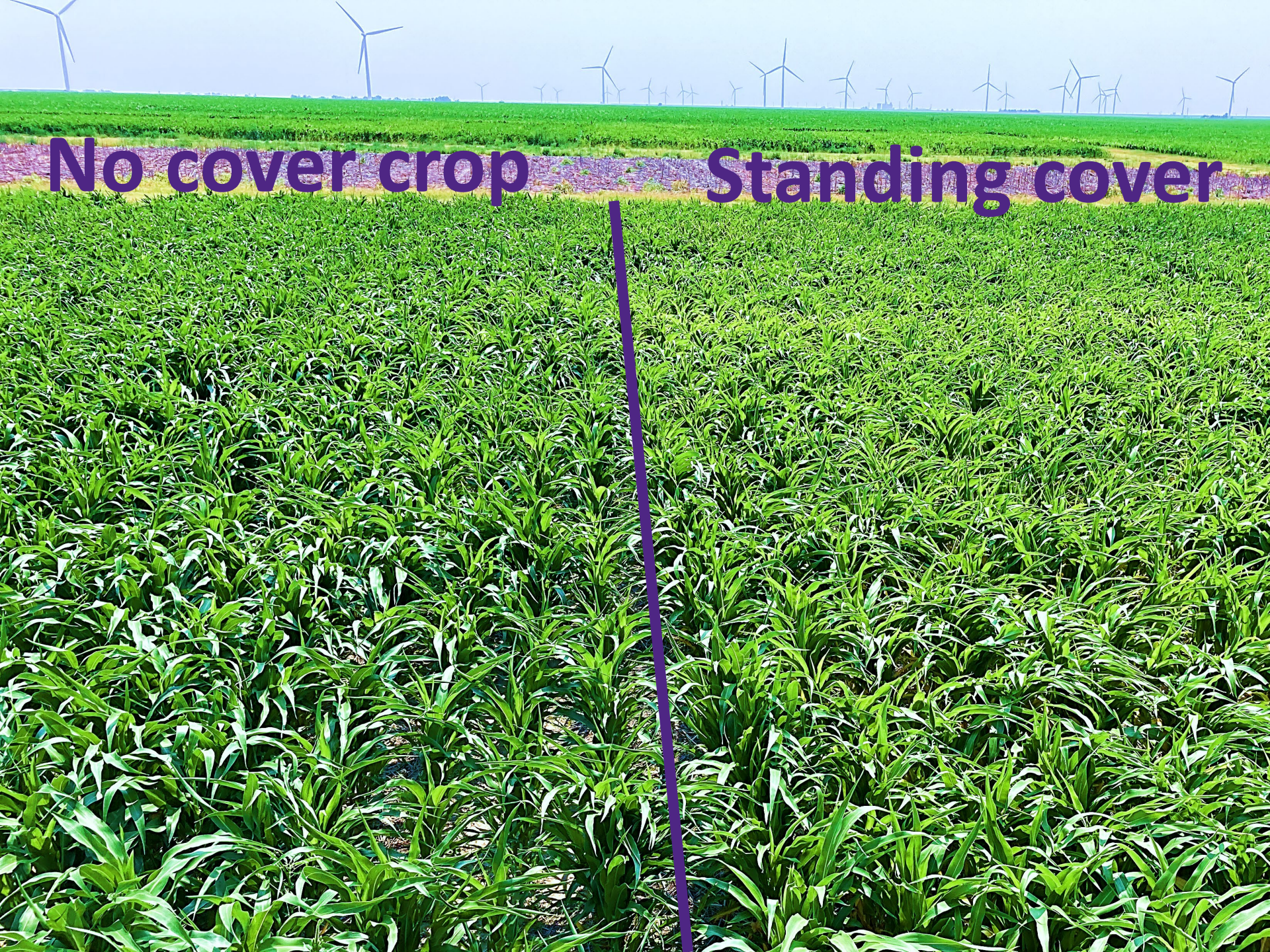
Grain sorghum yields after summer cover crops



