Kernza Agronomics and Ecosystem Services

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Environmental impacts of cropping systems

Perennial Crop

Crop production

Natural enemies

Climate and air quality

Carbon sequestration

Water quality

Pollinator resources

Habitat and biodiversity

Water quantity

after Foley et al., 2005
Kernza Crop Production Research

Agronomic experiments
• Dual-use study
• Preventing grain yield declines with defoliation

Environmental impacts
• Water quality benefits
• Carbon sequestration

Overview of Breakout Session
Kernza Annual Forage Yields Under Dual-Use
Kernza Grain Yield

![Bar chart showing Kernza grain yield for the first and second year with different cutting treatments.](chart.png)
Kernza Grain Yield
Kernza Crop Production Research

Results:

• Fall defoliation prevents grain yield declines with stand age
• Fall defoliation increases root biomass
Nitrate Leaching and Groundwater

Nitrogen Fertilizer

Unsaturated Zone

Nitrogen Leaching

Groundwater
Nitrate Leaching and Groundwater

Well water
NO₃ (ppm)

- Yellow: 3-10
- Red: > 10

Prepared by the Minnesota Department of Health, October 21, 2014
Nitrate Leaching and Groundwater

**Irrigation boosts potatoes, but Park Rapids pays more for water**

Dan Gunderson · Park Rapids, Minn. · Feb 13, 2014

**Tainted drinking water is costing Minnesota taxpayers millions**

Randall's water emergency is the latest sign of an environmental problem in Minnesota. Nitrogen fertilizer is leaching into groundwater from farm fields, contaminating wells and costing taxpayers millions of dollars a year.

By Tony Kennedy Star Tribune · APRIL 29, 2015 — 12:24PM
Nitrate Leaching and Groundwater

Nitrogen Fertilizer

Unsaturated Zone

Nitrogen Leaching

Groundwater
Kernza and Water Quality

Jungers et al., in prep

![Graph showing soil water nitrate (mg l⁻¹) over different dates with lines representing Corn (160 kg N/ha), Kernza (60 kg N/ha), and Switchgrass (120 kg N/ha).]
Kernza and Water Quality

40 acre Kernza planting in an instrumented wellhead protection area. Land owned by Lincoln-Pipestone Rural Water Supply and was previously farmed in corn and soybean.
Kernza and GHG mitigation

Objective: Determine the GHG footprint of Kernza

Experiments

• Stand maintenance: inter-row cultivation/disturbance
• Grazing
• Legume intercropping and N fertilization
Kernza and GHG mitigation

Measurements

• Crop yield & growth parameters
• Belowground biomass
• Labile C pool
• Microbial activity
Kernza and GHG mitigation

Measurements
• Soil GHG emissions
Kernza production and GHG mitigation

Objectives: Use ‘DayCent’ to simulate Kernza yield and C dynamics

Data inputs
- Land cover: CDL
- Soil: SSURGO
- Climate: DayMet
Kernza production and GHG mitigation

Simulate annual row crop production and GHG emissions
Kernza production and GHG mitigation

Simulate Kernza production and GHG emissions where annual crops are underyielding
## Kernza production and GHG mitigation

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Area Affected</th>
<th>Total Kernza Production</th>
<th>Difference in Annual Crop Production</th>
<th>Difference in Economic Value</th>
<th>Difference in GHG mitigation</th>
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</thead>
<tbody>
<tr>
<td>Replace all annual crop land that yields 10% less than county average</td>
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<tr>
<td>Replace all annual crop land grown within 100 meters of surface waters</td>
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<tr>
<td>Replace all annual crop land in wellhead protection areas</td>
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Kernza Agronomics Breakout Session

High priority agronomic research questions:

• Organic weed management during establishment year
• Harvest timing and techniques
• Agronomic methods for sustained grain yields
Kernza Agronomics Breakout Session

Action Items:

• Design a simple protocol to document Kernza stage and stand characteristics at harvest. Share info.

• Develop repository of experiments to share with researchers.
  – Include details on establishment and maintenance
Kernza Agronomics Breakout Session

Conduct research that connects GHG mitigation, climate change resiliency, and farmer profitability.
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• The University of Minnesota Forever Green Initiative
• SARE
• Ceres Trust Fund
Modeling Kernza GHG mitigation

Objectives: Parameterize ‘DayCent’ crop and carbon simulation model

Aboveground Biomass Calibration using 9 site-years of data.

Validation using 21 site-years of data.
Modeling Kernza GHG mitigation

Objectives: Parameterize ‘DayCent’ crop and carbon simulation model
• Aboveground biomass
• Belowground biomass
• Soil moisture
• Soil C dynamics
Annual crops

Nitrogen Fertilizer

Nitrate in drinking water

Well nitrate contamination

Nitrate leached to groundwater

Groundwater
Kernza and GHG mitigation

![Graph showing the relationship between time and N2O concentration with different treatments.](image)
Fertilized June 1