Kernza: a Perennial Grain and Forage Crop with Multiple Uses

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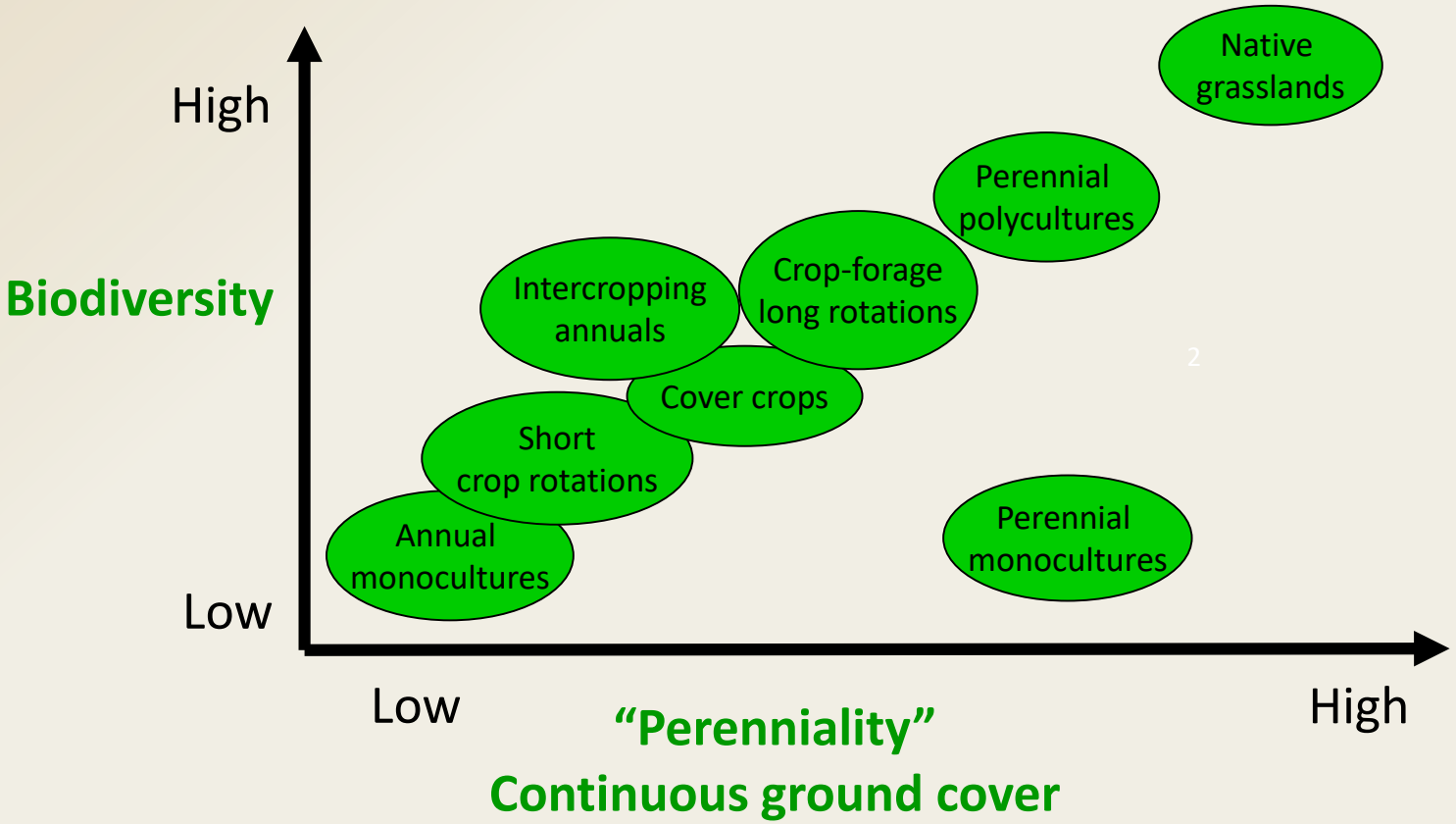
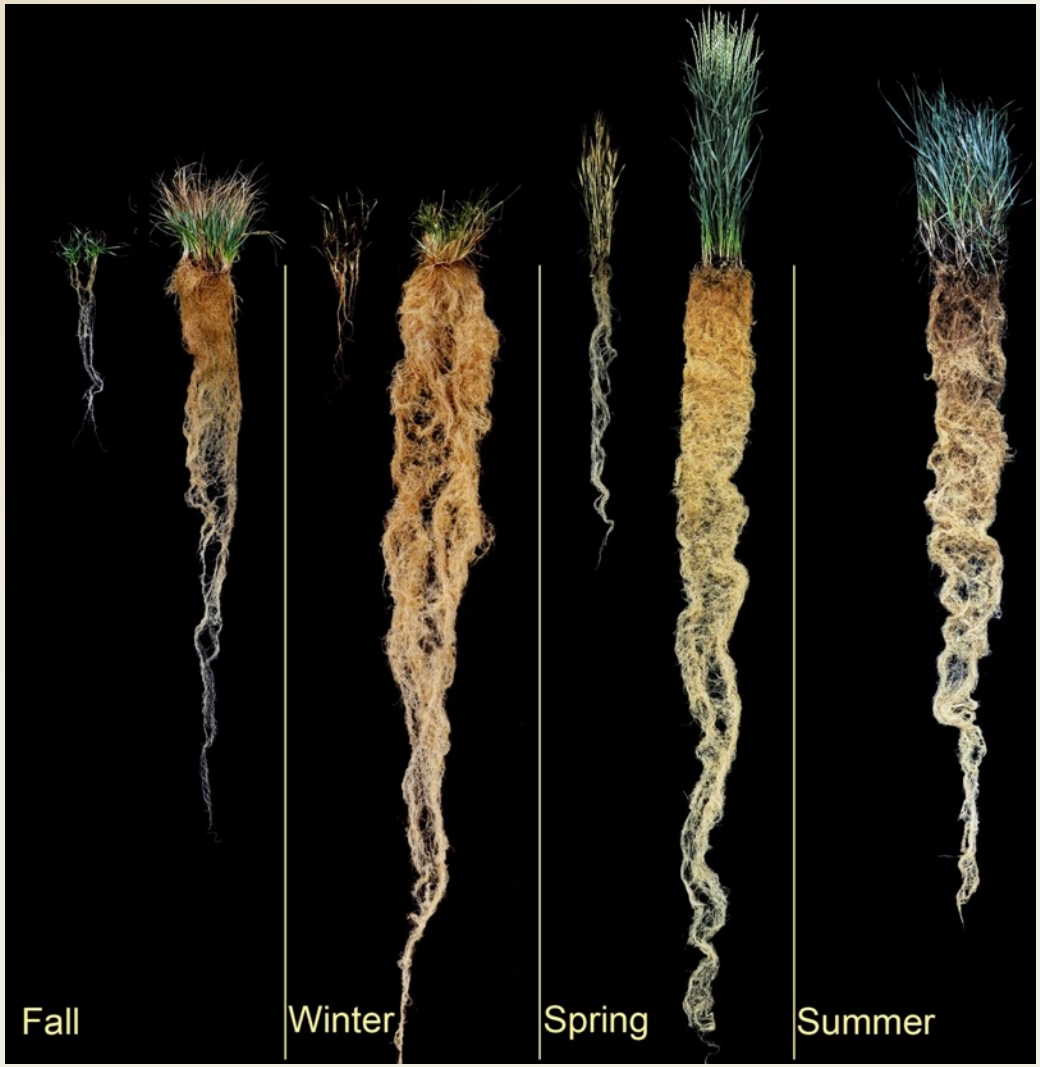
Ecological intensification of agroecosystems

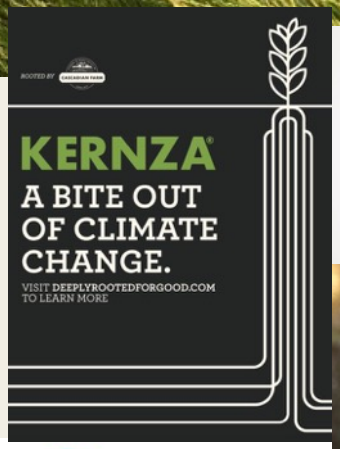


Perennials

- Ecosystem services:
  - Erosion control
  - Nutrient leaching reduction
  - Carbon fixation
- Multiple agricultural uses:
  - Pastures for grazing
  - Forages for feed
  - Biomass for energy
  - Perennial grains

Kernza intermediate wheatgrass





patagonia
PROVISIONS

General Mills

FOOD WRITER'S DIARY

WHAT'S HOT

Behold Kernza: Could this wheat save the planet?

Could perennial grains be the next climate-saving superstars?

RP Siegel
Thursday, November 30, 2017 - 2:00am

FOOD FOR THOUGHT

After A Long Day Of Fighting Climate Change, This Grain Is Ready For A Beer

October 26, 2016 · 4:00 PM ET

ALASTAIR BLAND

FOOD FOR THOUGHT

Can This Breakfast Cereal Help Save The Planet?

