Perennial Grains at Cornell
Learning from and with farmers

Sandra Wayman, Eugene Law
Sustainable Cropping Systems Lab
Cornell University
2nd Annual Kernza Conference, Green Lands Blue Waters, July 2017
July 2016: Kansas Kernza Conference
Topics

• Planted 3 on-farm trials
• Tiny update on the Culman experiment
  • Yields in 2016
  • Got our first fall cut in 2016
• Farmer perennial grains survey
• Ergot
• Eugene’s intercropping work
Questions for the group

• How do grain heads develop? At what rate? Evenness across field? Difference by age of plants?
• What do people use to store seed? How long does it last? Difference in storage for re-planting vs. food use?
• What are the trade-offs with spring seeding vs. fall seeding?
• Has anyone tried a nurse crop with Kernza?
• Forage quality numbers to trust? Which method is best? Not NIR...?
• Have other people had ergot in their stands?
• Combine settings: cylinder to concave clearances, cylinder speed, any chaffer or sieve to put in there, air level?
New on-farm trials
On-Farm Fall 2016 Plantings

• 3 organic grain farmers in Fingerlakes area
  • Klaas Martens, Lakeview Organic Grain
  • John Myer, Myer Farm and Distillery
  • Thor Oechsner, Farmer Ground Flour

• ACE1 Perennial Rye and Kernza planted
  • Under an acre for each crop

• Farmer-driven research questions
  • Swathing vs. Direct Combining (Thor)
  • Influence of fertility application (John)
  • Kernza Seeding rate (25 vs. 15 lb/ac, Klaas)
# On-Farm Seeding

<table>
<thead>
<tr>
<th>Farm</th>
<th>Equipment</th>
<th>Planting Date</th>
<th>Actual seeding rate (lb/ac)</th>
<th>Area covered</th>
<th>Drill Setting</th>
<th>Actual seeding rate (lb/ac)</th>
<th>Area covered (ft)</th>
<th>Drill Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thor</td>
<td>10-foot IH5300 grain drill</td>
<td>9-9-16</td>
<td>23</td>
<td>400x80ft 0.73 acre</td>
<td>12</td>
<td>95</td>
<td>400x60 0.55 acre</td>
<td>12</td>
</tr>
<tr>
<td>Klaas</td>
<td>Amazone Airstar Prafi</td>
<td>9-21-16</td>
<td>Targeted 15 lb/ac 25 lb/ac</td>
<td>290x60ft (low rate) 290x60 (high rate) aka 0.40 acre each</td>
<td>0 (15 lb/ac) 8 (25 lb/ac)</td>
<td>50</td>
<td>120x290 0.80 acre</td>
<td>6</td>
</tr>
<tr>
<td>John</td>
<td>Case III 5400 No-till Drill</td>
<td>9-15-16</td>
<td>14</td>
<td>75x600ft 1 acre</td>
<td>12</td>
<td>51</td>
<td>60x600 0.83 acre</td>
<td>12</td>
</tr>
</tbody>
</table>

**Planting Notes**

**Thor**: half inch rain the day before, but field had previously been “talcum powder” dry.

**Martens**: drill is not accurate under 40 lb/ac rate. Field was rolled after planting. Klaas only field site to plant 2015 Archarya ACE1 lot.

**Myer**: fairly dry planting conditions.
Planting

John’s

Thor’s (very rocky)

Klaas’
Establishment
(30-days after planting)
Thor’s, 1 month after planting

Kernza

ACE1 Rye
Myer’s, 41 days after planting

Kernza

ACE1 Rye
Marten’s, 35 days after planting

It was hard to tell grass weeds from rye.
Farmers’ Impressions fall 2016
Early thoughts about perennial grains on their farms

• Thor:
  • Heard about Kernza years ago and excited about trialing it. Skeptical of the “pathetic” looking Kernza in the fall. Is interested to see how Kernza does on “poor” fields.

• John:
  • Also really interested and curious. So far pretty quiet about the process. Interested in distilling ACE1 rye.

• Klaas:
  • Compares Kernza to emmer and cheatgrass. Concerned about small seed size. Thinks that forage will be important for Kernza success.
Kernza left, Rye right
John, 4-21-17

Kernza →

Rye →

Kernza row
John – great rye, poor Kernza
Thor – Kernza was mostly field pennycress

Kernza, May 2

Kernza, June 8
Thor – ACE1 rye looks great
What happened with the Kernza?

• Wrong planting depth? (0.5 in)
• Very dry at time of planting
• Needed better weed control?

• What can we learn for next time?
A moment for a Culman study update
Kernza growth stage ranged from V0 to V2 at the fall clip, 10-18-16 (Moore, 1991)

Fall forage was only harvested in 2016, because in 2015 the plants did not mature sufficiently past summer harvest to safely cut for fall forage.

Culman study

776 lb forage/ac

555 lb forage/ac.
Culman study
planted August 2014 (snapshots June 28 2017)

Control, N80, Block 1

Summer, N120, Block 1
Lodging (for the first time in the experiment)
Perennial Grains Survey

Conducted spring 2016
Survey on perennial grains

- Farmers & Processors
- Gauge interest and current knowledge
- France and USA
- Christophe David
- To inform research and market goals
- 407 farmer responses
- Be aware of survey bias
Some example questions for farmers

• Farm size, organic vs. conventional, crops produced...

• What top 2 soil issues are you most concerned about?

