

## Final report

**Title: Fostering complex soil food webs and building soil fertility with organic production: perennial wheat PHASE TWO**

**Principal Investigator:** Sieglinde Snapp, Soil and Cropping Systems Ecologist, Professor, Department of Plant, Soil and Microbial Sciences Michigan State University, snapp@msu.edu

**Co-Principal Investigator:** Vicki Morrone, Organic Vegetable and Field Crop Outreach Specialist, Michigan State University, sorrone@msu.edu

**Collaborators:**

Lee and Linda Purdy, *Farmer Educator, Westwind Milling and Organic Grain Farmers*

### SUMMARY

Blog posts have been posted on the Michigan State perennial grains website that summarize assessment by researchers and farmers engaged with perennial grains ([www.pwheat.anr.msu.edu](http://www.pwheat.anr.msu.edu)). Twelve interviews of farmers and researchers were conducted in 2016 to document preferences and experiences of those engaged in production and research on intermediate wheatgrass (including the grain Kernza®). The interviews spanned a geographic area that encompassed 7 states and Canada. The farmers that we interviewed have different levels of expertise with perennial grains (Table 1). We have summarized perceptions of the production challenges and future opportunities associated with perennial grain crops and dual purpose intermediate wheat grass. Interviews with plant breeders and scientists documented that significant progress has been made with breeding Kernza® and identifying recommended agronomic practices. Despite this progress, there remain challenges and unanswered questions with this new perennial grain crop. As one researcher said “Programs are doing what they need to be doing. Right now there’s a need for answering the basic agronomic questions. It is still a new crop but it will be helpful to have long-term projects that assess how the stand ages over time.”

Three themes surfaced through the interviews: **First, production of Kernza surprisingly posed only a few challenges**, as farmers have been able to surmount issues that have emerged, such as those related to small seed size and initially slow establishment. Seed yield is quite low compared to wheat, but farmers expressed interest in the value of growing a perennial crop, for ecological and economic values. Fortunately, most farmers have been able to carry out Kernza production using standard grain equipment, which is promising as seed yields continue to increase with each breeding cycle.

**Second, the grain yield falls off in the third year**, this was the one aspect that farmers were highly concerned about, and researchers are actively implementing experiments to extend the life of the stand. A past Michigan State graduate student noted “As the plants age, they invest fewer resources into seed production and more into the ability to withstand cold stress in winter, late fall and early spring. Older plants produce less seed per plant than younger plants, devote a smaller fraction of their total carbon budget to seed production, and have a lower photosynthetic capacity under warm, more favorable conditions. However, they have higher photosynthetic capacity and higher levels of enzymes related to stress tolerance during cold conditions in winter. “ From this we can

see that this crop can grow in colder regions but may only be used as a semi-perennial in some regions. Perhaps if the crop is grown in a more moderate climate it will produce grain for a greater number of years.

**The third point was that farmer interest in this crop continues to grow across the Midwest region.** Farmers are excited about the possibility of a dualpurpose crop, though many are still skeptical about factors such as weeds, pests, diseases, and the small seed size. Weeds are the greatest challenge for organic farmers, especially to manage them after the first season (as tillage is not possible). But researchers point out that farmers who are interested in growing Kernza need to continue to experiment and give the crop time to be developed, and to succeed. A scientist at The Land Institute said, “We need farmers who are willing (and able) to take risks and are not afraid of taking on these types of challenges. Since it’s not a commodity crop with clear markets, the farmer has to deal with uncertainty. Also the farmer has to be able to give it the time to do well—if they’re growing only 5-10 acres on the side, it might be easy to forget about it.”

*Future directions:* We plan to continue to share the content of these interviews on the MSU perennial grains blog ([www.pwheat.anr.msu.edu](http://www.pwheat.anr.msu.edu)). Also, planned for this summer is a field day at our Michigan-based on-farm site with Randy Hampshire, co- owner of Hampshire Family Farms in Kingston, Michigan. He is growing the Intermediate wheat grass for grazing by his dairy cows and for grain to mill for his commercial breads.

### **Objective 1. Expand farmer involvement through establishing on-farm experiments and expanded outreach through field days, website and educational materials.**

This phase of the Ceres supported perennial wheat and intermediate wheatgrass (Kernza) research focused on working with organic farmers to evaluate the variations and application opportunities associated with these new crops. The impetuosity of this action is that farmer objectives and soils are variable across farms so and have a strong impact on the grain in terms of how it germinates, grows and produces and overwinters. Beyond the biological implications, organic farming practices vary greatly and so our intent has been to seek innovations that can help to better manage these novel crops under organic management. The perennial wheat lines have proved to not be suitable for perennial production in Michigan, but the intermediate wheatgrass continues to show promise.

#### ***Organic Farmer Educational Meetings***

Initial educational opportunities included four meetings and field days held Midwest farmers in 2014 which provided over 300 farmers information on our findings to date. One talk was on Feb 13, 2014 at a University of Minnesota symposium on ‘Enhancing cropping system performance under increased environmental variability’ which provided an opportunity for Sieg Snapp to report on perennial wheat and IWG effects on soil water quality, soil organic matter and generally on performance of these new crops.