April 13, 2019 · 8:16 AM ET
Heard on Weekend Edition Saturday

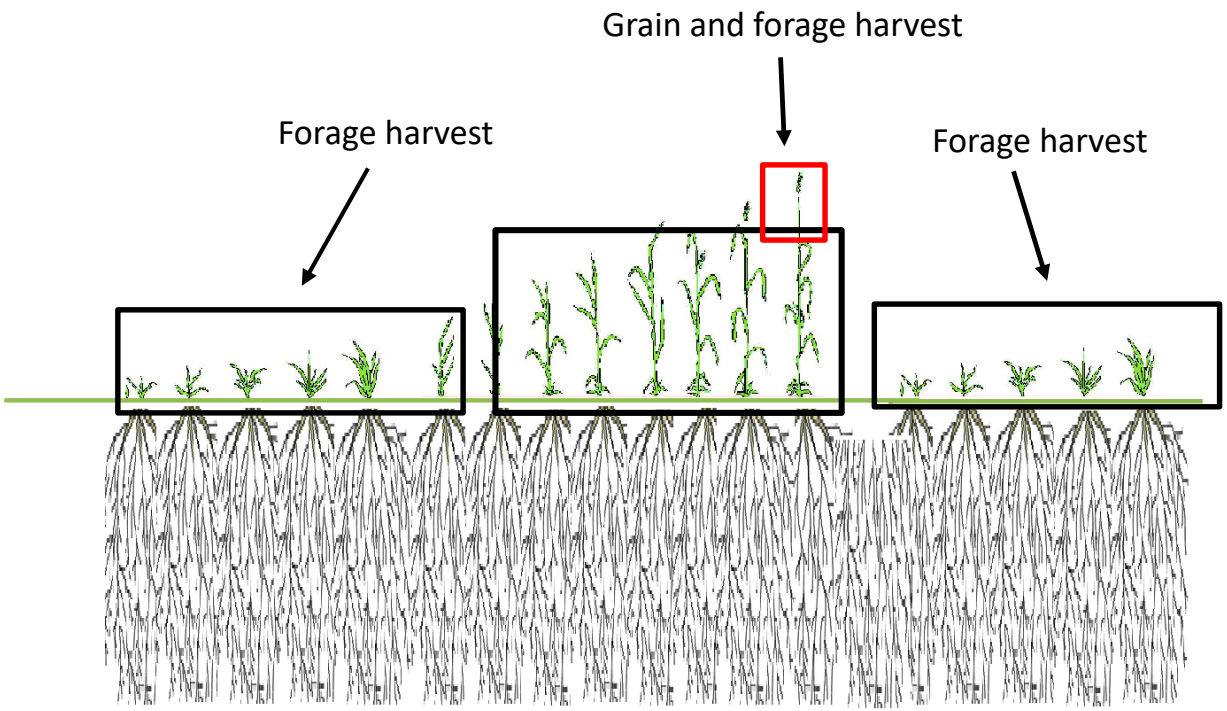
DAN CHARLES

NEWS · FEATURES

Kernza: The wheat ecologists dream about

Wed., Oct. 26, 2016

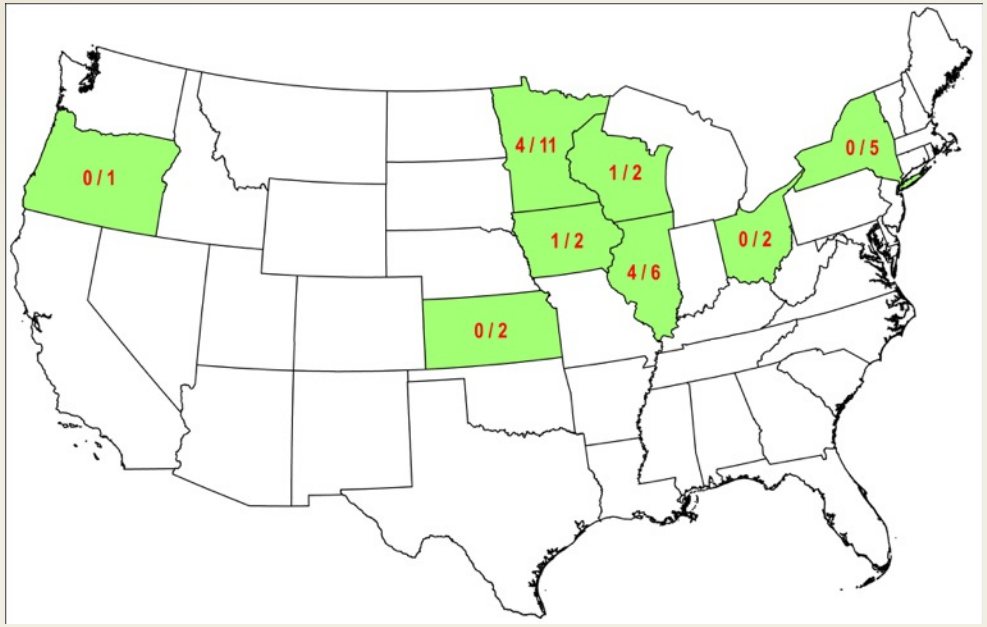
Dual-use management in IWG cropping systems



- What do Kernza farmers say?
- Dual use: grain and forage
  - What is the forage nutritive value?
  - Grazing impacts on grain yield?
  - Can cattle be fed Kernza crop residue?
- Weed suppression with Kernza
- Intercropping with legumes
  - Which legume species?
  - Which varieties?
  - Which management?

Farmer Perspectives on Growing Kernza

Lanker et al., 2019



- 10 semi-structured, on-farm interviews with Kernza growers
- Summer 2017, U.S Midwest (MN, WI, IA, IL, OH)
- Ages: 30 to 80 years old
- Crops: Diversified row crops, some w/ livestock, some grass seed
- 4 Organic, 3 Conventional (except Kernza), 3 Mixed
- Farm acreage: 160 to 10,000; Kernza acreage: 1 to 38
- Kernza start date: Fall 2011 to fall 2016

Motivations - "I guess I was just interested in something new, looking to try something different."

- **Sense of innovation**
- Personal connection to Kernza social network
- Environmental consciousness
- Interest in niche markets
- Some level of criticism of the dominant system

Management -

"we don't know much about the management."

- Lack of agronomic management information
- Planting: diverse methods, late dates
- Harvest grain: 3 Combine, 4 swathing
- Limited inputs (some fertilizer)
- Weeds: perennials; Cutting/mowing

Lanker et al., 2019

Farmers' questions and challenges

- Establishment (seeding, density, spacing)
  - *"nobody knows much about thow to establish this."*
- What's a 'good stand'
  - *'Should I terminate this? Is this an adequate stand?"*
- Obtaining seed on time
  - *"the seed not coming 'til late. Just everything happened too late…."*
- Forage value
  - *"If I had cattle and I could feed it …"*
- Weed management
  - *"pretty much squeezes everything else out."*
  - *"quickly become a weedy mess."*
- How to keep Kernza productive over years
  - *"it became sodbound"*
- Economics, processing & markets
  - *"what would the market price for it be right now?"*

Lanker et al., 2019

Kernza
A Perennial Grain and Forage Crop with Multiple Uses

Dorothy & John Priske

Fountain Prairie Farm

Fall River, WI


JOHN DEERE


705
705
Long Root
Long Root
Long Root


FEATHERLITE STL
RAM 2500

John and Dorothy Priske's farm

John and Dorothy Priske's Fountain Prairie Farm

W1901 State Road 16, Fall River, WI, 53932

First organic perennial grain polyculture commercial field: Kernza-clover with cattle grazing

Paddock 1: Red clover frost seeded 1.2 acres	Paddock 3: Red clover frost seeded 2.6 acres
Paddock 2: Red clover drilled in fall 1.2 acres	Paddock 4: Red clover drilled in fall 2.6 acres
	Paddock 5: Red clover frost seeded 2.4 acres
12.3 acres total ← **North**	Paddock 6: Red clover drilled in fall 2.4 acres

Field preparation: On improved pasture being used for grazing and migratory bird habitat.

Moldboard plowing Aug. 25, 2017; tandem disc Sep. 8, tandem disc Sep. 11, Cultipack Sep 11.

Kernza planting: Sep 13, 2017; Drilled with John Deere 1590 grain drill, large box, setting 25, 15 inch row spacing: 9.3 lbs/acre. Population Kansas Cycle 4, seed harvested in Lancaster, WI in 2017.

Red clover (variety Red Wing) planting (2 planting date treatments):

Sep 13, 2017: Drilled with 1590 grain drill-small box, setting 6: 7 lbs PLS/acre

March 10, 2018: In the paddocks not planted to red clover in the fall, frost seeded at 11.5 lbs PLS/acre with conical broadcast seeder

Kg/ha	Summer (8/14)	Fall (10/12)
IWG forage	4100	1100
Red clover forage	800	700
Weeds	500	65

Summer Hay: 97 bales of 682 lb average = 66,154 lb
Hay nutritive value: CP: 9.6%; ADF:51%; NDF: 77%; NDFD:23%; RFV: 59

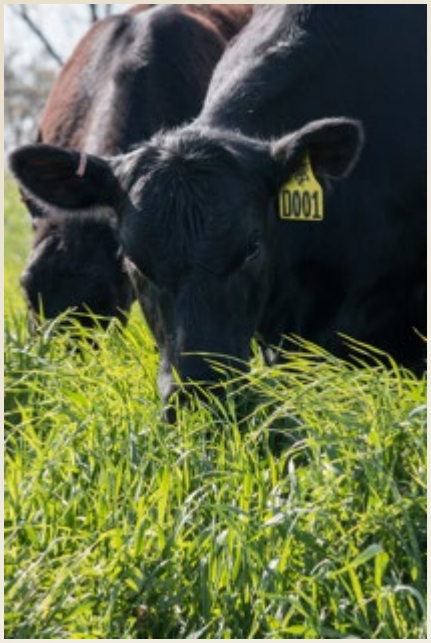
Kernza grain: estimated in quadrats: 450 kg/ha; after combine harvest and cleaning: 484 kg total (100 kg/ha)

Forage value of Kernza intermediate wheatgrass in monoculture vs mixture with red clover