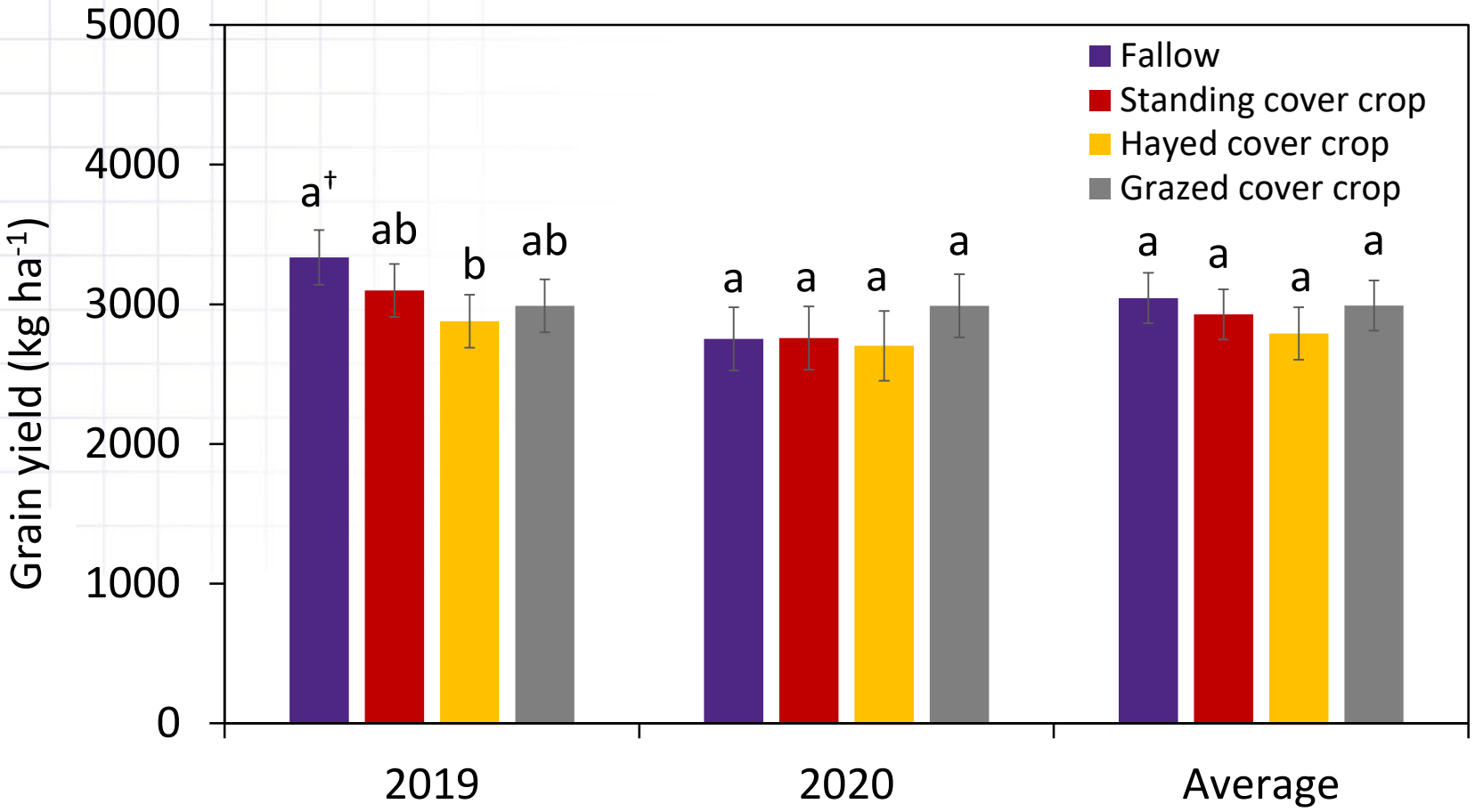
†Error bars indicate standard error (α =0.05) and bars with the same letter are not significantly different (α =0.05) among treatments within the same year.

