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Developing high-quality cereals for organic and perennial systems in the Upper Midwest

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Some of our current challenges

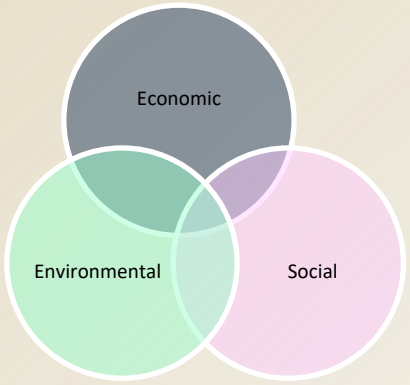









Breeding for systems



Cropping System Performance

Crop Protection

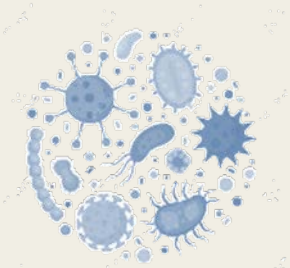
Stability and Resilience

Profitability

Healthy and Nutritious Food

Soil Health

Weed Suppression



Soil Microbiomes

Crop Rotation

Supports Communities

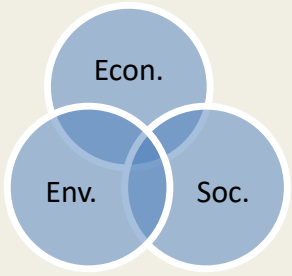
Nutrient Use Efficiency

Winter cover

Water Quality

Multiple Targets

Why high value food grade grains in organic rotations?



- Improve the diversity and sustainability of agricultural systems
- Ecosystem services:
  - build organic soil matter
  - reduce erosion by providing winter cover
  - break disease cycles
  - control weeds, and
  - increase landscape diversity
- Perennials further reduce erosion and production costs for farmers