Favre et al., in review

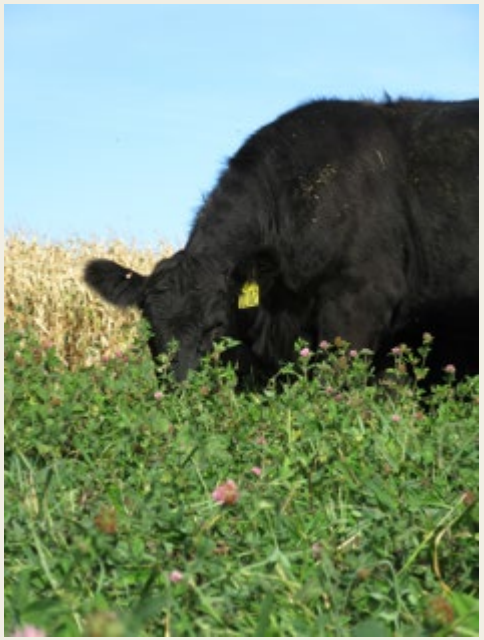
Dual-use management

Spring forage harvest



Grain/straw harvest

Fall forage harvest



Vegetation

1. Kernza monoculture
2. Kernza – red clover

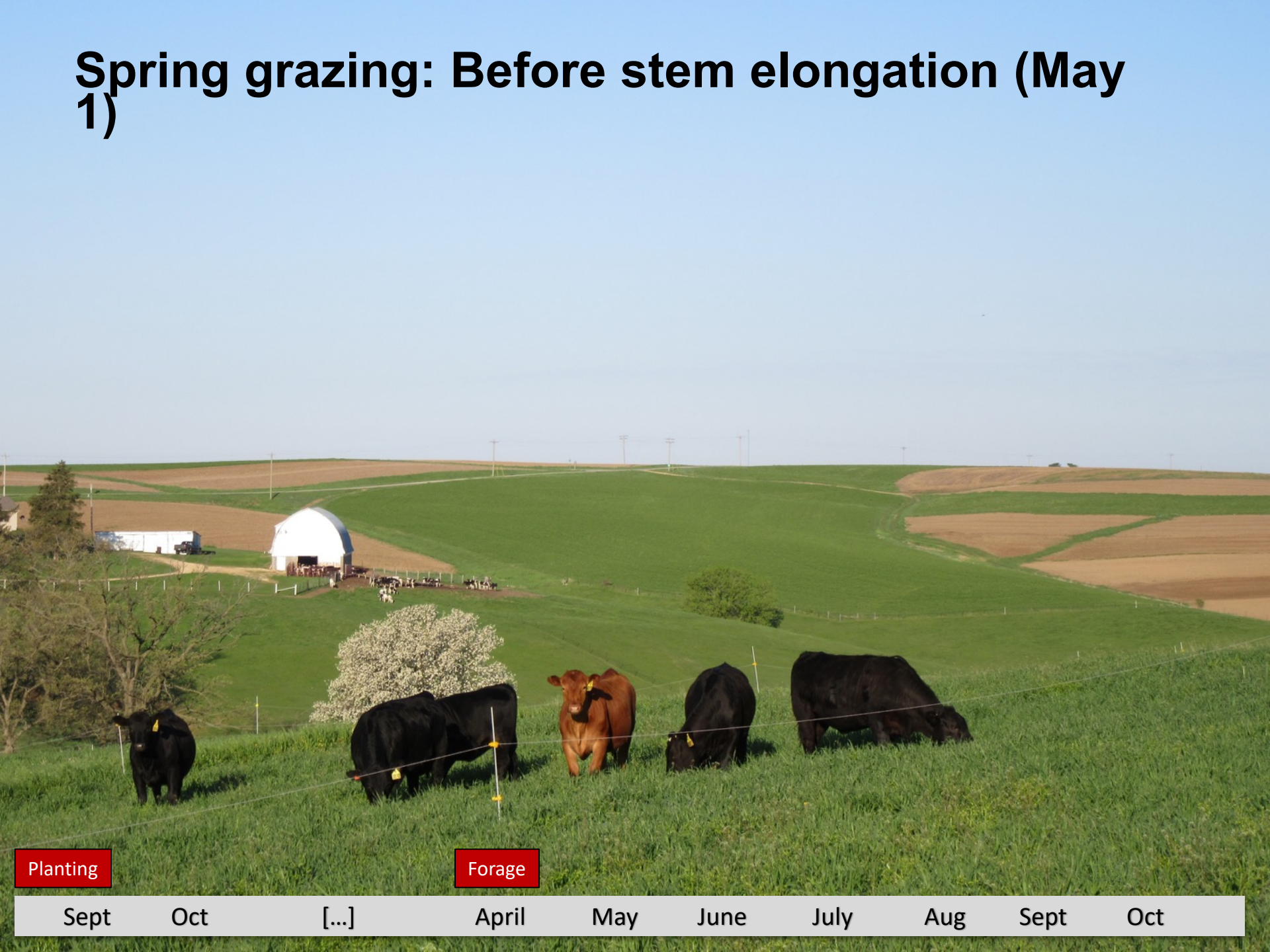
Sampling: Quadrat harvest at the soil level

Planting: August 15 - Sept 20

Planting

Sept Oct […] April May June July Aug Sept Oct

Spring grazing: Before stem elongation (May 1)



Grain harvest: ~Aug 1

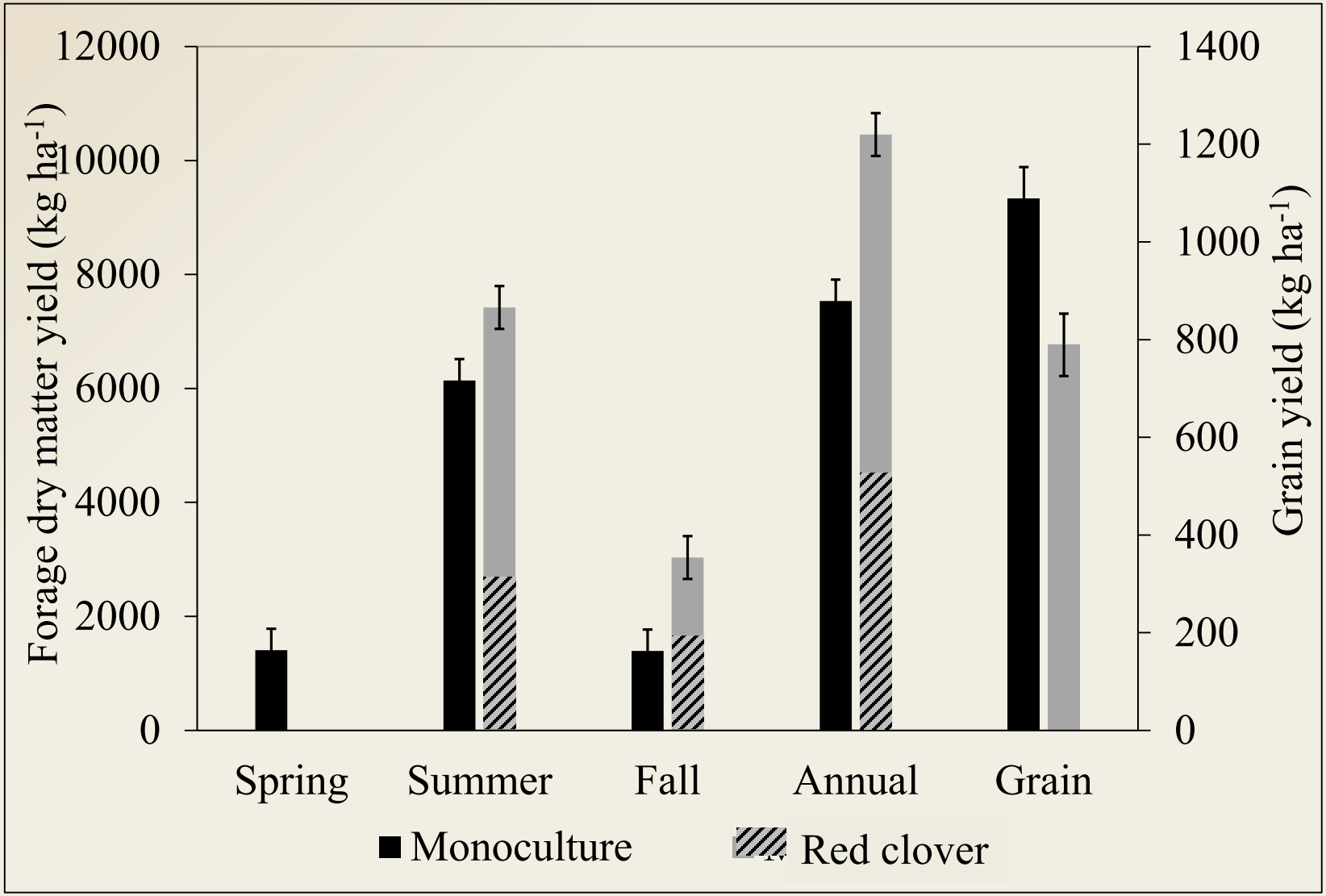
Planting | Forage | Grain

Sept Oct […] April May June July Aug Sept Oct

Grain harvest: ~Aug 1

Fall grazing : Mid-October

Forage and grain yields – 1st year, Wi

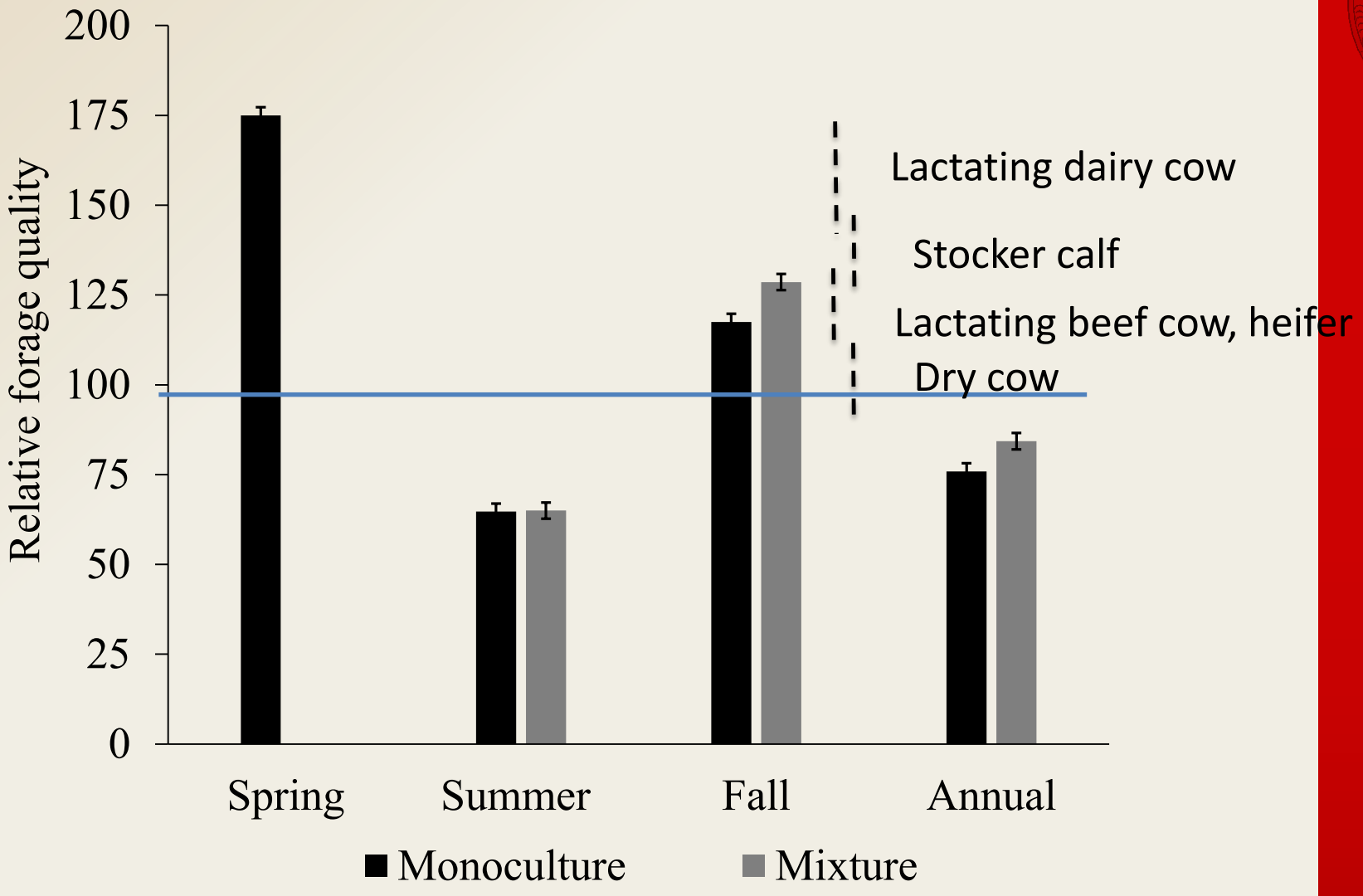


Favre et al., in review

Forage nutritive value – 1st year, Wi

	Material	Season		
		Spring	Summer	Fall
NDF (%)	IWG monoculture	46 ef	70 ab	59 cd
	IWG/clover mixture	-	64 bc	44 f
ADF (%)	IWG monoculture	25 d	43 ab	34 c
	IWG/clover mixture	-	41 b	28 d
CP (%)	IWG monoculture	23 a	5 f	12 d
	IWG/clover mixture	-	9 e	18 bc
ttNDFD	IWG monoculture	0.53 a	0.41 b	0.40 b