K-STATE Research and Extension

Knowledge for Life


No cover crop
Standing cover

Wheat yields after summer cover crops

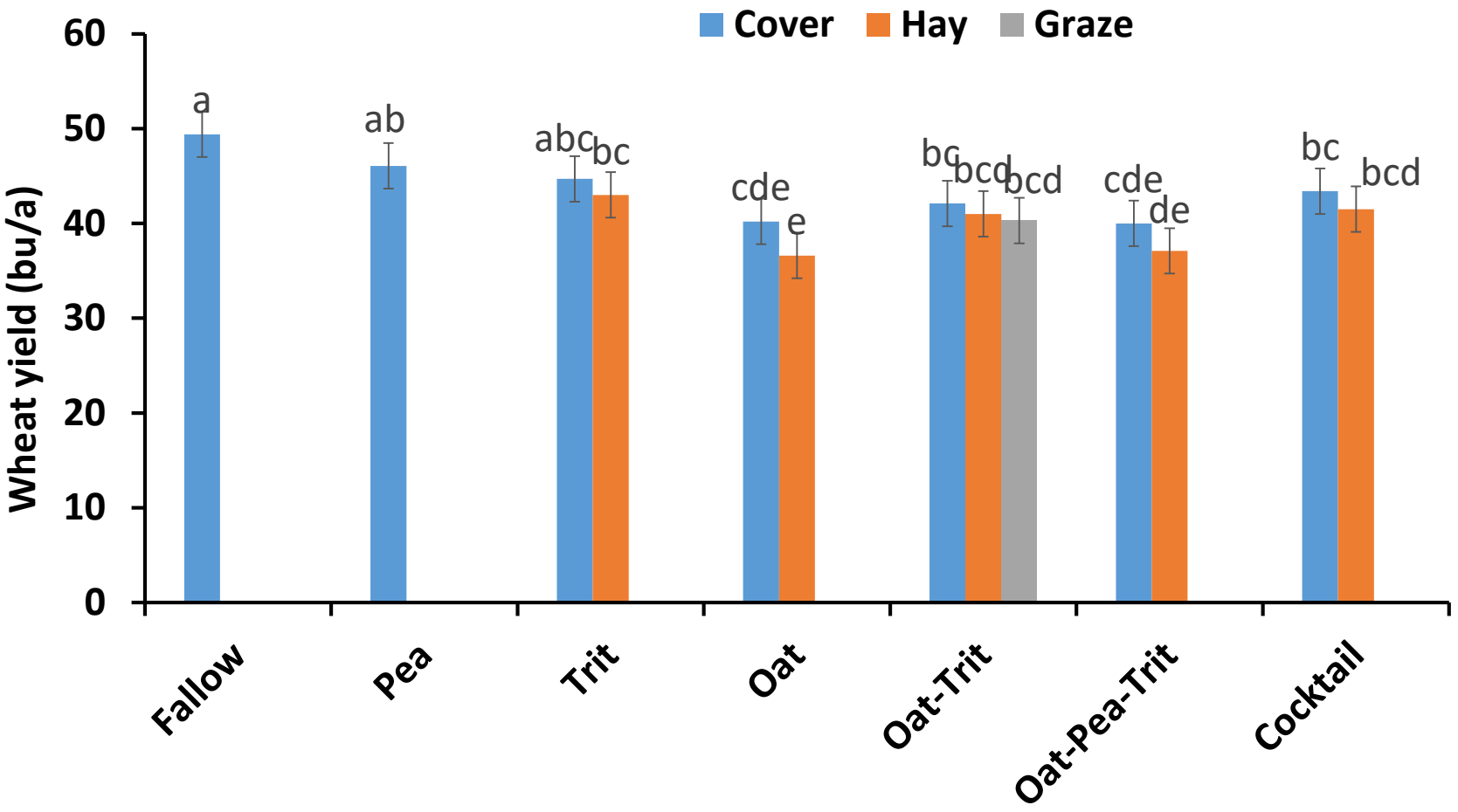


†Error bars indicate standard error (α =0.05) and bars with the same letter are not significantly different (α =0.05) among treatments within the same year.

K·STATE Research and Extension

Knowledge for Life

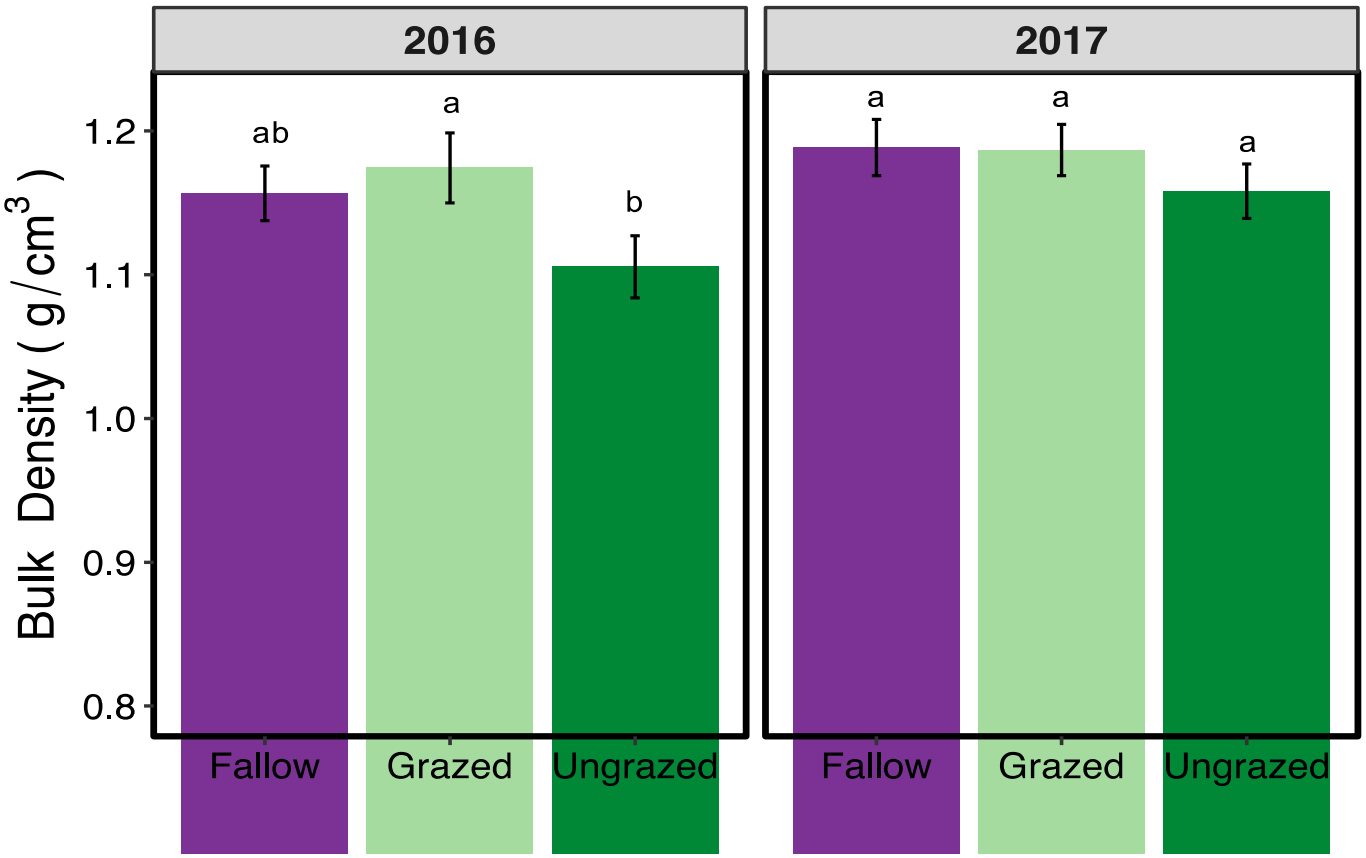
Wheat yield after spring cover crops (2016-2018)



Soil Properties

- Bulk density
- Soil Organic Carbon and Organic Matter
- Water Stable Aggregates
- Dry Aggregate Stability
- Water Infiltration Rate

No increase in surface bulk density across ten farms in Colorado and Kansas



Kelly et al., 2021

K-STATE Research and Extension

Knowledge for Life

Soil properties at Marquette, KS

		BD	SOC	P	Fe	MWD
Depth	Treatment	g cm^{-3}	g kg^{-1}	mg kg^{-1}		mm
0 – 5 cm	Ungrazed	1.26	19.4	50.9	73.2	1.12
	Grazed	1.32	15.6	68.3	79.8	1.11
5 – 15 cm	Ungrazed	1.48	10.8	30.0	67.5	
	Grazed	1.51	11.2	31.5	69.8	

No significant differences at α=0.05.

