POTENTIAL FOR PERENNIAL GRAINS

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Reducing the Health Impacts of the Nitrogen Problem

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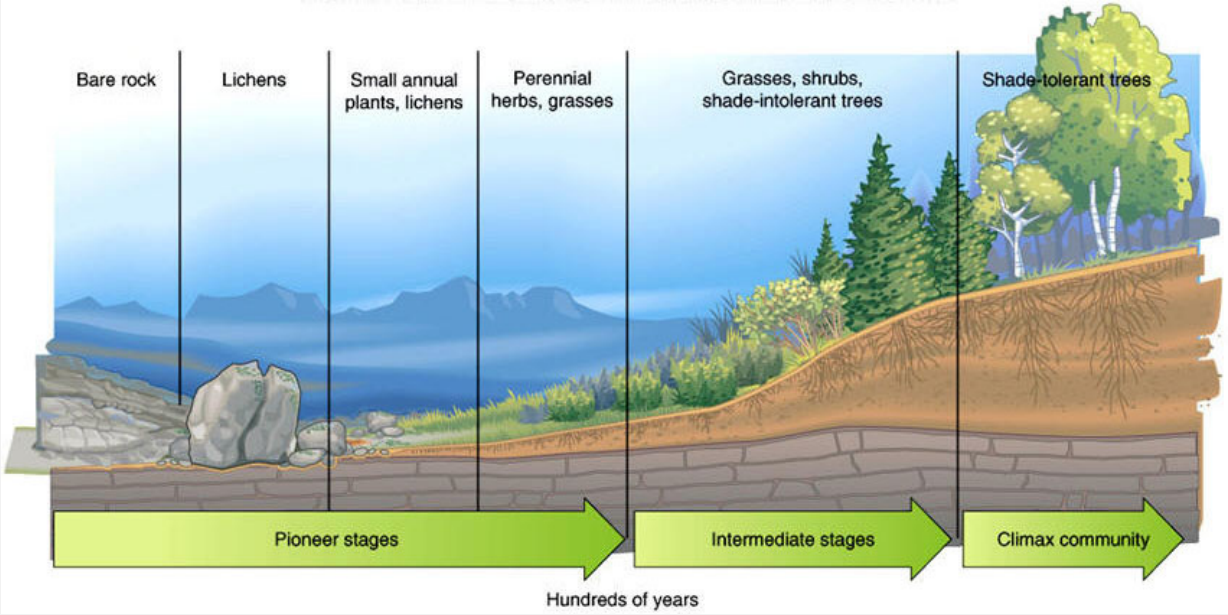
Agriculture: An Arrested State of Disturbance

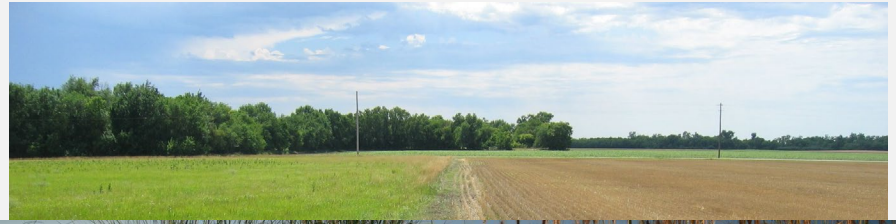
"Humanity's long-standing dependence on a disturbance-based food and fiber producing ecosystem has resulted in degraded soil structure, unsustainable levels of soil erosion, losses of soil organic matter, low nutrient and water retention, severe weed challenges, and a less-diverse or functional soil microbiome."