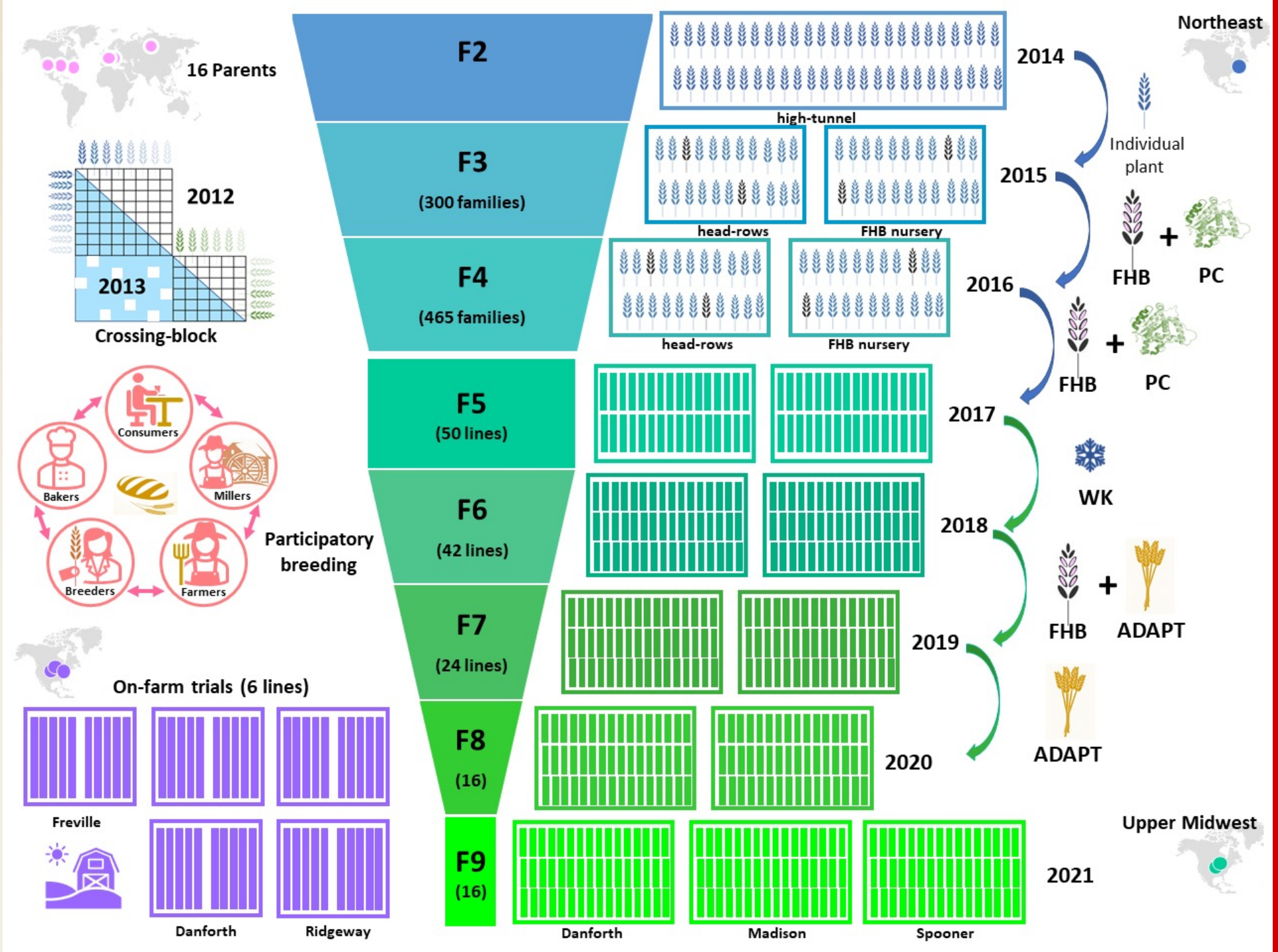
Problems and opportunities

- No organic wheat or Kernza variety testing information is available for farmers.
- No prior selection for locally adapted organic wheat varieties has been conducted in the Midwest.
- There is a strong market for high value options such as bread wheat
- Farmers have been involved in field days of on-station trials of winter wheat and intermediate wheat grass in recent years

Organic wheat breeding - Why hard winter wheat?

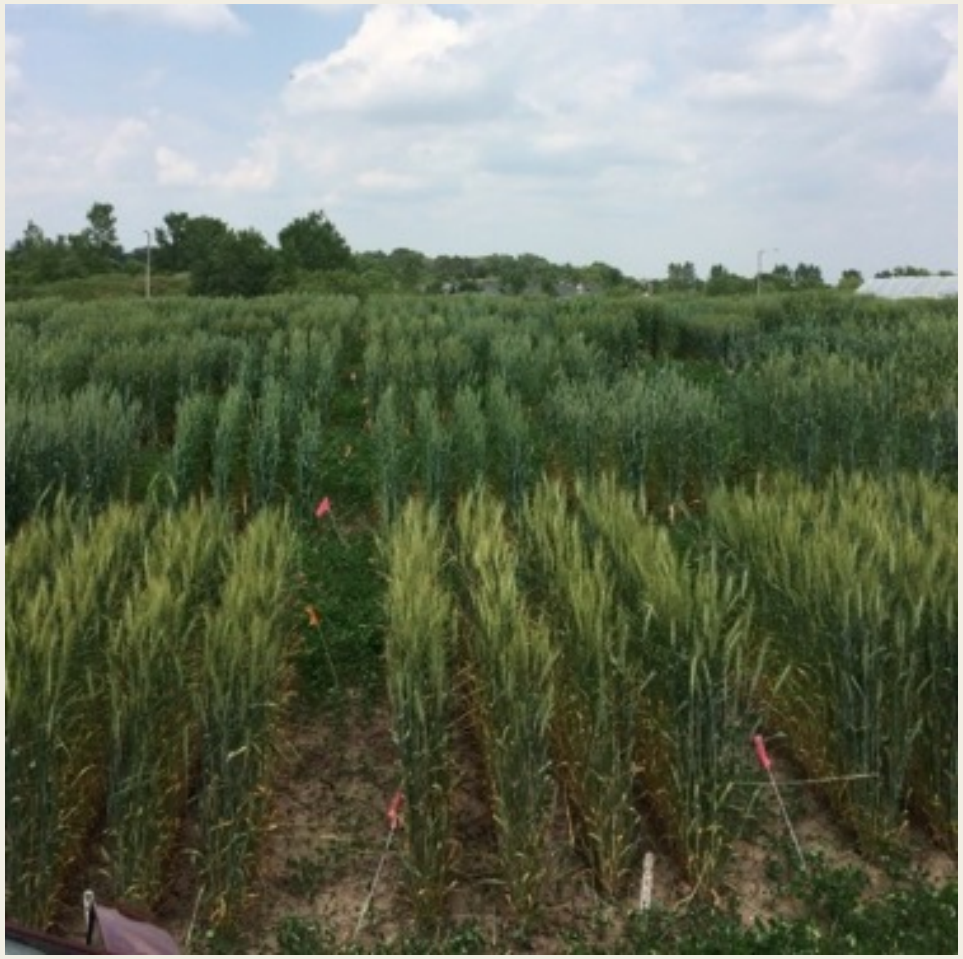
- Easier and environmentally beneficial to grow winter grains - diverse rotations, planting time, weed control
- Higher yields than spring wheat will improve returns for farmers and potentially reduce costs for bakers
- Harder to get high protein, so variety selection is necessary, for higher protein or better baking quality at lower protein levels