Favre et al., in review



Favre et al., in review

Grazing impacts on Kernza grain yield

NCR-SARE grant – UW, UMN, TLI

- Lancaster, WI
- Morris, MN

Treatments

Vegetation (2 treatments):

- a) Kernza monoculture
- b) Kernza + legume intercrop

Grazing (4 treatments):

- a) Spring grazing
- b) Fall grazing
- c) Spring and fall grazing
- d) No grazing

Grain harvest from every plot

Planting

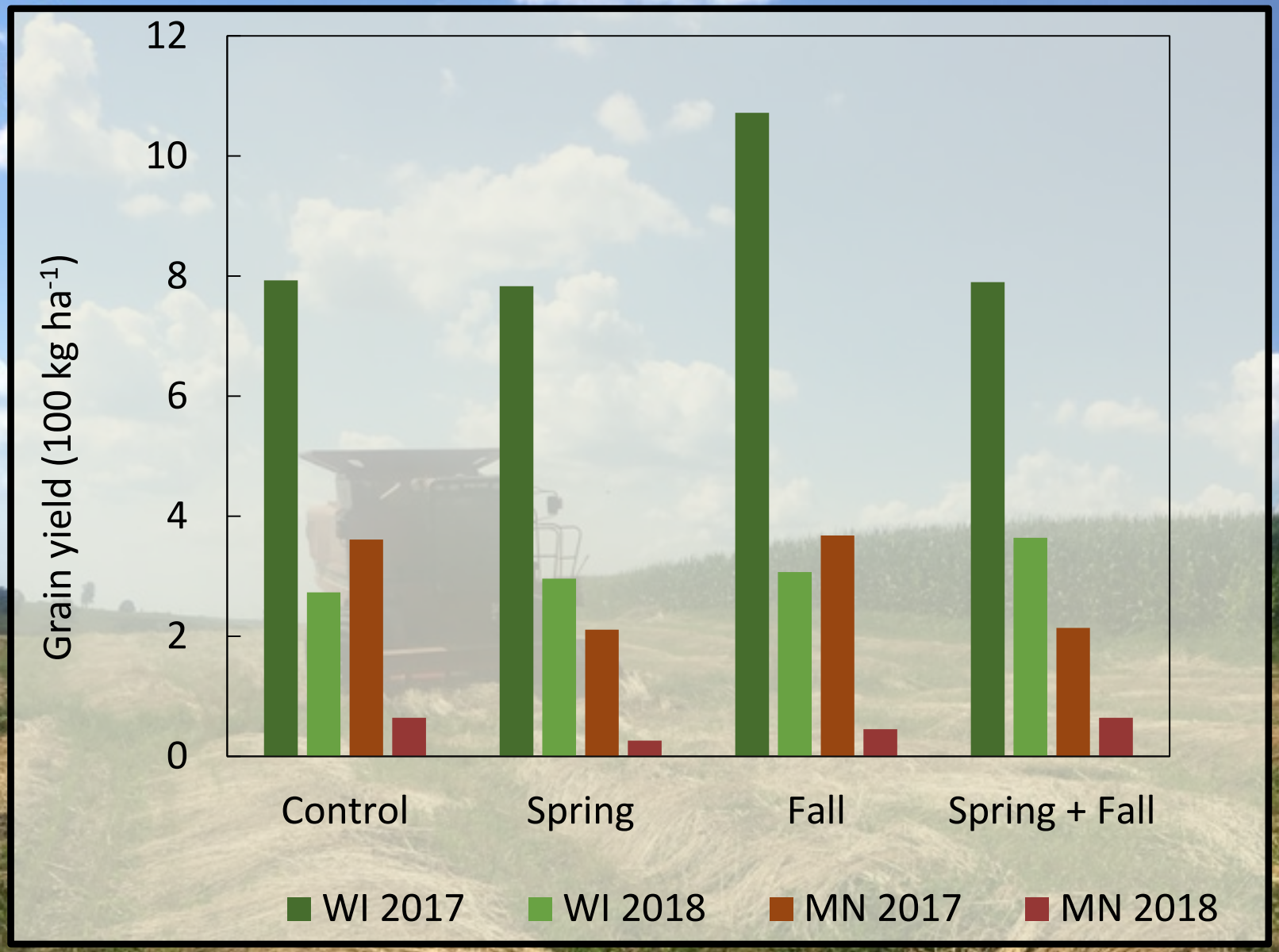
Grazing

Grain harvest

Grazing

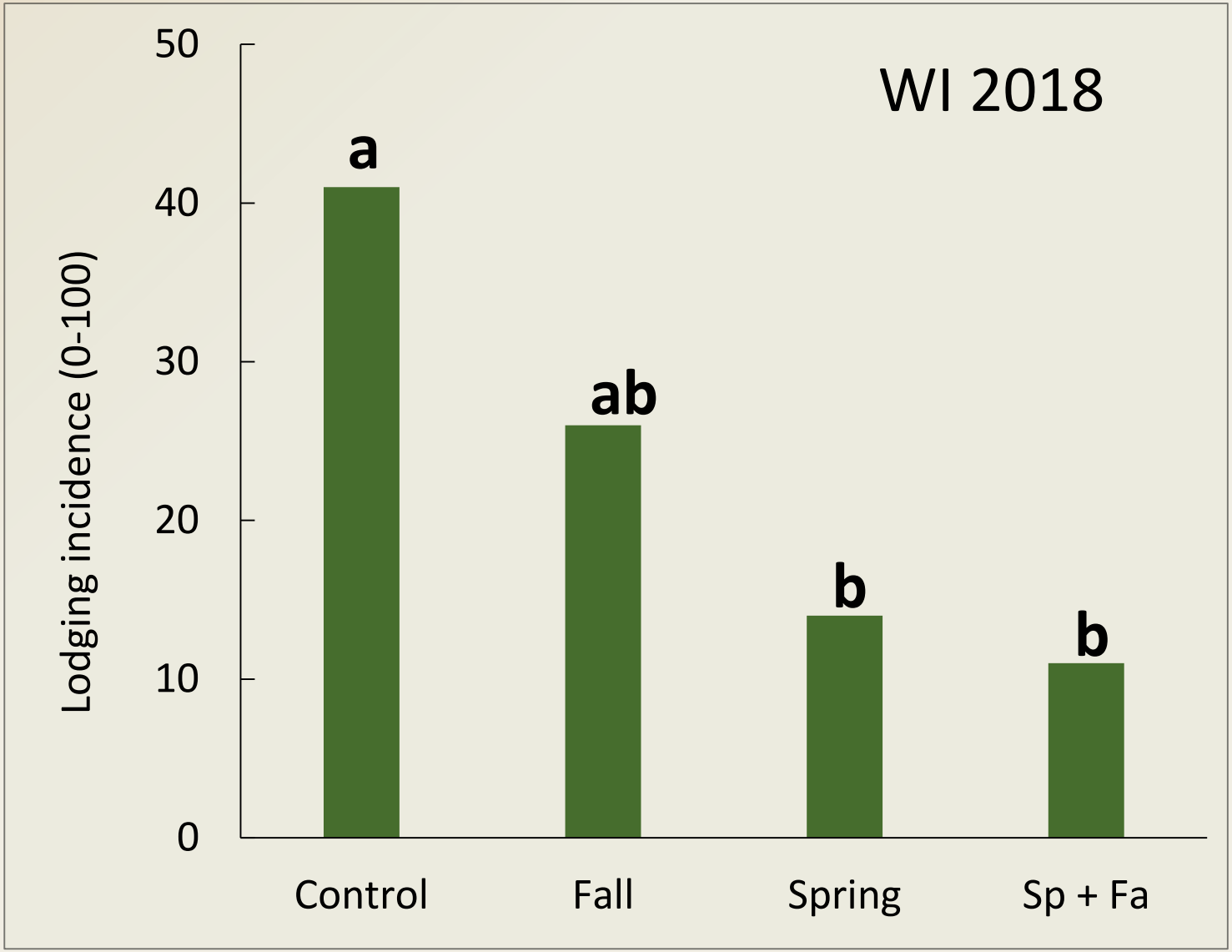
Sept Oct Nov […] April May June July Aug Sept Oct

Grain yield vs grazing timing



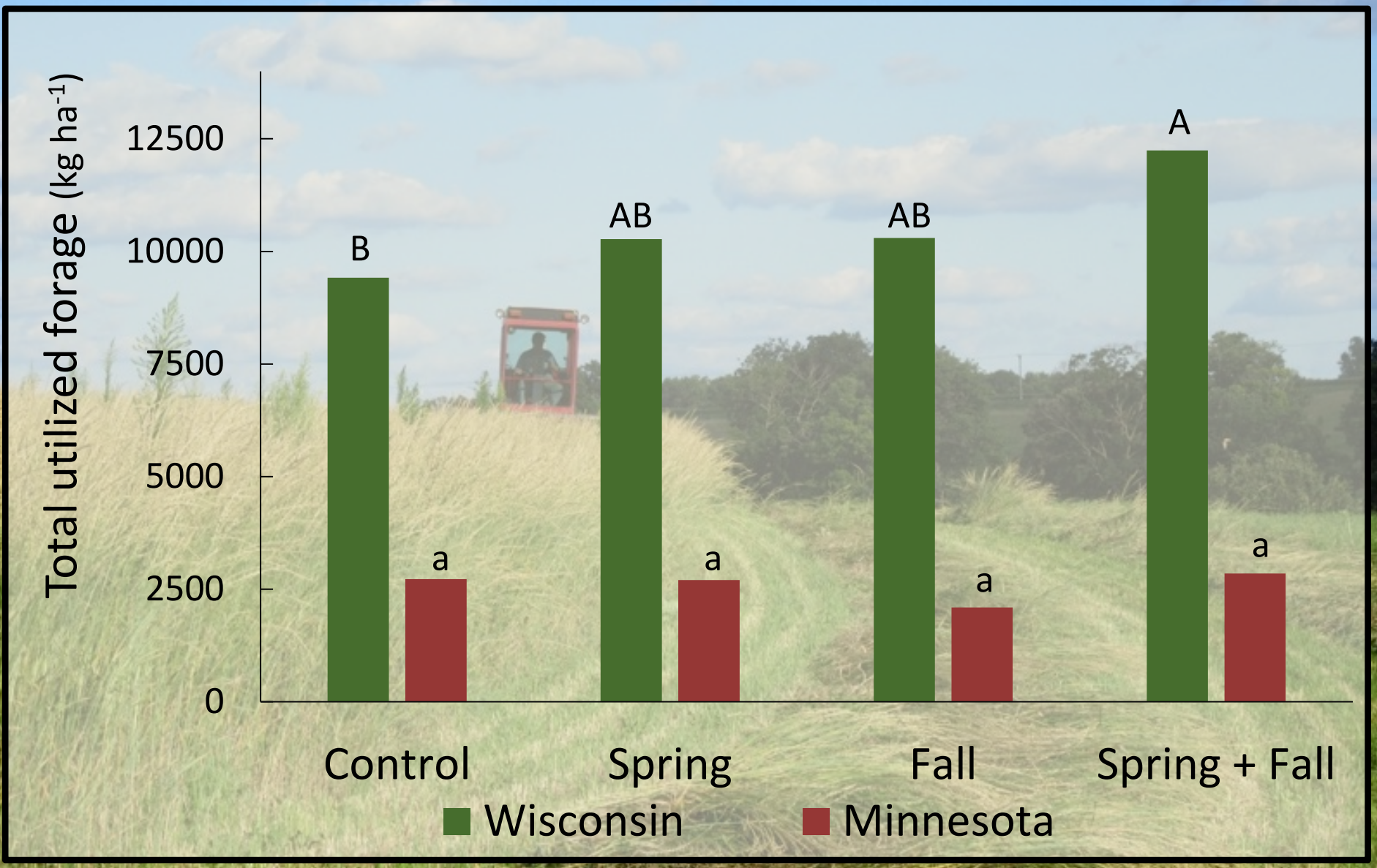
Favre et al., in prep.