Crews et al., 2016, Ag, Eco & Env



Perennial grains can shift agriculture from early succession ➔ mid-succession

Perennial Grain Agriculture



Culman et al., 2010, *Ag, Eco & Env*; Glover et al., 2010, *Science*

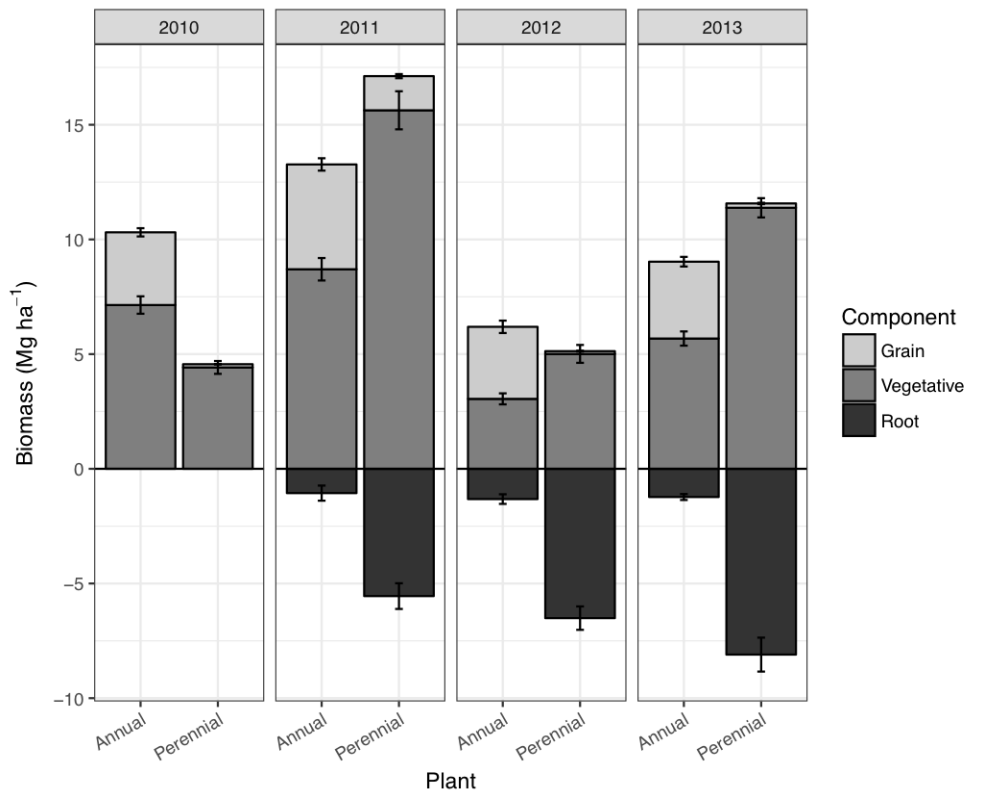
Kernza

Intermediate Wheatgrass
(*Thinopyrum intermedium*)
Domesticated trade name = Kernza