Midwest organic wheat breeding



Midwest organic wheat breeding

- Trials at West Madison Agricultural Research Station from 2017-2021
- On-farm trials in Illinois (Janie's Farm)
- On-farm trials in WI 2020-2021 (Meadowlark)
- Baking trials in 2020 & 2021



Advanced lines

- **260.06: Rouge de Bordeaux x Warthog**

RdB, a historic winter wheat variety from France with good baking quality crossed to Warthog, a modern hard red winter wheat popular with organic farmers.

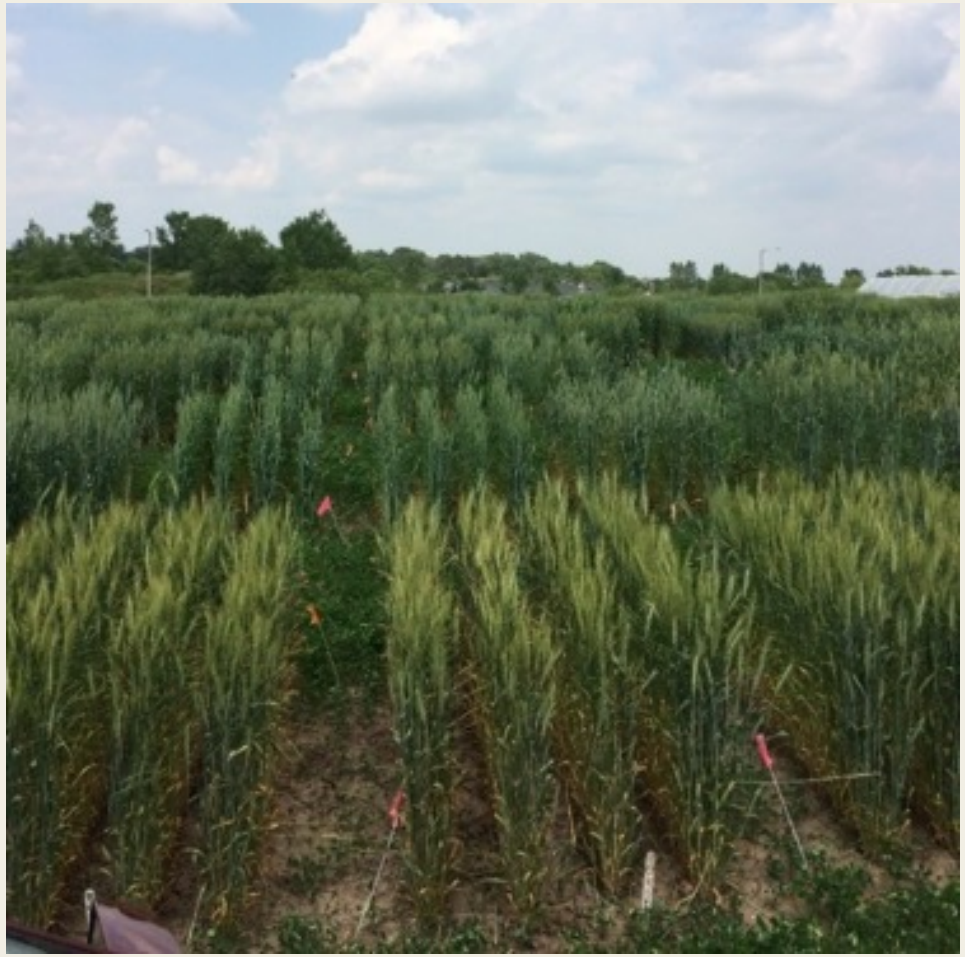
- **47.04 Maxine x Gua**

Maxine, a hard red winter wheat from Ag Canada crossed to Gua, a historic variety that has done well in organic trials in France.