Lodging vs grazing timing



Favre et al., in prep.

Forage yield vs grazing timing



Favre et al., in prep.

Beef cattle performance in a feeding trial with Kernza crop residue

		100% grass-alfalfa haylage	50% Kernza crop residue + 50% haylage	p-value	SEM
Cow final body weight	kg	769	739	0.05	7.6
Average daily gains	kg day^{-1}	0.92	0.45	0.02	0.1
Dry Matter intake	g kg BW^{-1}	28.7	21.4	<0.01	0.4
Increase in Body Condition Score	-	0.3	0.1	0.05	
Calf birth weight	kg	40.8	39.5	0.55	1.44
Calf weaning weight	kg	203	211.2	0.42	5.5

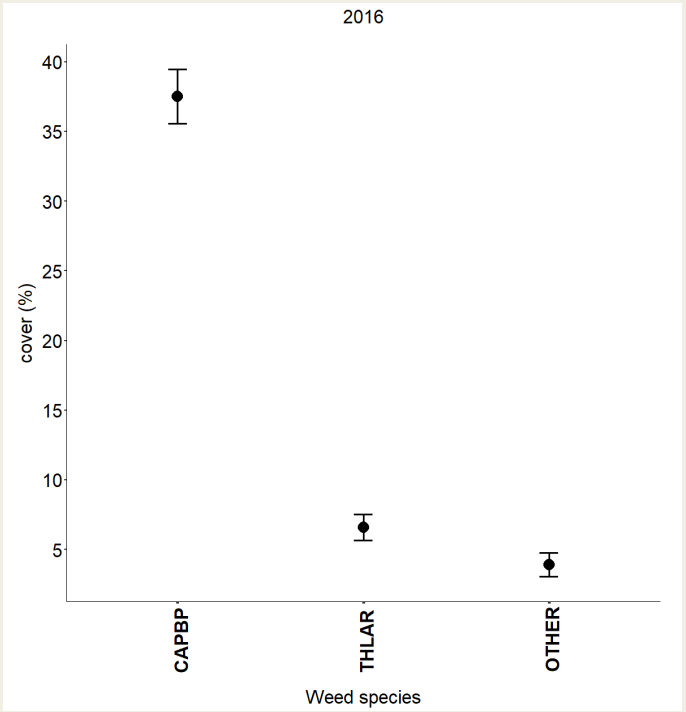
Favre et al., in prep.

Dual-use Intermediate wheatgrass cropping systems effectively suppress weeds over three production years

Zimbric, Stoltenberg, and Picasso, in prep.

Weed community composition (first year)

Shepherd's purse

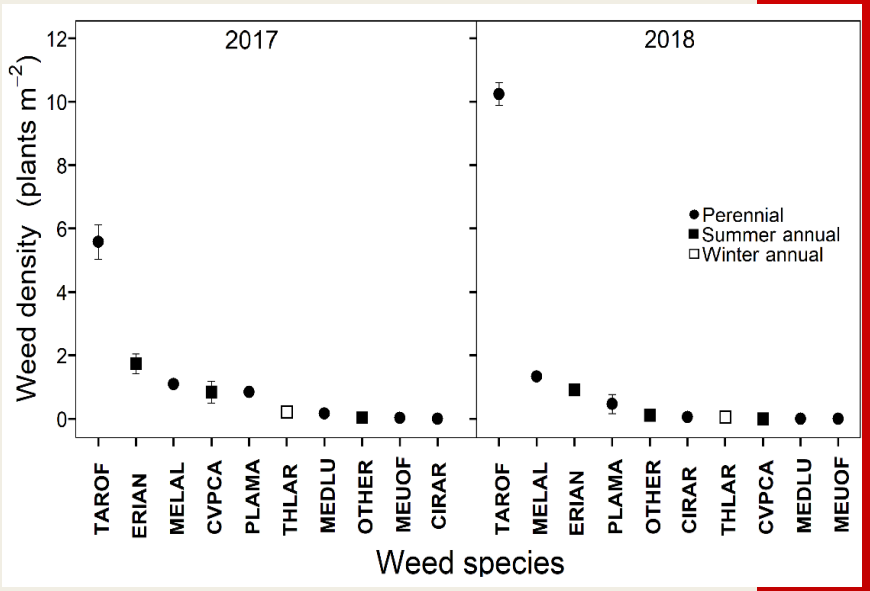


Weed community composition (second and third year)