BD, bulk density; SOC, soil organic carbon; P, phosphorus, Fe, iron

MWD, mean weight diameter of water stable aggregates.

On-farm soil properties at Hays and Alexander, KS

Location	Depth	Treatment	BD	SOC	NO_3	P	MWD
			g cm^{-3}	g kg^{-1}	mg kg^{-1}	mg kg^{-1}	mm
Hays	0 – 5 cm	Ungrazed	1.25	20.5	14.4	48.3	1.96
		Grazed	1.32	18.9	16.4	45.2	1.46
	5 – 15 cm	Ungrazed	1.38	15.3	5.2	24.6	-
		Grazed	1.41	15.8	8.7	23.8	-
Alexander	0 – 5 cm	Ungrazed	1.32	12.4	7.0	33.7	1.61
		Grazed	1.40	14.0	9.7	42.0	1.41
	5 – 15 cm	Ungrazed	1.39	9.0	3.5	15.2	-
		Grazed	1.45	9.3	3.6	8.27	-

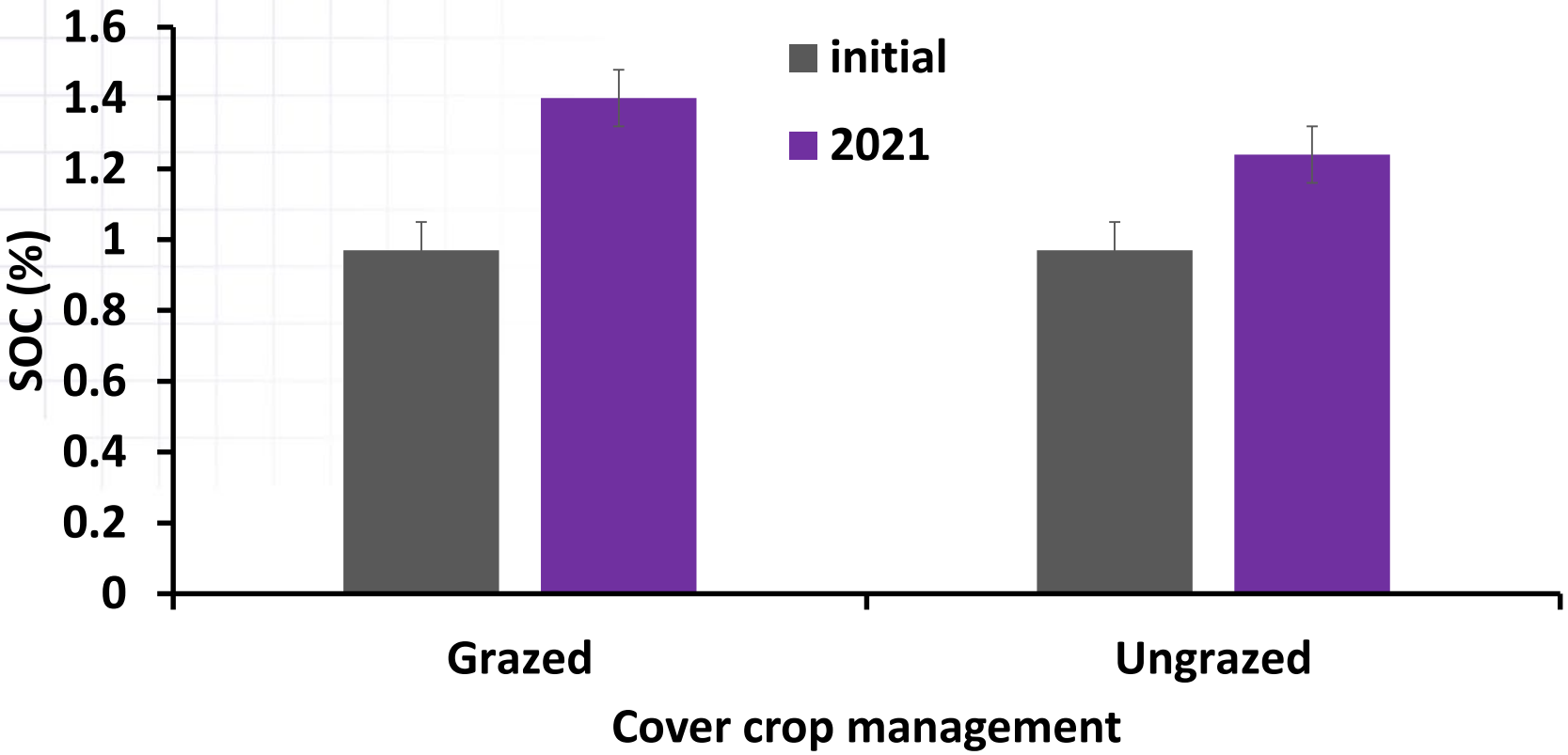
No significant differences at α=0.05.

BD, bulk density.