- **212.08: Red Fife x Arapahoe**

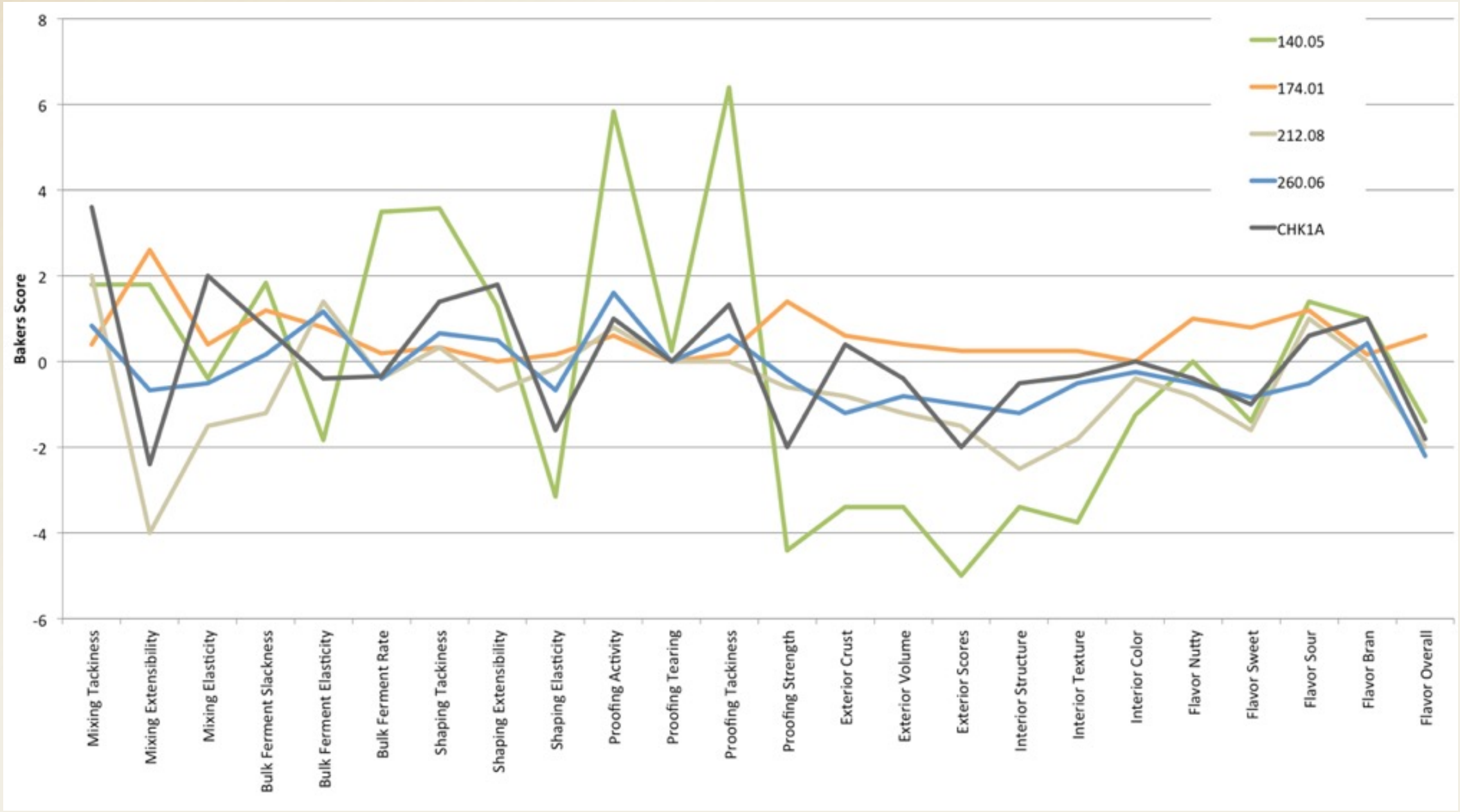
Red Fife, a historic spring wheat from Ontario, Canada, crossed to Arapahoe, a modern hard red winter wheat.