Kernza Root Production – 4 yrs

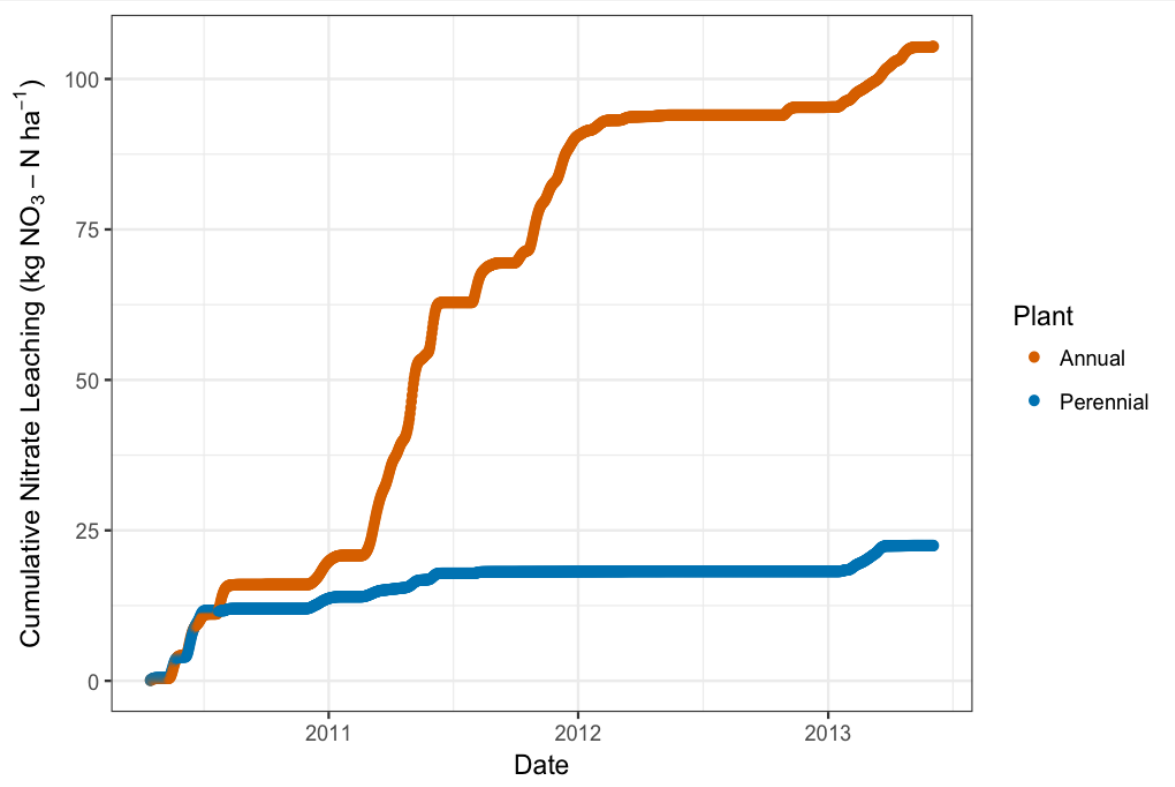


Compared to annual wheat, Kernza had:

- *4.8x more coarse roots,*
  2.6x more fine roots
- *Greater active organic matter pools*
- *More structured soil food webs*

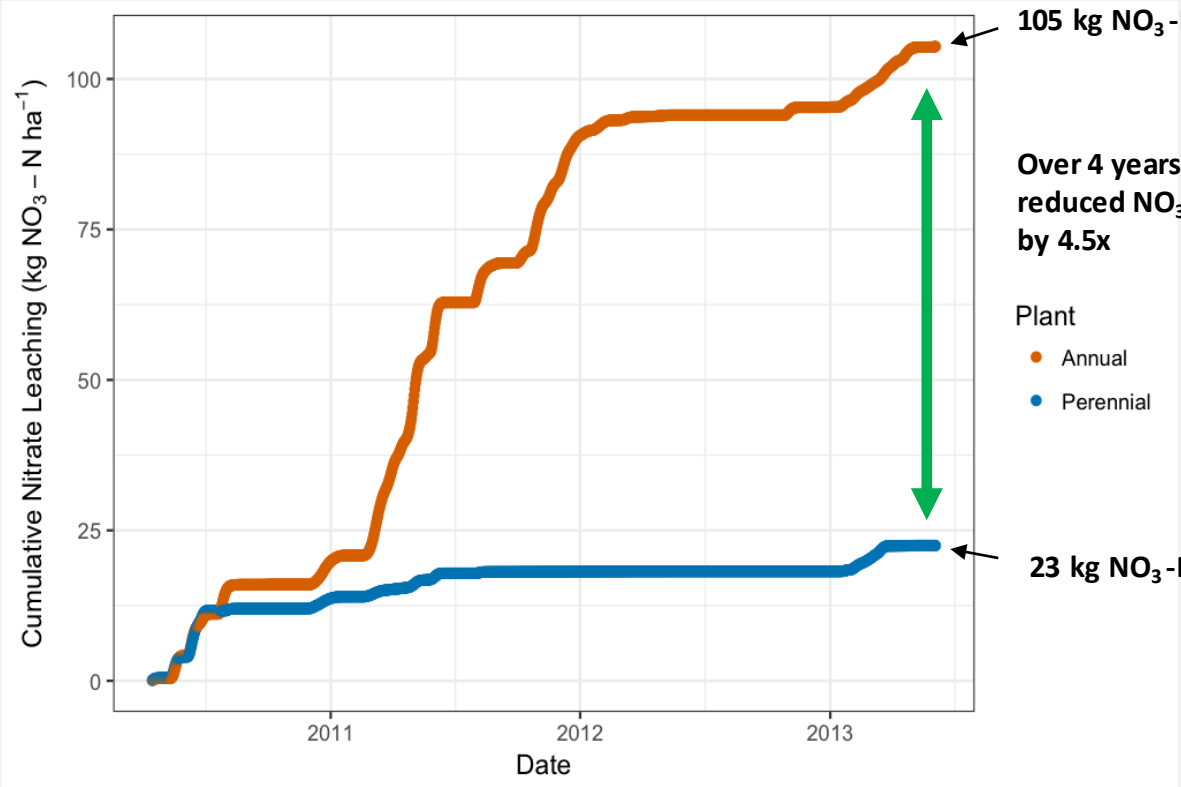
Sprunger et al., 2019, *Soil Bio & Biochem*