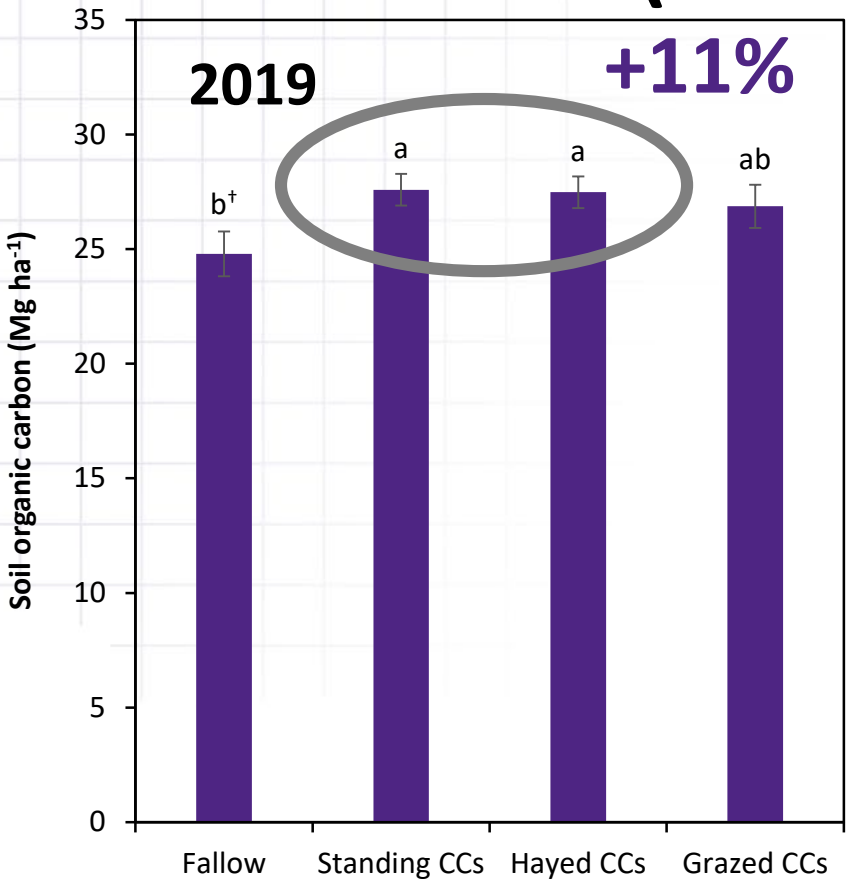
SOC, soil organic carbon.

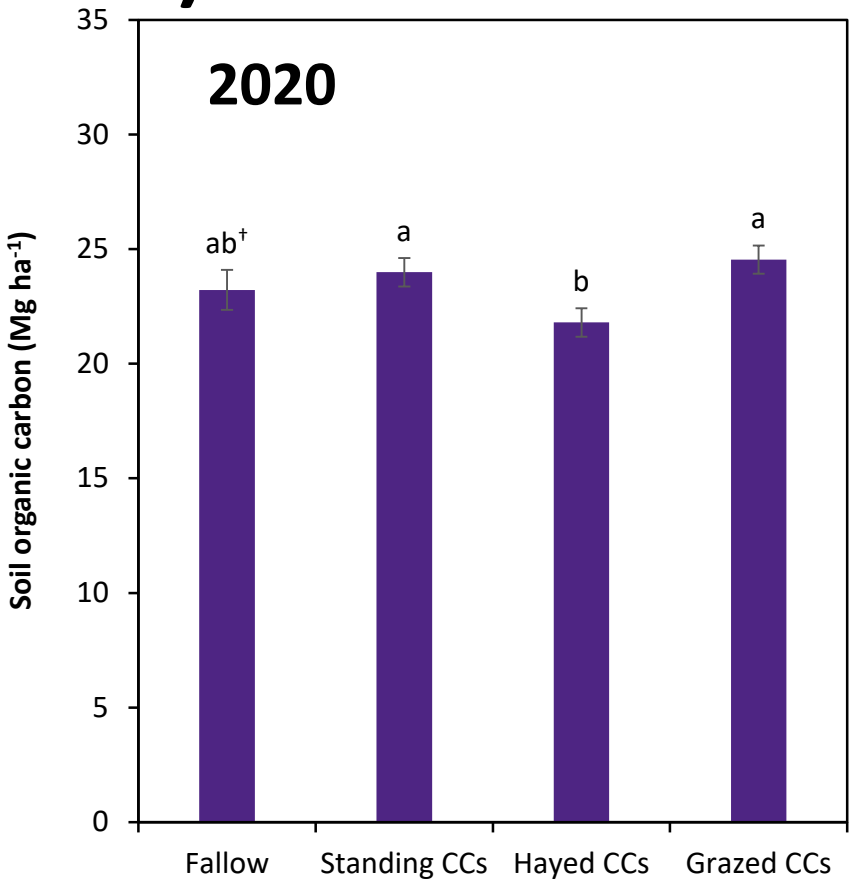
MWD, mean weight diameter of water stable aggregates.