- **140.05: Warthog x Gua**

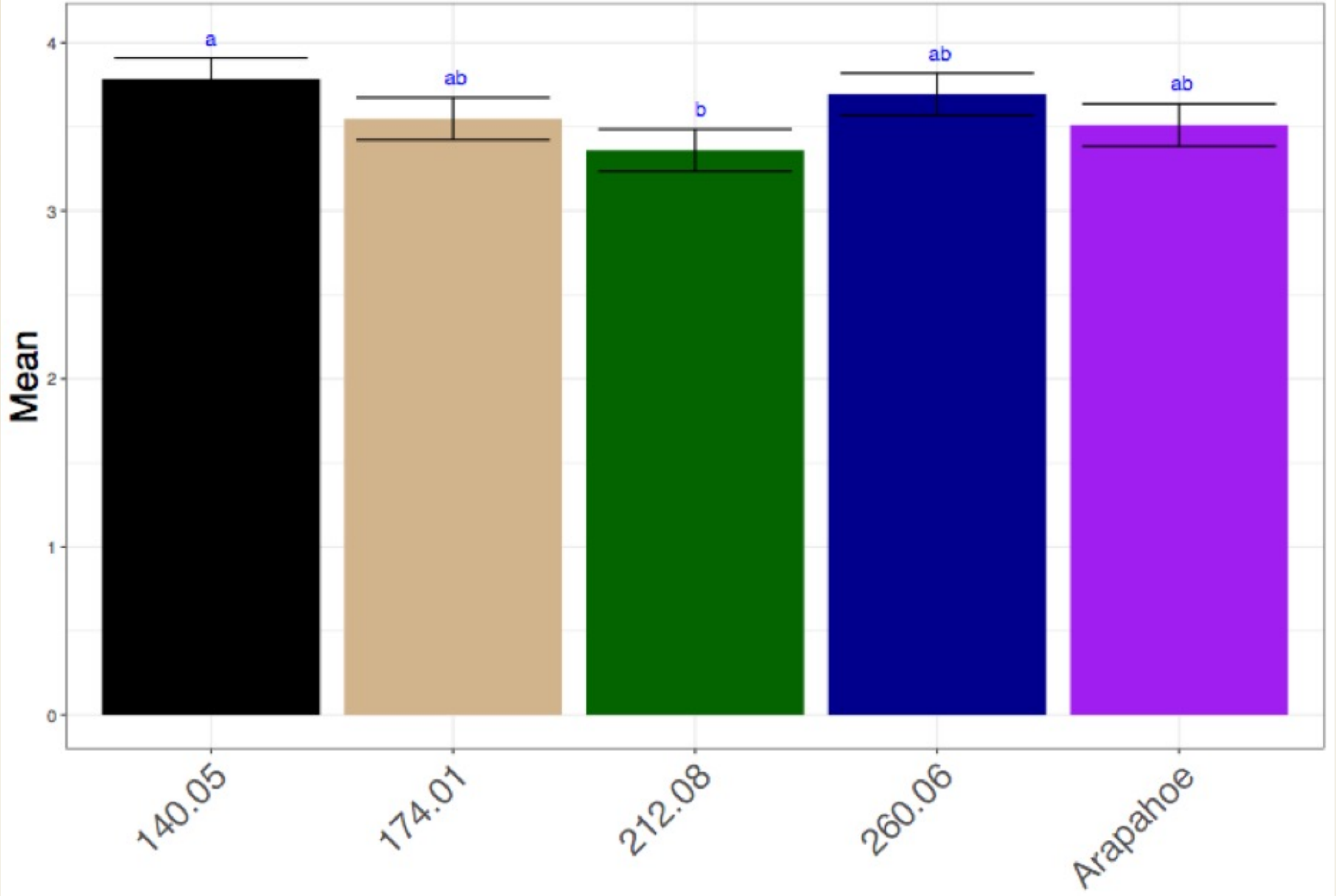


Artisanal baking tests

2020 organic wheat sourdough bake test



Bread Public Tasting Flavor

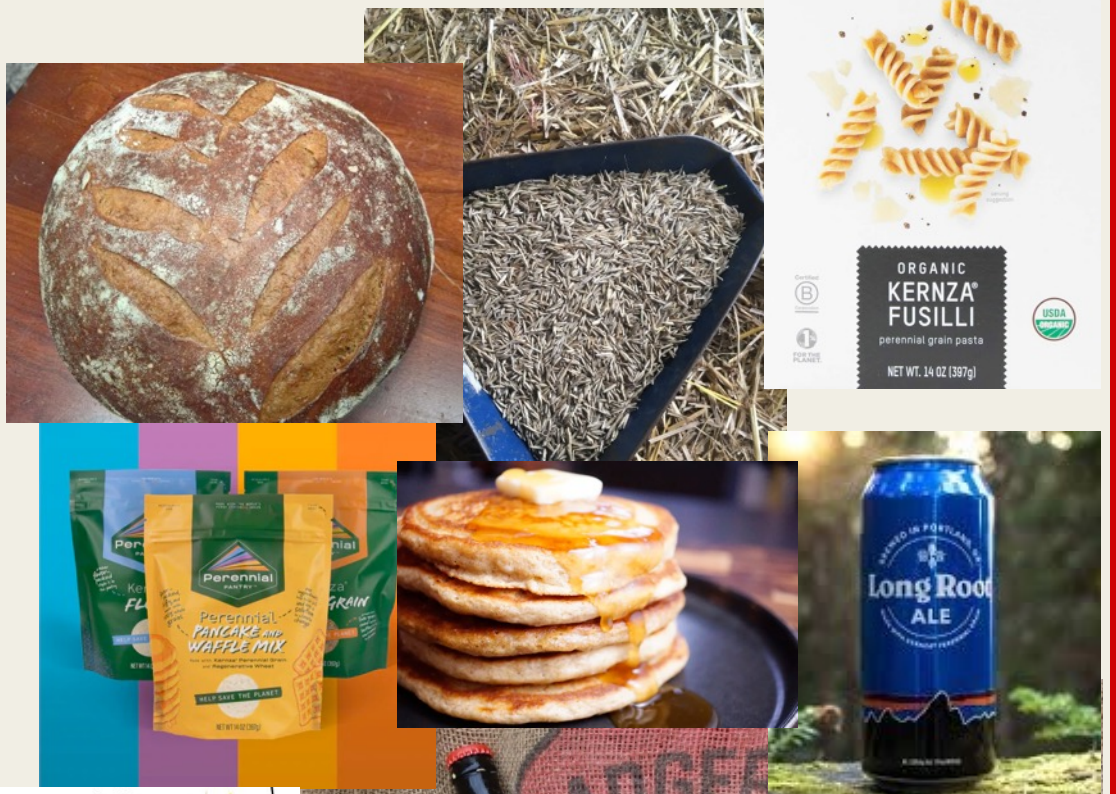


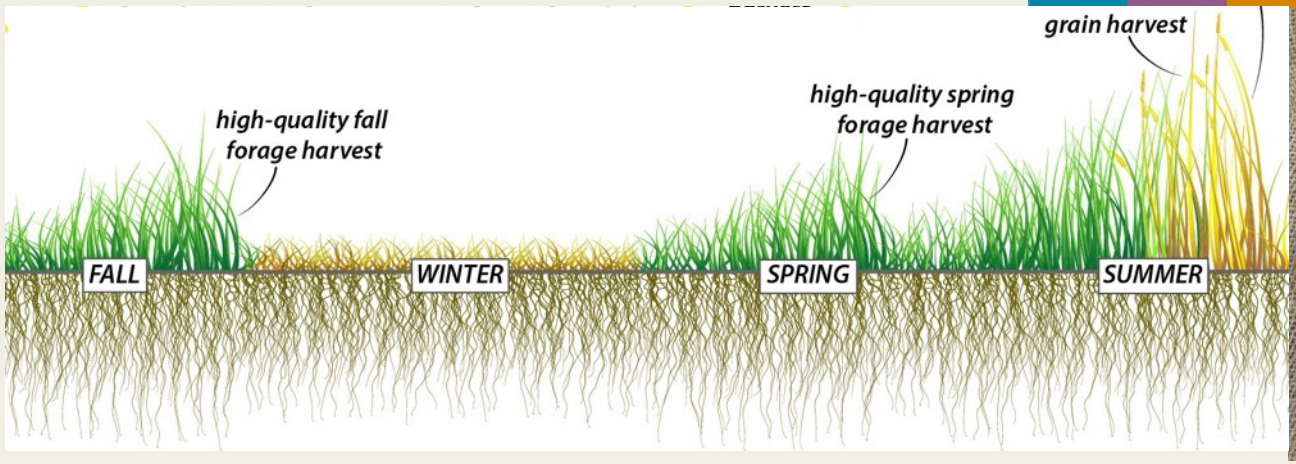
Organic Cereals Field day – Pablo Sandro

- https://www.youtube.com/shorts/fw1KO7cgvxE

Intermediate wheatgrass Kernza® perennial grain

- Forage crop in western US
- Breeding for for increased grain yield (The Land Institute, UMN, UM)
- Deep rooted perennial
- Demand from food sector
- Dual-use: forage and grain





Kernza breeding populations trial at Arlington, WI

16 breeding populations from

- Kansas (TLI)
- Minnesota (UMN)
- Canada (U Manitoba)

Randomized complete block design with 4 reps

	Experiment 1	Experiment 2
Year established	2017	2018
Intercrop species	Alfalfa	Red clover
Planting date	September 29	September 21
Harvest method	Combine	Hand harvest
Data collection	3 years	2 years
Measurements	Grain yield	Grain yield Biomass