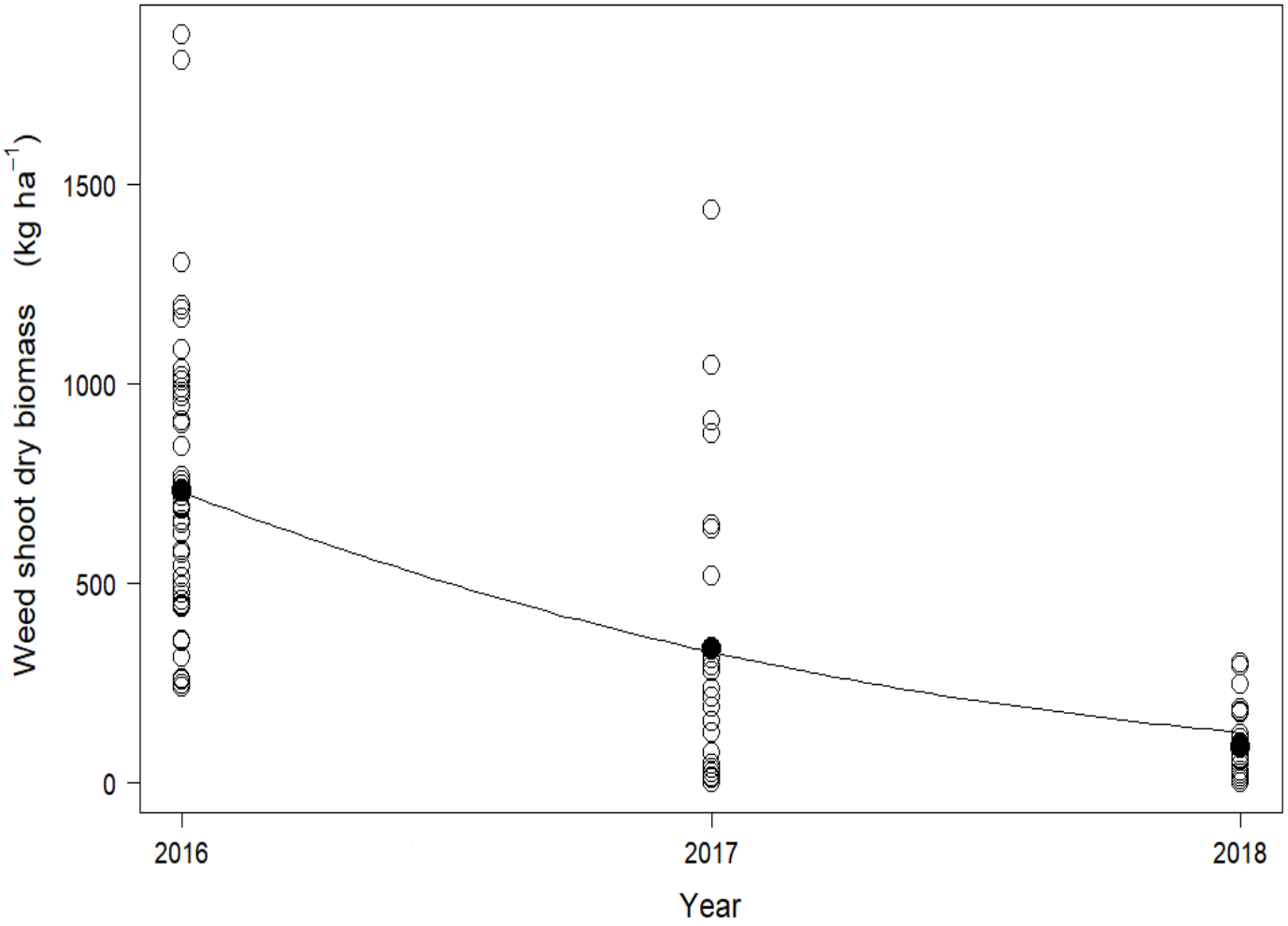
Dandelion

White cockle

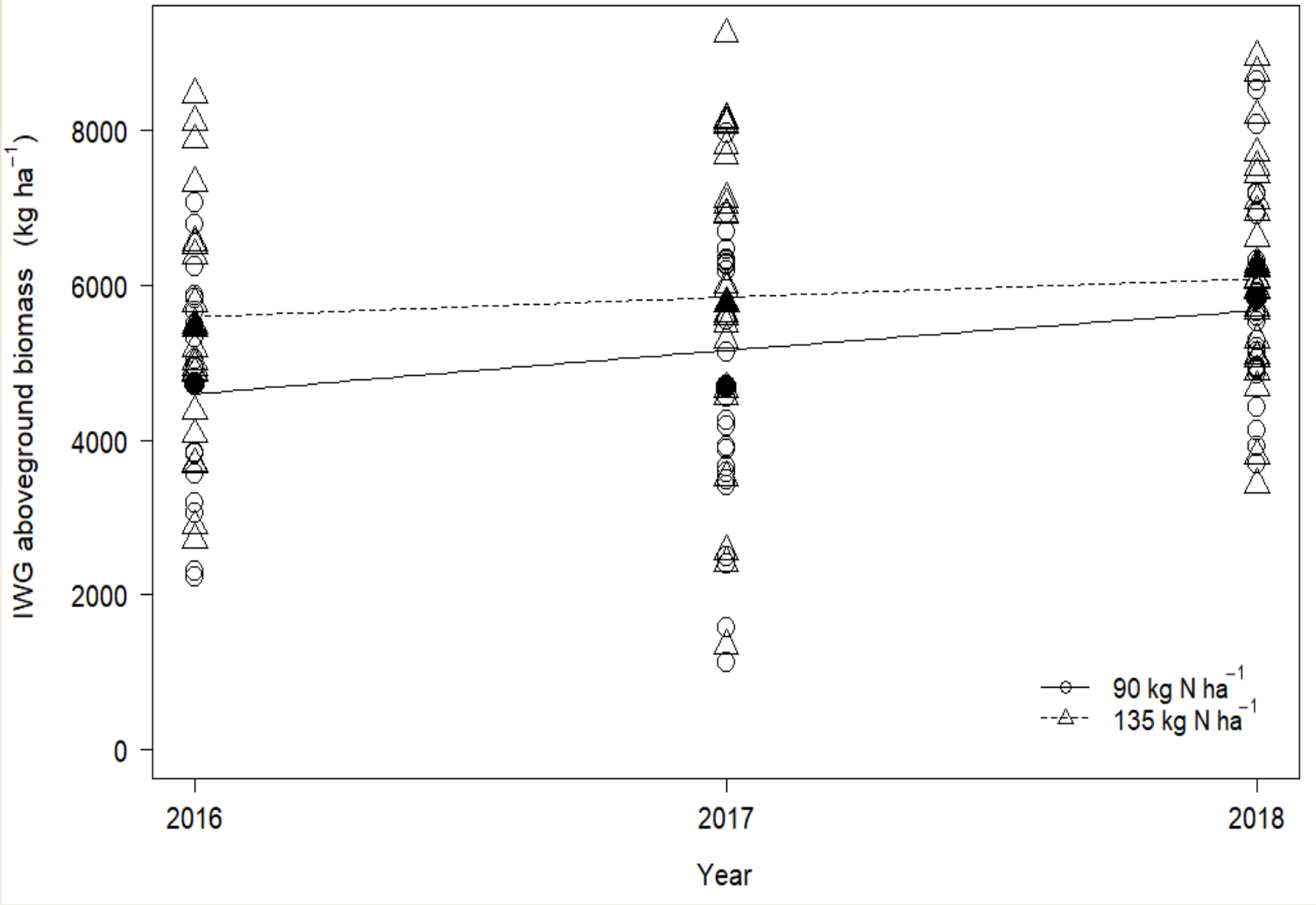
Annual fleabane



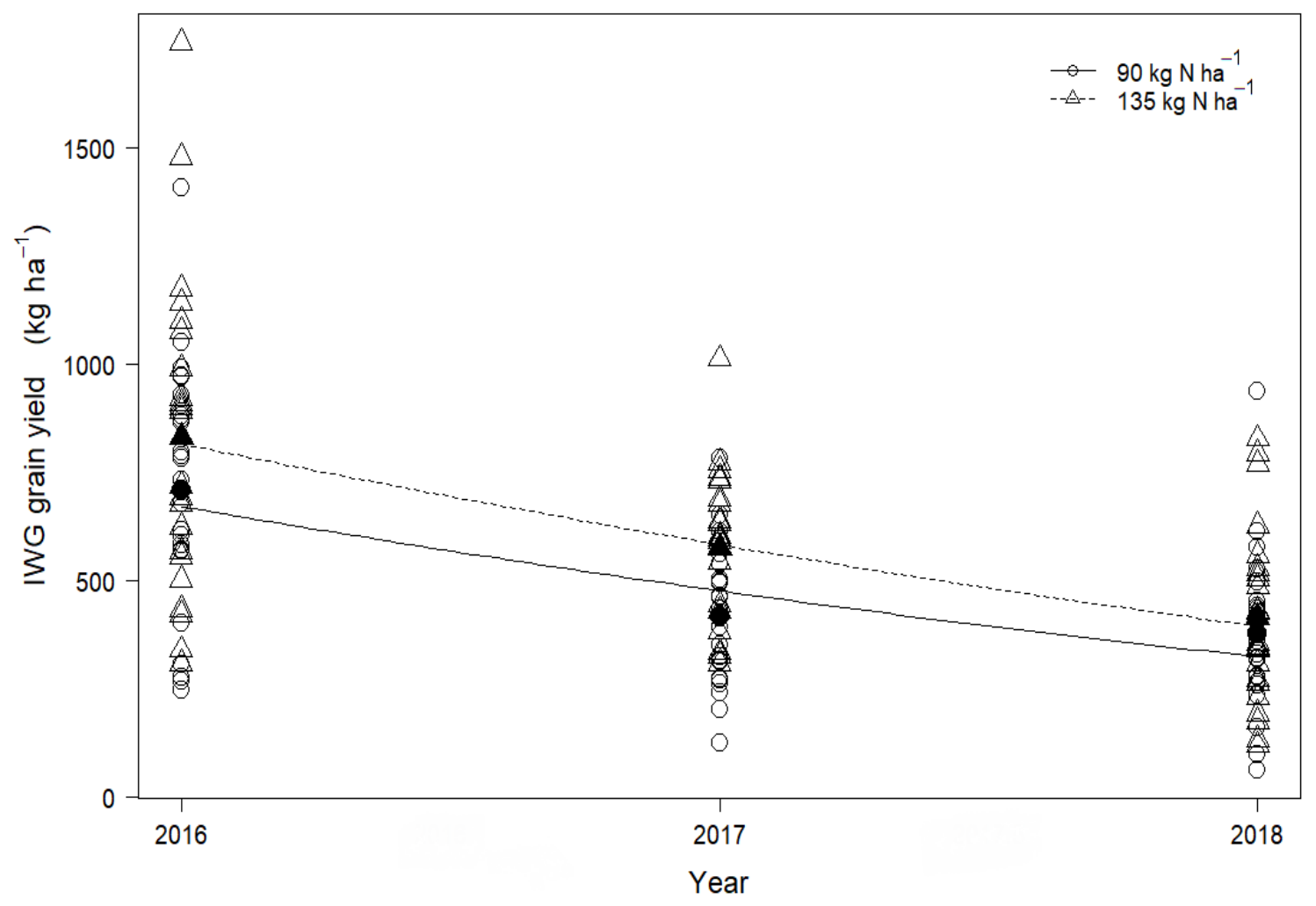
Results: Weed biomass



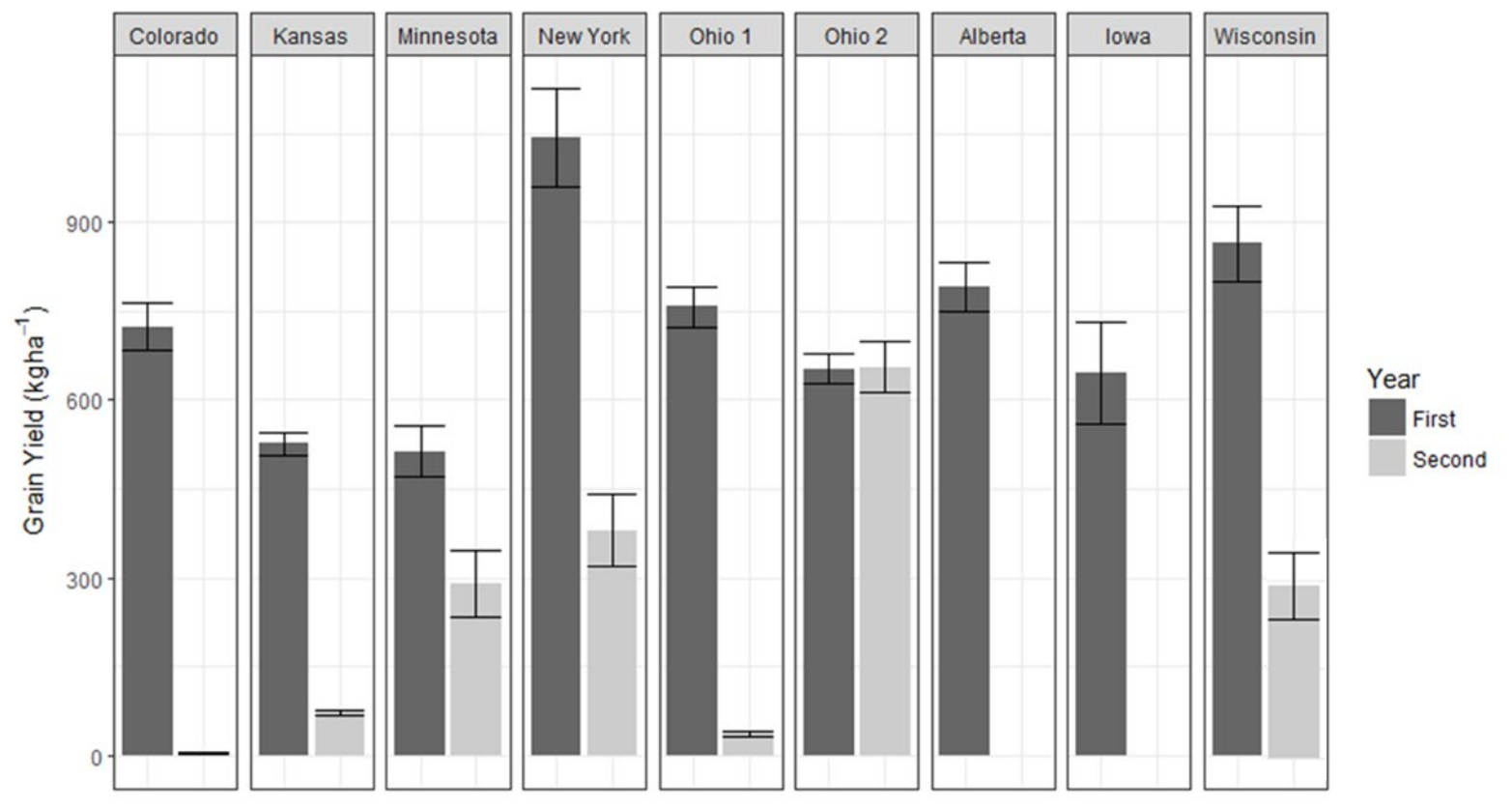
Results: IWG aboveground biomass



Results: IWG grain yield



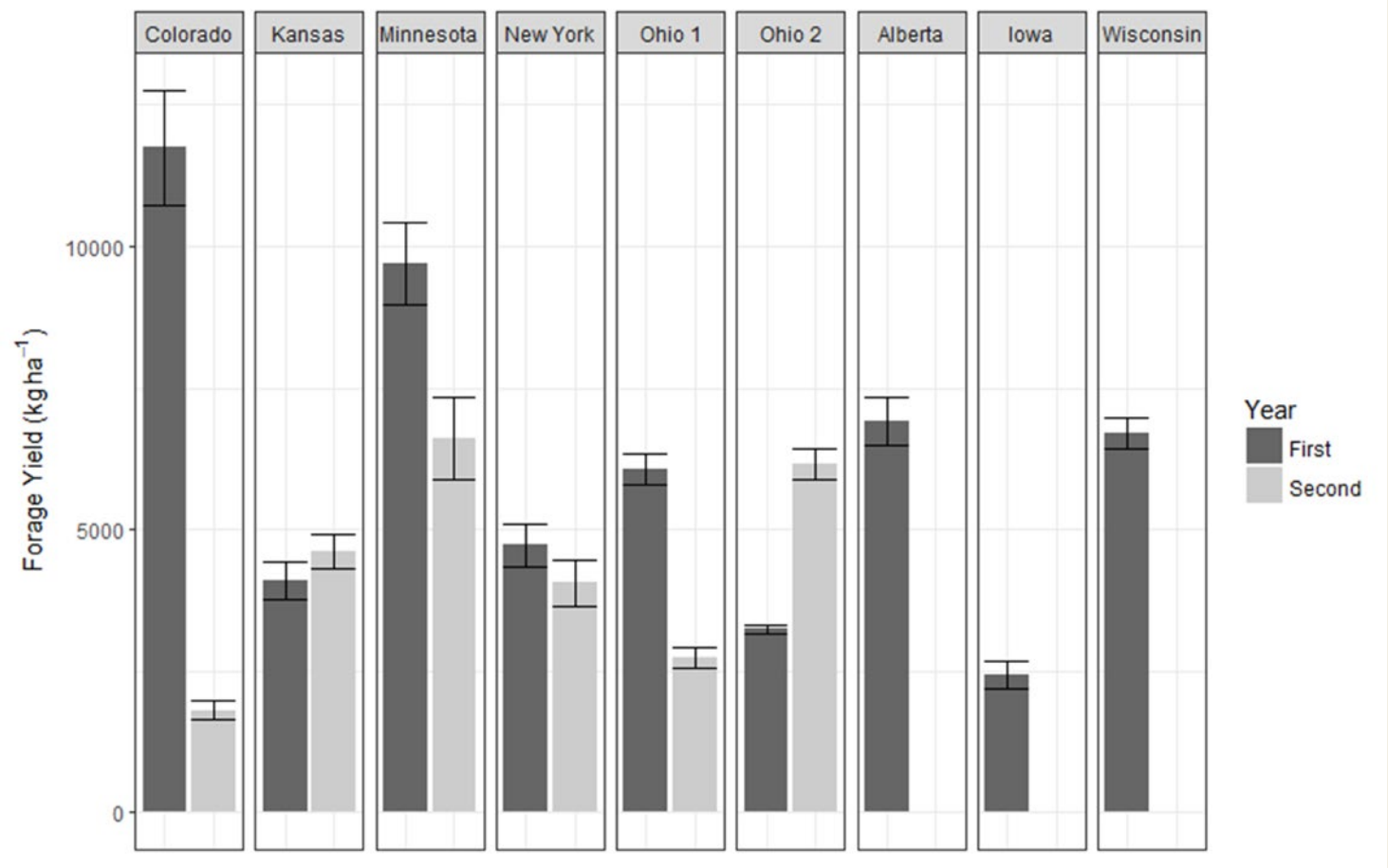
Kernza Grain Yields in the US



1st year: ~ 500 – 1000 kg ha^{-1} (450-900 lb ac^{-1})

2nd year: ~ 3– 650 kg ha^{-1} (3-580 lb ac^{-1})

Kernza Forage Yield in the US



1st year: ~ 4 – 12 Mg ha^{-1} (3.5 - 11 Ton ac^{-1})

2nd year: ~ 2.5– 9 Mg ha^{-1} (2.2 - 8 Ton ac^{-1})

Bushel weight of Kernza ~ 20 lb/bu

Grain	Test weight (g/L)	lb/cu ft	Bushel weight (lb/bu)
K-Min	161*	10	12
K-Mean	241*	15	19
K-Max	283*	18	22
Grass	179	11	**14**
Oats	412	26	**32**
Barley	617	39	**48**