Cumulative Nitrate Loss



Culman et al., 2013 Agron J; unpublished

Cumulative Nitrate Loss



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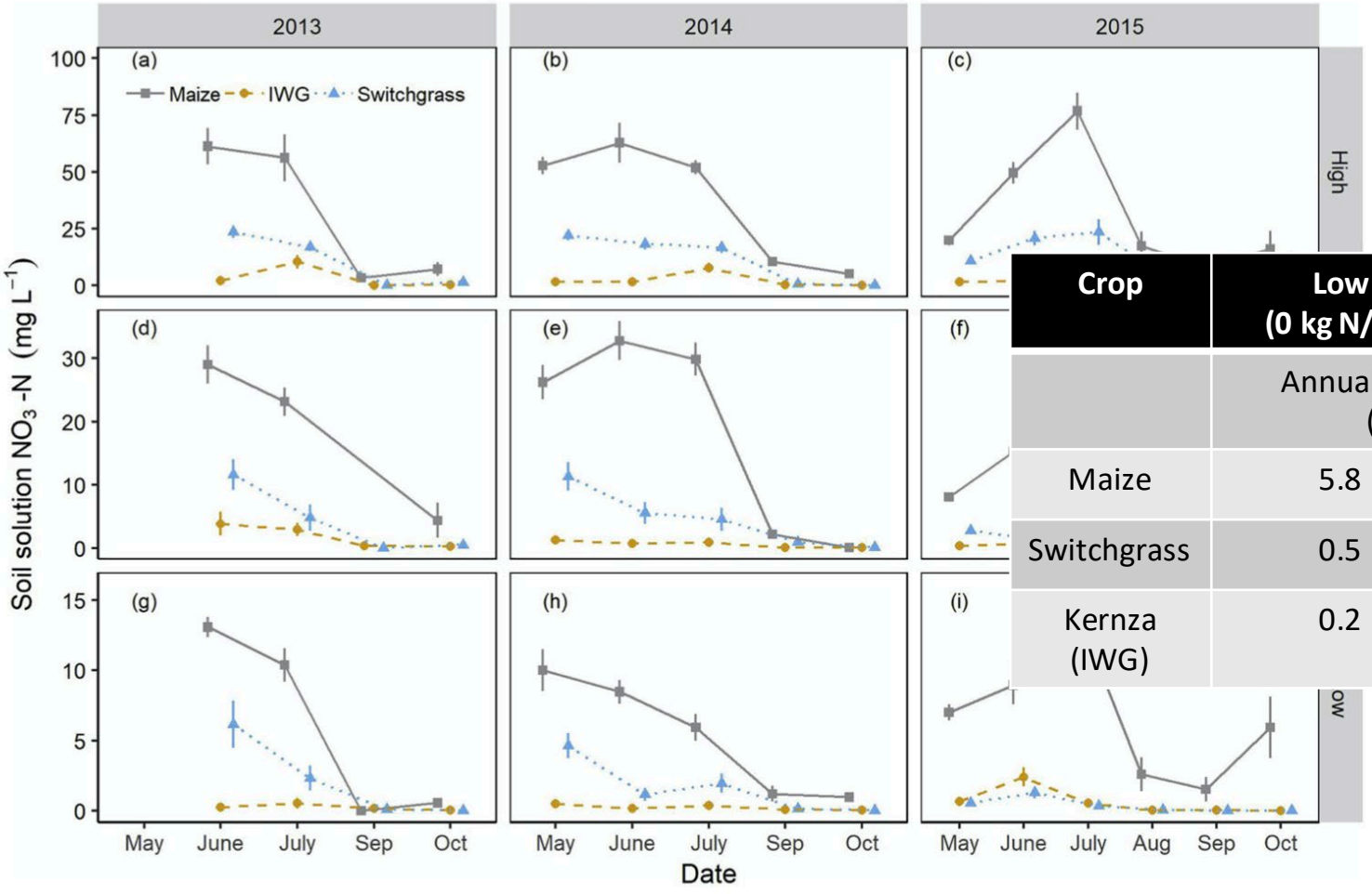