Kernza experiment 1 - grain yield combine harvested

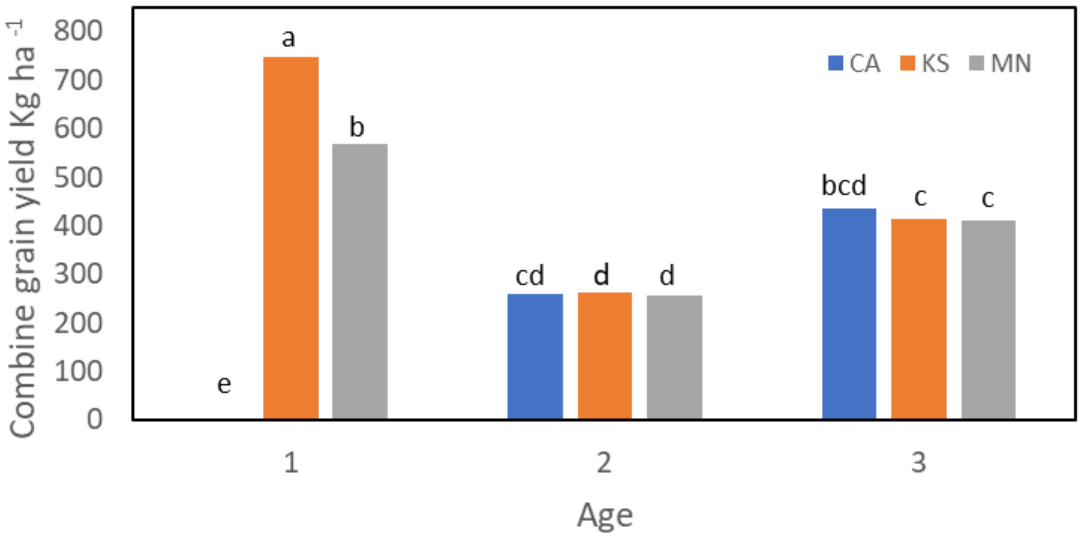
	2018 (age 1)	2019 (age 2)	2020 (age 3)
Population	Combine grain		
	Kg ha $^{-1}$		
MN Cycle 4 - LK1	928 a	255	412
Kansas Cycle 3	911 ab	242	403
MN Cycle 4	832 abc	283	429
KS Cycle 4 - HK1	829 abc	263	360
Kansas Cycle 5	815 abc	298	440
KS Cycle 4 - AK1	780 abc	201	421
MN Cycle 4 - PK1	743 abc	228	415
KS Cycle 4 - AK2	606 abcd	289	413
Kansas Cycle 4	585 abcd	262	429
MN: 1503	536 abcd	277	366
MN: 1501	530 abcd	242	380
MN: 1504	394 bcde	261	472
MN: 1505	339 cde	265	392
MN: 1502	203 de	239	447
CA Early lines	0 e	283	408
CA Late lines	0 e	236	463