Cover crop increased near surface SOC at Alexander, KS



Cover crop effects on soil organic carbon (HB Ranch)



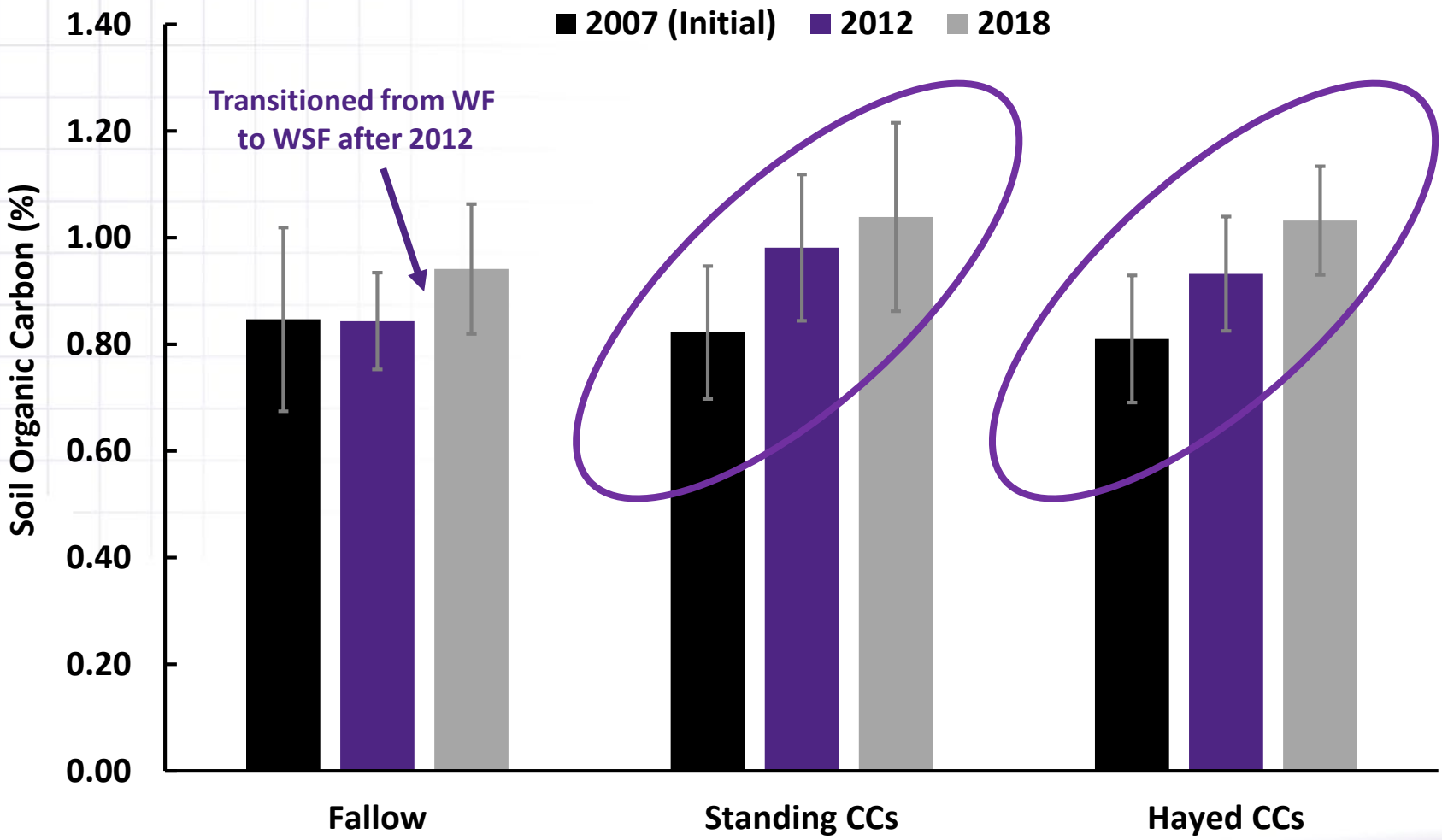


†Error bars indicate standard error (α =0.05) and bars with the same letter are not significantly different (α =0.05).