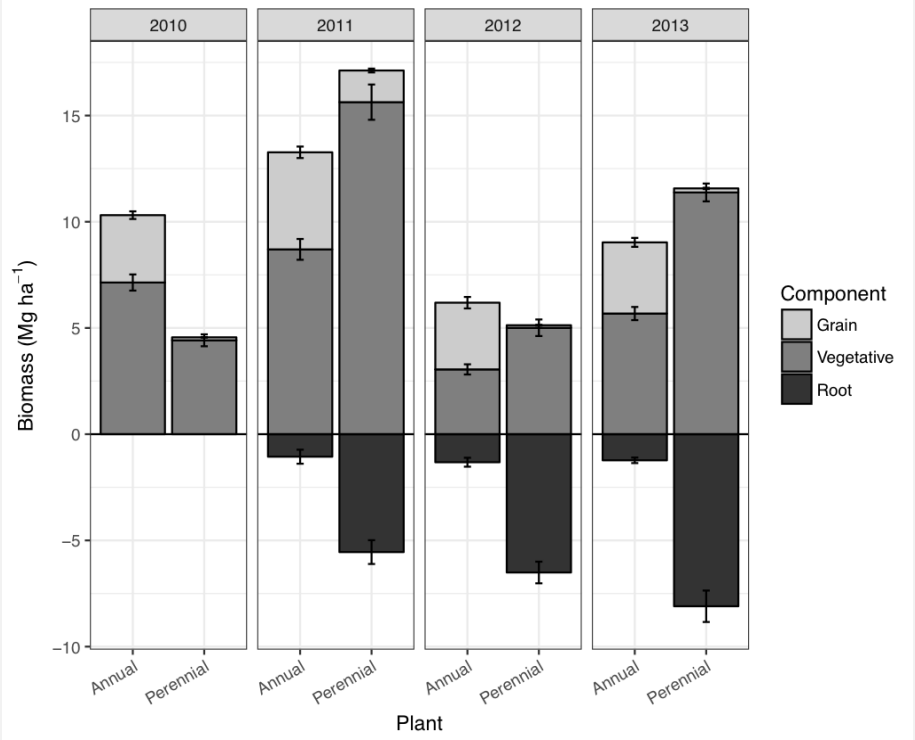


Crop	Low (0 kg N/ha)	High N (160 kg N/ha)
	Annual Nitrate-N Leached (kg N/ ha/yr)	
Maize	5.8	21.7
Switchgrass	0.5	3.7
Kernza (IWG)	0.2	0.2

Jungers et al., 2019 Ag, Eco & Env.