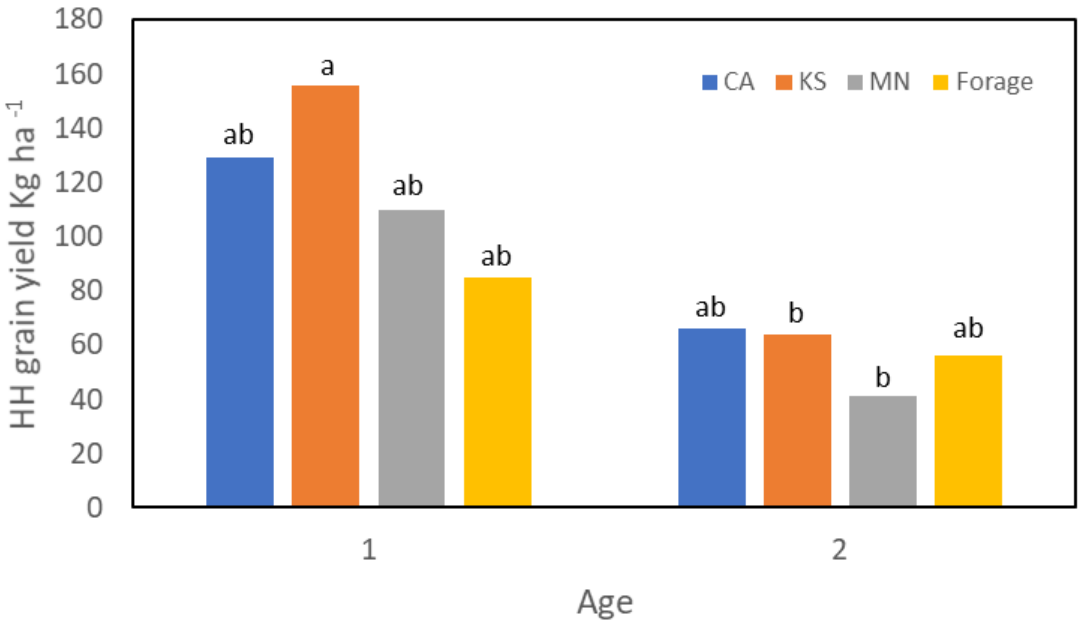
MN Clearwater

Kernza experiment 2 - yield from hand harvested quadrats

Population	2019 (age 1)				2020 (age 2)			
	HH grain	HH IWG	HH Red clover	HH weed	HH grain	HH IWG	HH Red clover	HH weed
				kg ha^{-1}				
KS Cycle 4 - AK5	228	3970 a	1960	628	79	1241	1800	60
MN: 1502	150	3330 ab	1950	969	21	980	1300	-
Rush forage	67	2818 ab	2230	1275	49	1021	2320	71
CA Early lines	150	2639 ab	1720	667	90	1288	2440	17
KS Cycle 4 - HK1	137	2480 ab	1000	486	56	1310	1600	679
Kansas Cycle 5	184	2363 ab	1530	770	61	1578	2040	100
CA Late lines	95	2280 ab	2150	1115	51	980	2280	124
Kansas Cycle 4	165	2252 ab	1640	698	60	1182	1940	195
Kansas Cycle 3	91	2140 ab	1920	473	56	1560	1240	-
MN: 1501	161	1989 ab	1520	905	15	605	2080	30
MN: 1503	83	1840 ab	2100	822	97	1380	2870	63
Oahe forage	109	1670 ab	1560	975	61	1420	1880	72
MN: 1505	88	1385 ab	1980	893	52	688	2250	153
MN: 1504	55	1359 ab	1910	1496	47	1155	2410	205
KS Cycle 4 - AK2	115	972 b	1900	894	84	1454	1780	120

Grain yield by breeding program



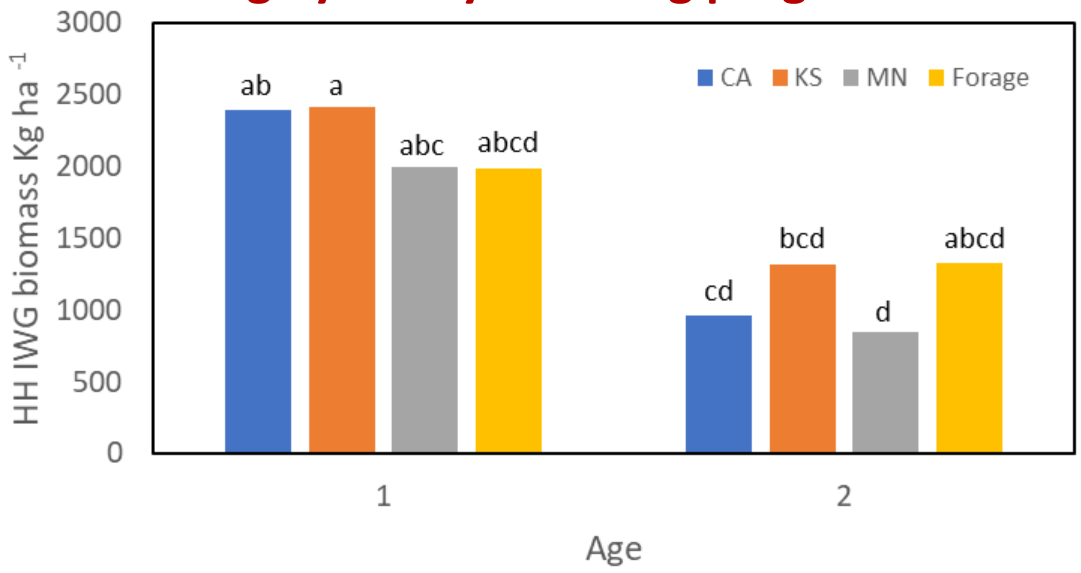


Kansas populations had higher gain yields in first year.

Lower grain yields in 2019 overall

Forage yield was no different across programs.

Forage yield by breeding program



Thank you!

Picasso Lab members,

Gutierrez Lab members,

Dawson lab members

Arlington and West Madison Agricultural Research Stations staff