• Given the potential challenges associated with perennial grain production, what would be your top 3 concerns?

• What level of interest do you have in growing perennial grains? ("definitely not interested" – "very interested")
Table 1. Proportions of respondents by farm type, farm size, and production type.

<table>
<thead>
<tr>
<th>Farm Type</th>
<th>Farm Size</th>
<th>Production type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Small¹</td>
<td>Medium¹</td>
</tr>
<tr>
<td>Conventional</td>
<td>44%</td>
<td>10%</td>
</tr>
<tr>
<td>(n=20)</td>
<td>(n=39)</td>
<td>(n=9)</td>
</tr>
<tr>
<td>Organic</td>
<td>69%</td>
<td>50%</td>
</tr>
<tr>
<td>(n=61)</td>
<td>(n=159)</td>
<td>(n=101)</td>
</tr>
<tr>
<td>France</td>
<td>21%</td>
<td>63%</td>
</tr>
<tr>
<td>(n=68)</td>
<td>(n=202)</td>
<td></td>
</tr>
</tbody>
</table>

¹Small: under 100 ha; Medium: 100 to 200 ha; Large: above 200 ha

(Could choose multiple production types)

Range of farm sizes
Farmer survey responses

319 French farmers

88 USA farmers
Farmer interest in perennial grains by country

χ²=16.1
P=0.003
USA n=76
France n=267
Farmer interest in perennial grains by farmer type

χ² = 10.1
P = 0.04

- Conventional (n=80)
- Organic (n=220)

<table>
<thead>
<tr>
<th>Interest Level</th>
<th>Conventional</th>
<th>Organic</th>
</tr>
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<tbody>
<tr>
<td>Definitely not interested</td>
<td>10%</td>
<td>5%</td>
</tr>
<tr>
<td>Not interested</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>Interested</td>
<td>40%</td>
<td>55%</td>
</tr>
<tr>
<td>Very interested</td>
<td>30%</td>
<td>25%</td>
</tr>
<tr>
<td>Need information</td>
<td>15%</td>
<td>15%</td>
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Farmers’ potential concerns about perennial grains

- Increased pest problems (weeds, diseases, insects) **
- Low grain yield
- High cost of seed
- Lack of market to sell the crop
- Low profitability **
- Specialized equipment requirements
- Decreased grain yield over time/limited crop life span **
- Difficulty harvesting *
- Low seed availability
- Low grain quality *

Frequency of being selected as one of top three reasons

Organic vs Conventional
### Farmer agreement with 3 statements on perennial grains

<table>
<thead>
<tr>
<th></th>
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<th>Neutral</th>
<th>Disagree</th>
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<tr>
<td>Organic</td>
<td>148</td>
<td>55</td>
<td>12</td>
</tr>
<tr>
<td>Conventional</td>
<td>36</td>
<td>22</td>
<td>18</td>
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- I am interested in dual-purpose perennial crops that can be harvested for both grain and forage

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<tr>
<td>Organic</td>
<td>113</td>
<td>62</td>
<td>40</td>
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<td>22</td>
<td>20</td>
<td>34</td>
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- I would grow perennial grains to provide environmental benefits even if they were not as profitable as other crops

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- Research funding should be spent on annual grain crops rather than developing new perennial grain crop

#### Percentage of respondents by each response

0% 20% 40% 60% 80% 100%
Important points from survey

• Farmer interest in dual-purpose crop
  • Likely very important for adoption/economics

• Top motivations:
  • Economic profitability
  • Reduce input use
  • Soil health improvement

• Conventional farmers interested in economics of perennial grains; organic farmers interested in environmental benefits
Ergot
Ergot (*Claviceps purpurea*)

- A fungus, makes “sclerotia” in place of a grain head
  - In Kernza the hull can’t form
  - Transmitted by coming in on seed, blowing in from neighboring field
  - Contains toxic alkaloids
- 0.1% in 30 gram sample is FDA allowance
- Wheat is considered “ergoty” if it contains 0.05% (USDA Grain Inspection Handbook)
- Swiss chemist A. Hoffman wanted to make medicine out of ergot in 1938, found lysergic acid. LSD is purely synthetic but based off ergot compound.
• Ergot incidence worse in wet year
• Cleaning it out?
  • Gravity table, color sorter, floating
• Baking does not break down toxin
• Ergoty grain can be used for distilling, but byproduct should not be fed to cattle.
• Controlling ergot?
  • Rotation (hard with perennials)
  • Ergot incidence worse in wet year
  • Mow field edges because grasses there could host it
  • Use an ergot-free seed source (that’s a way it comes in)
  • Don’t harvest edge of field (Lee)
PhD Candidate Eugene Law
Intercropping in Perennials and Annuals

Comparing Kernza, perennial rye, winter wheat, and winter barley over three growing seasons

Planted September 2016, medium red clover interseeded March 2017

Data Being Collected:

- Grain yield
- Aboveground biomass / potential forage yield
- Weed, disease, and insect problems
- Soil health and erosivity
- Energy, labor, and material usage
Grain Legume Intercropping in Kernza

Food-grade soybean and field pea intercropped with 4-year-old Kernza

Questions:
- Does strip tillage stimulate Kernza growth or reproduction?
- Is there complementarity between Kernza and grain legumes as intercrops?
- How do strip tillage and intercropping affect pests?
- Does intercropping affect overall cropping system productivity/profitability?
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