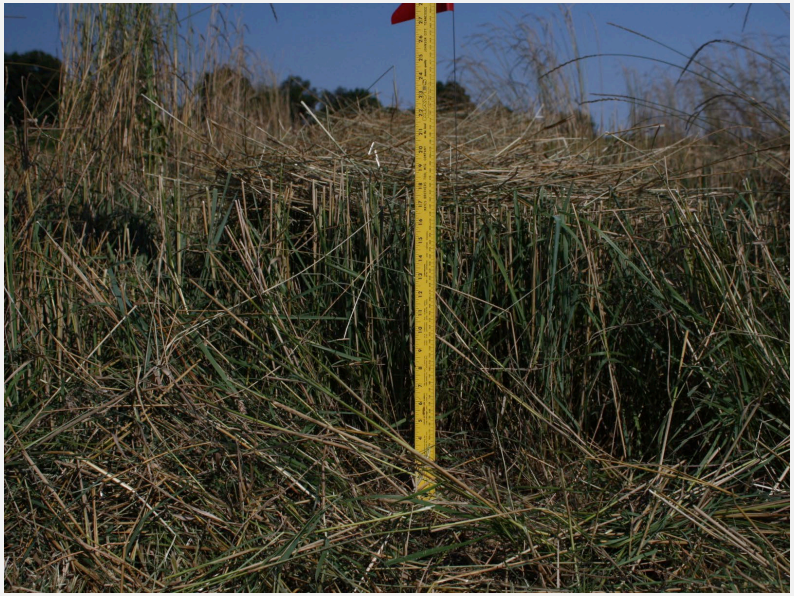
Barriers to Growing Kernza

- Low seed yields
- Decline in seed yield over time
- Markets
- Economics

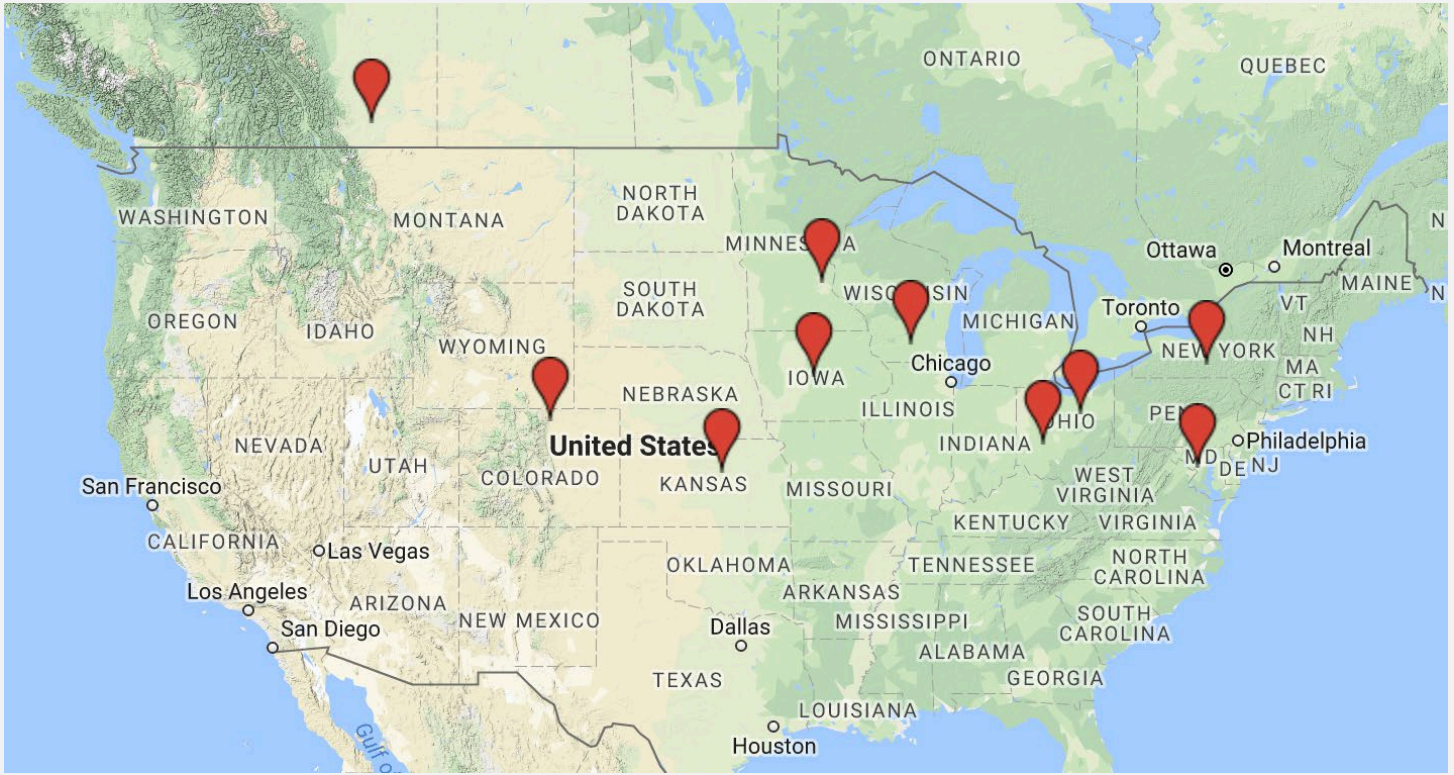


A Dual-Use Solution? Grain + Forage

- Provides two sources of income
- Could help mitigate decline in grain yields with age



Kernza Dual-Use Study



Yields Across 10 Diverse Sites

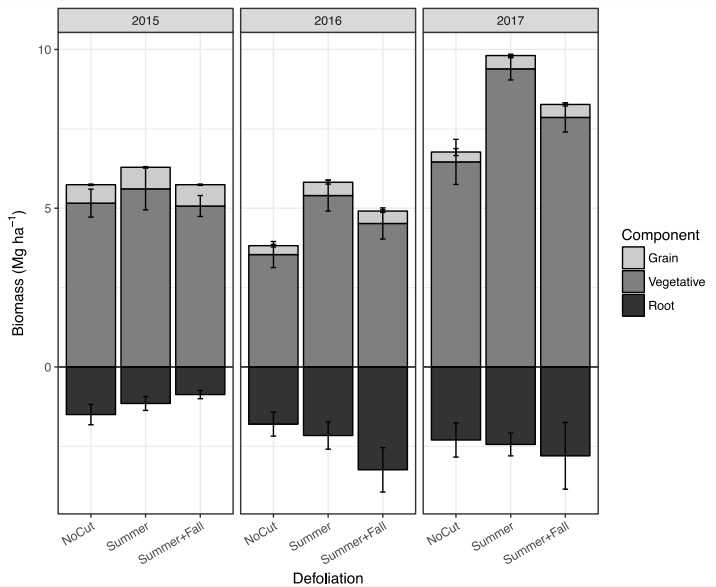
Year	Forage	Grain
	Mg ha^{-1}	*kg ha^{-1}*
First	6.33 (0.33)	768 (23)
Second	4.64 (0.20)	294 (29)
Third	5.85 (0.33)	225 (19)

Clipping Forage:

- Did not reduce grain yields

Culman et al., unpublished

Ohio



Clipping Forage:

- Increased root and shoot production
- Increased N cycling

Pugliese et al., 2019, Plant and Soil

Summary Thoughts

- Kernza first true commercially-viable perennial grain crop, but work remains on many fronts
- Reductions in N losses are promising, but need to balance with breeding efforts for grain yields
- Kernza can serve a role now: highly erodible slopes, buffer strips, etc.

Collaborators: Lee DeHaan, Sieg Snapp, Christine Sprunger, Ariane Peralta, Mary Ollenburger, Bruno Basso, Tianna DuPont, Jennie Pugliese, Mark Sulc, Jamie Larsen, Meagan Schipanski, Mary Wiedenhoeft, Tim Crews, Jake Jungers, Craig Sheaffer, Matthew Ryan, Sandra Wayman, Valentin Picasso, Muhammet Sakiroglu, Jude Maul

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