K-STATE Research and Extension

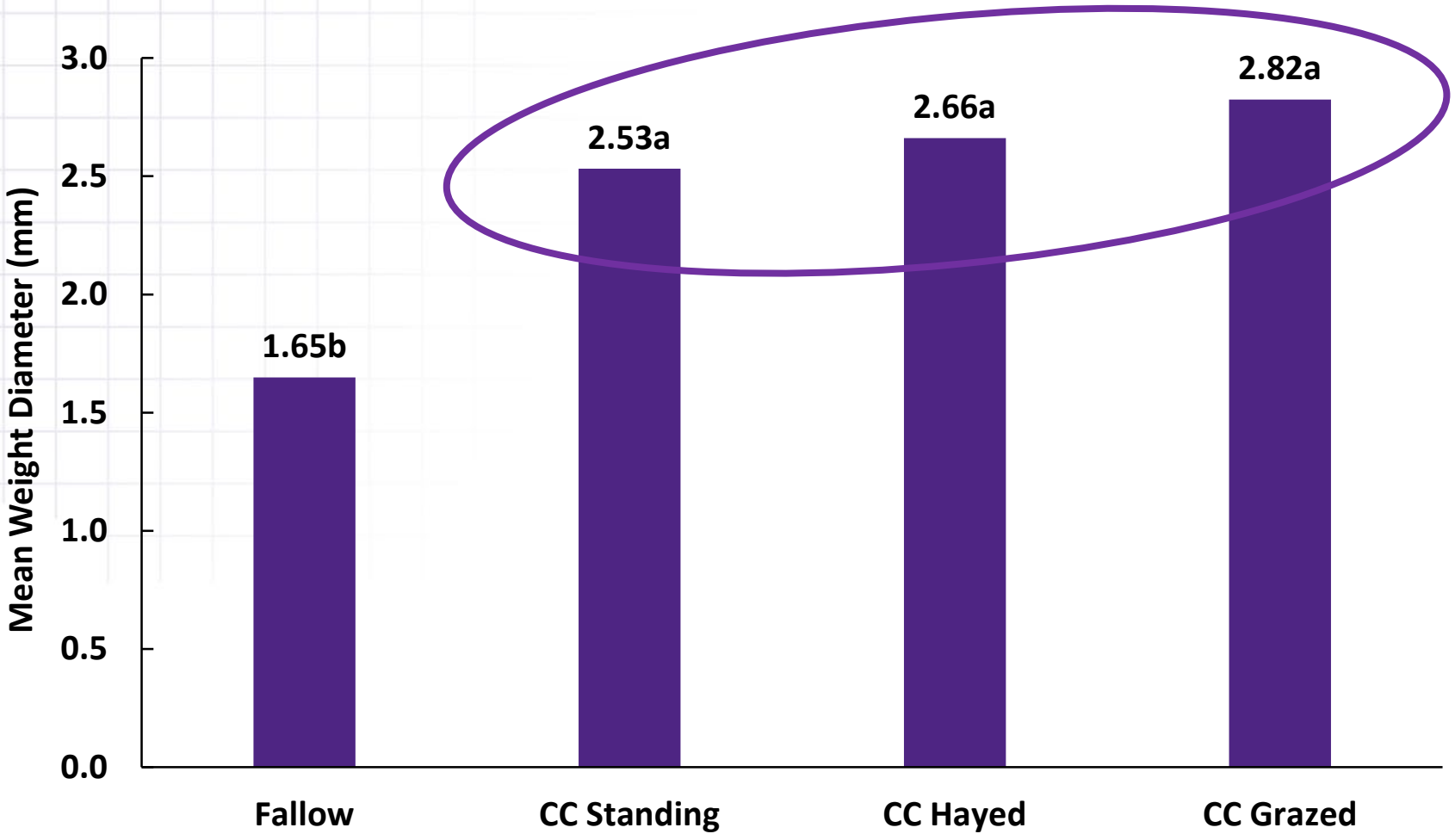
Knowledge for Life

Soil Organic Carbon at Garden City

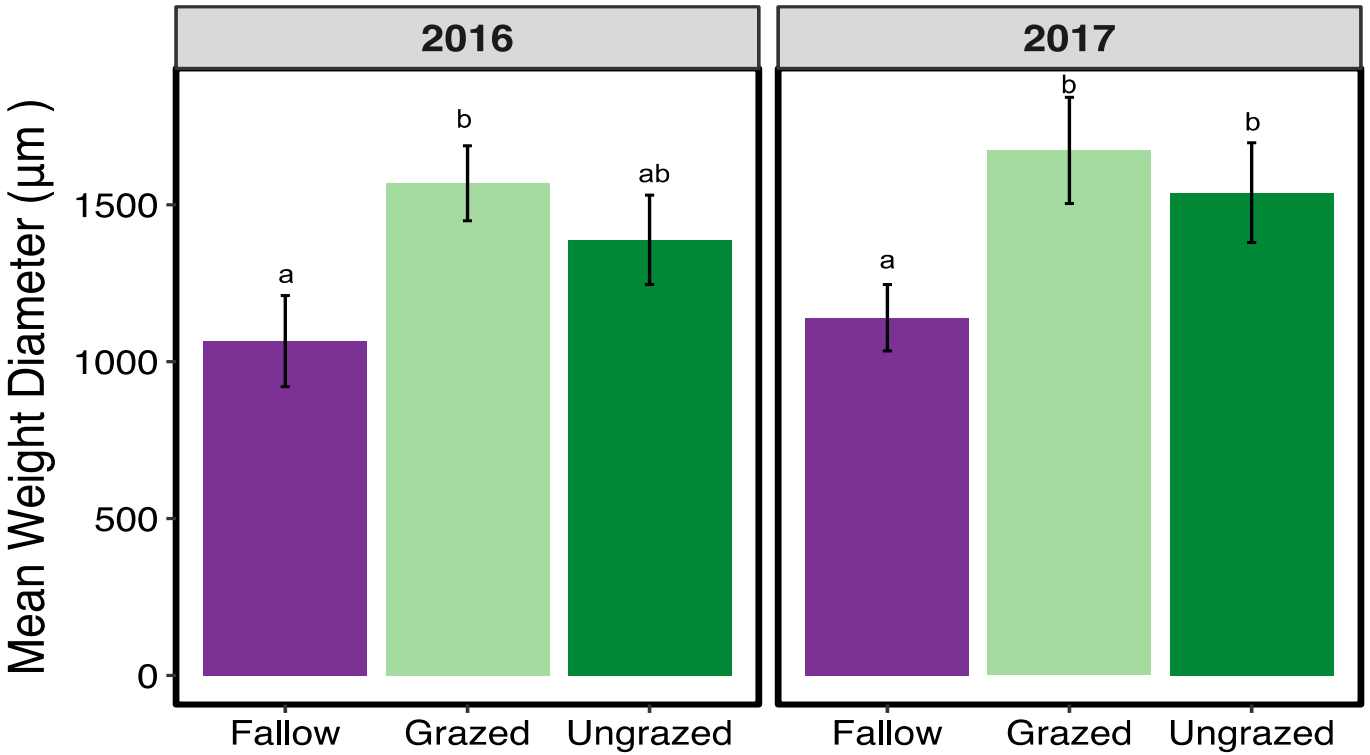


Cropping intensification with sorghum has significant impact on soil organic carbon