Wheat	771	48	**60**

* Data from Arlington, Wisconsin 2017 AK1 and AK2

Factors: 1 bushel is a volume of 1.24 cubic foot; 1 g/L = 0.0624 lb/cubic foot

Intercropping legumes with Kernza

Experimental design

Locations: Arlington and Sturgeon Bay, WI

Seeds from Cycle 4 IWG – TLI, 11 kg ha^{-1}

5 replications

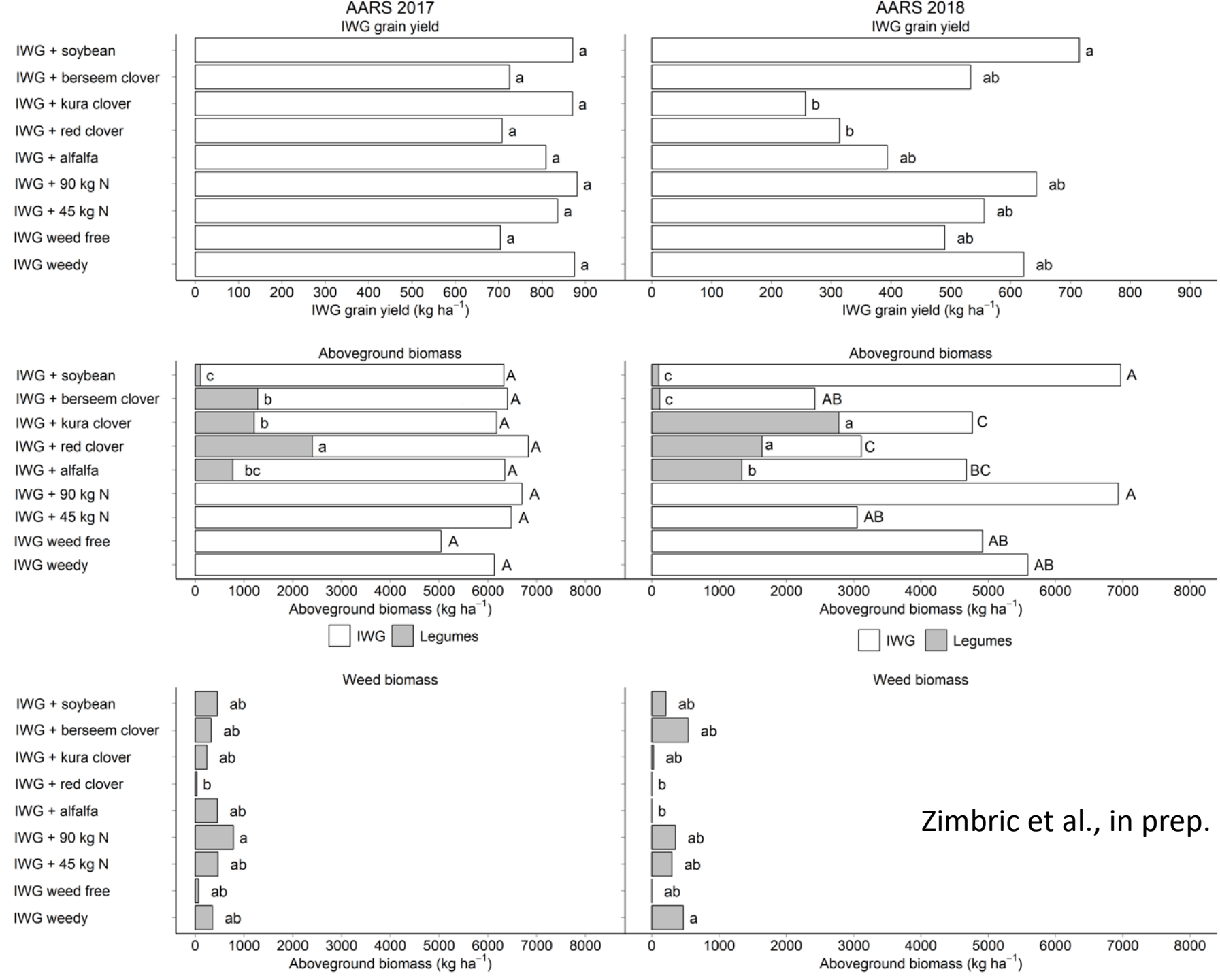
Main plot factor: Row Spacing

- 38 cm
- 57 cm

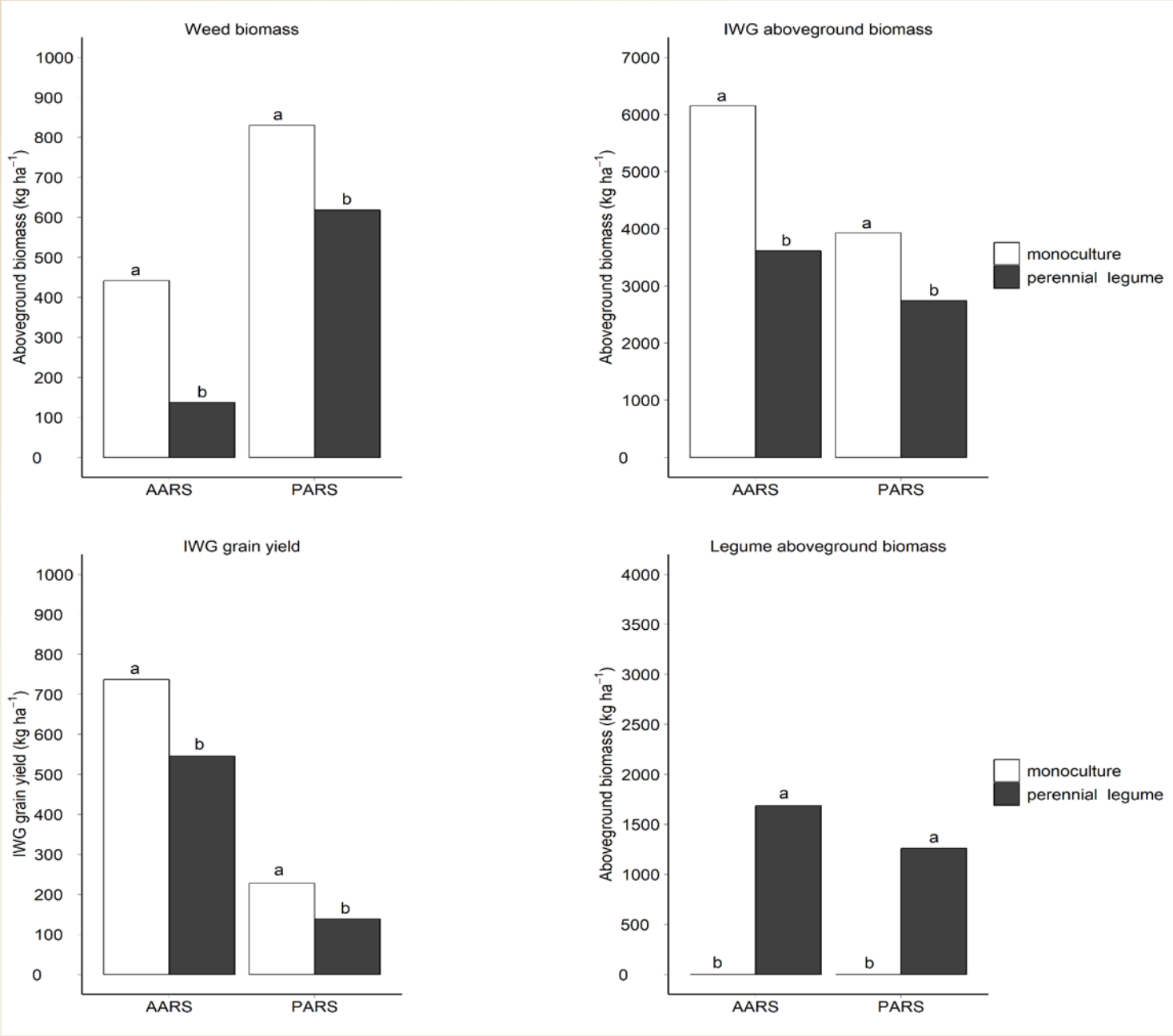
Sub-plot factor: IWG cropping system

- IWG monoculture – weedy
- IWG monoculture – weed free
- IWG monoculture + 45 kg N ha^{-1}
- IWG monoculture + 90 kg N ha^{-1}
- IWG + Alfalfa
- IWG + Red Clover
- IWG + Kura Clover
- IWG + Berseem Clover
- IWG + Soybean


Red clover
Trifolium pratense
Kura clover
Trifolium ambiguum
Alfalfa (Lucerne)
Medicago sativa



Zimbric et al., in prep.

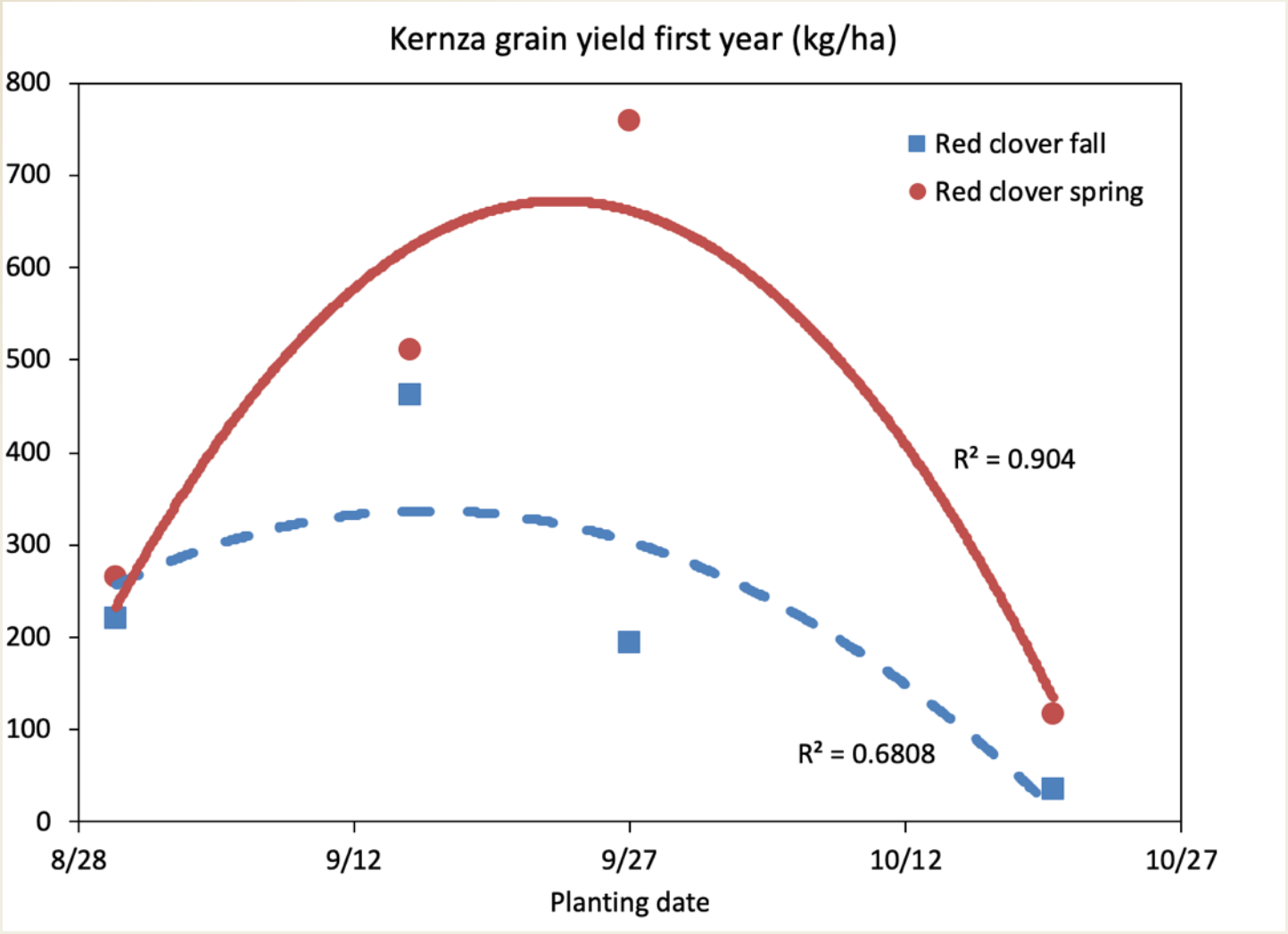


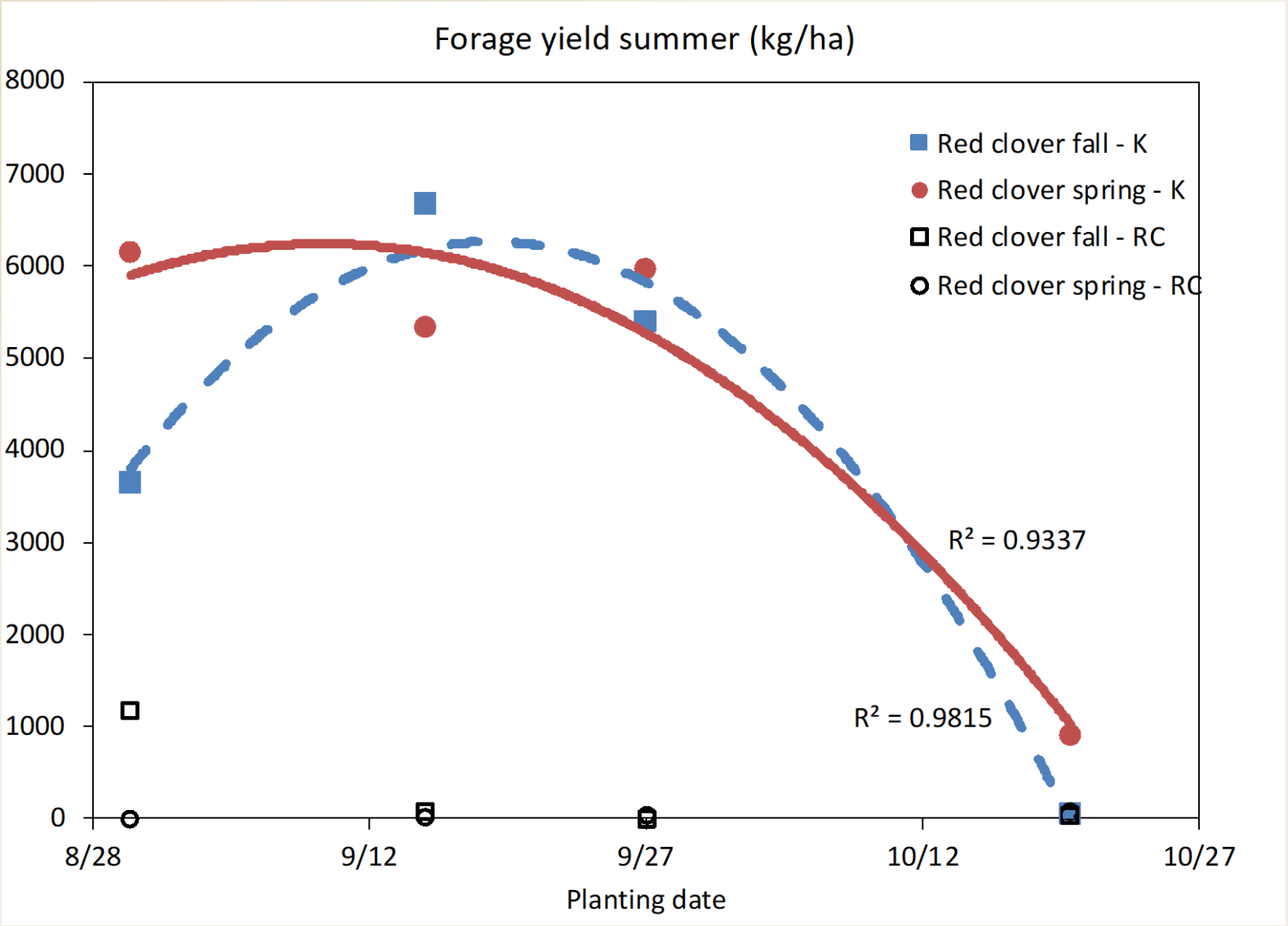
Zimbric et al., in prep.

Alfalfa varieties for Kernza intercropping

Brandon Schlautman et al.

Planting date of Kernza and legume




Forage yield summer (kg/ha)
8000
7000
6000
5000
4000
3000
2000
1000
0
8/28
9/12
9/27
10/12
10/27
Planting date
Red clover fall - K
Red clover spring - K
Red clover fall - RC
Red clover spring - RC
R² = 0.9337
R² = 0.9815

Invitation – on farm research

On-farm comparisons of Kernza grain yield, total biomass yield, and changes in soil nitrogen in two intercropping treatments:

1) Kernza intercropped with alfalfa, and
2) Kernza intercropped with another perennial legume best fit for the growing conditions of the on-farm participant.

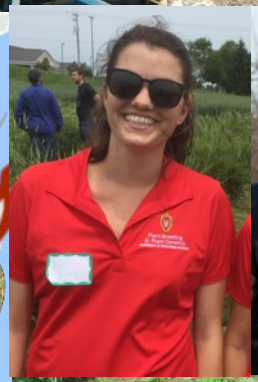
This experiment will be conducted in partnership with two farmers per state associated with each institution.

Based on discussions with the on-farm participants, legumes currently being considered for intercropping in addition to alfalfa include red clover, birdsfoot trefoil, and sainfoin.

SARE project (UMN, UW, TLI)







Chequamegon-Nicolet National Forest

Chequamegon-Nicolet National Forest

Thank you!

Wausau

Eau Claire

WISCONSIN

Stevens Point

Appleton

Oshkosh

Wisconsin Dells

Janesville

Milwaukee

No Farms No Food

USDA

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UNIVERSITY OF WISCONSIN-MADISON

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Sustainable Agriculture Research & Education

GREEN LANDS BLUE WATERS