Aggregate Stability in 2019 at Brownell

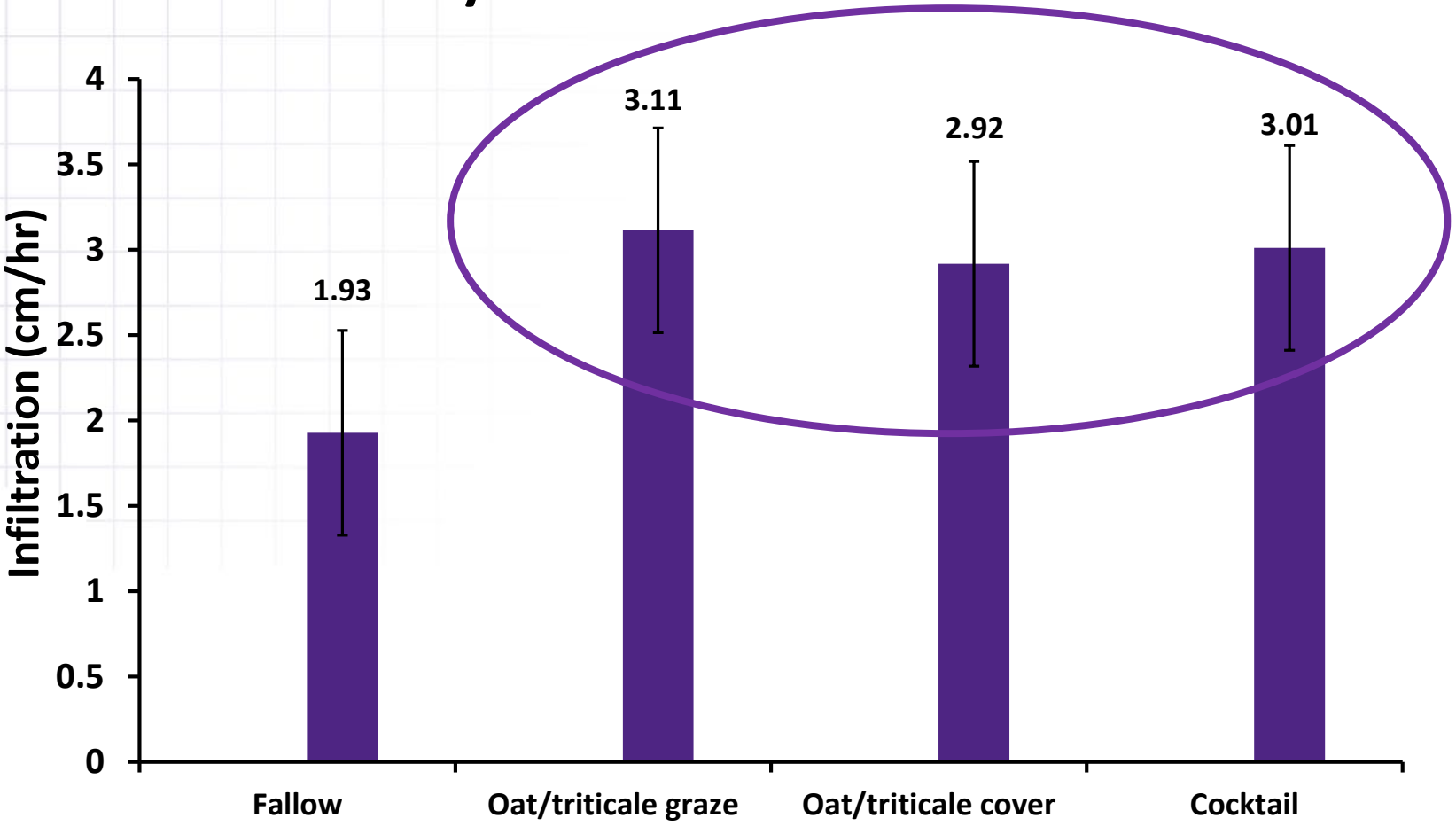


Aggregate stability increased with cover crops across ten farms in Colorado and Kansas in



Kelly et al., 2021

Infiltration rates measured in May 2018 at Brownell



Conclusions

- Cover crops may be productive in dryland systems, but are **variable from year-to-year**
- Grazing cover crops had **no negative impact on soil bulk density**
- Soil organic carbon/organic matter **increased** with cover crops (when adequate biomass are produced)
- Cover crop **increased aggregate stability** compared to fallow

Conclusions

- **Grazed or hayed** cover crops can provide similar soil health benefits compared to standing cover crops
- **Residue management** is more critical to ensure soil health goals
- Cover crop mixtures should be simple and dominated by **productive grasses species** to maximize forage and residue retention
- Wheat and sorghum yields following cover crops **were less than that after fallow**
- Utilizing **cover crops for forage** will allow cover crop use in dryland systems to improve soil health and profitability

Funding and Contact Info

Contact information

Dr. Augustine Obour

aobour@ksu.edu

785-625-3425 ext. 215

Kansas State University

Ag Research Center-Hays

K-STATE Research and Extension

Knowledge for Life