Vicki Morrone and Sieg Snapp reported on perennial wheat and Kernza at the MOSES meeting, to an audience of over a hundred (certified organic, transitioning and sustainable farmers) in LaCrosse Wisconsin March 28<sup>th</sup>, the Friday II session. The title of our session was: **F2B- Multipurpose Perennial Grains for your Farm, Sieg Snapp and Vicki Morrone.**

In Michigan, the Soil and Water Conservation Society asked Sieg Snapp to speak March 7<sup>th</sup> on perennial cover as a critical ingredient for soil and water quality. Vicki Morrone organized the Michigan Organic Reporting Session (also on March 7<sup>th</sup>, 2014, MSU campus, East Lansing, MI), which included discussion of Michigan organic farmer priorities. Soil quality as well as the need for new market opportunities for novel crops such as perennial wheat are two important issues that emerged.

An important extension education achievement in 2014 was production of the first ever Extension Bulletin that summarizes the knowledge to date on perennial wheat. It is attached to this report, and was distributed at the MOSES meeting to interested farmers. It is also available at <http://pwheat.anr.msu.edu>

Snapp, S.S. and V.L. Morrone. 2014. Perennial wheat Michigan State University Extension Bulletin. E3208

In 2016, interviews were conducted to follow up on perceptions of researchers and farmers engaged with growing and testing intermediate wheatgrass (12 interviews, see table 1.) As described in the summary, the findings show continuing and expanding interest in this new dual purpose crop despite the challenges, and the need for better varieties that can persist for more years and continue to produce grain yield into the third and fourth year.

The findings from the interviews will be presented through a poster at the Agriculture and Natural Resources Week at Michigan State University to share with the MSU Extension educators (3/1/17) and at the Michigan Organic Reporting Session, an educational event for farmers and researchers on organic production that hosts hundreds of participants each year (3/10/17). A poster will depict the progress of research on Intermediate Wheat Grass and Kernza® in North America from the last 30 years in the form of a timeline, highlighting researchers and institutions that have been instrumental in the progress of this crop's development.

Interview Number	Researcher, Farmer	State	More information
1	Researcher	Kansas	Plant breeder
2	Researcher	Michigan	Farm manager and agronomist
3	Researcher	Illinois	Crop Scientist, working with MSU
4	Farmer	Michigan	Planted Kernza® in certified organic fields in 2016
5	Researcher	Minnesota	Post-doc
6	Researcher	Manitoba	Plant breeder
7	Researcher	Washington	Ph.D. student
8	Farmer	Minnesota	Planted Kernza® in certified organic fields in 2011
9	Farmer	Illinois	Planted Kernza® in certified organic fields in in 2011
10	Farmer	Michigan	Planted Kernza®, perennial rye and other perennial grasses in certified organic fields in in 2009 and baked with Kernza® flour
11	Researcher	New York	Manages Kernza® trials
12	Researcher	Washington D.C.	Perennial grain advocate

Map of Kernza growers in 2016 across Midwest.



**Objective 2. Extend the field trials to conduct multi-year investigations of yield, forage and root growth of perennial grains.**

***On-farm Trial Sites***

The four sites were selected to allow us to evaluate perennial wheat on different soils and under various organic management regimes. Since all soil managed organically is NOT created equal we chose farmers that have been practicing organically and certified for several years and who are savvy on how to building soil for the short and long term. We expected to see differences compared to Kellogg Biological Station, where the soil is sandy to sandy loam and has been managed organically for three years (it was just certified this past year by GOA). However, it was found that only intermediate wheat grass was good candidate as a perennial grain in Michigan and there is need for larger seeded and persistent (for three or more years) varieties of this crop as well.

**Farmer engagement**

We worked with four farmers who expressed interest in perennial grains to conduct on-farm research while maintaining the site at Kellogg Biological Station (KBS) in Gull Lake MI. The four farmers were chosen to gain a wider perspective of the ability for perennial grains to grow, establish and regrow as perennials, which is the greatest challenge we have experienced at KBS.

<b>Farmer</b>	<b>Location</b>	<b>Possible use of crop</b>	<b>Results</b>	<b>Observations</b>
Farmer 1	South Central MI	Grind flour for bread	Winter killed crop	Find higher ground and plant earlier
Farmer 2	Central Mi	Animal grazing	Did not plant - Selling farm	
Farmer 3	North-Central MI	Soil cover	Hard freeze 2 days after planting	Need to plant earlier in this northern site
Farmer 4	South East MI	Alternate crop (grain)	Good stand and good potential for regrowth for 2015.	Weeds are the greatest problem.

**Trial**

Each farm that was able to participate (all but farmer #2 who sold farm) planted three varieties of annual wheat (Red Devil, Hopewell, Frankenmuth), Intermediate wheat grass (Kernza) and 2 lines of perennial wheat (P19 and P15). Farmers had provided earlier their

goals for this trial, and a range of management plans described in the 2013 annual report and summarized here.

Individual survey was conducted to identify each farmer's goal. The four participating farmers differ from one another in terms of their farming goals and we show here the key characteristics that farmers expressed interest in testing the grain for, from the lines grown in the on-farm trial:

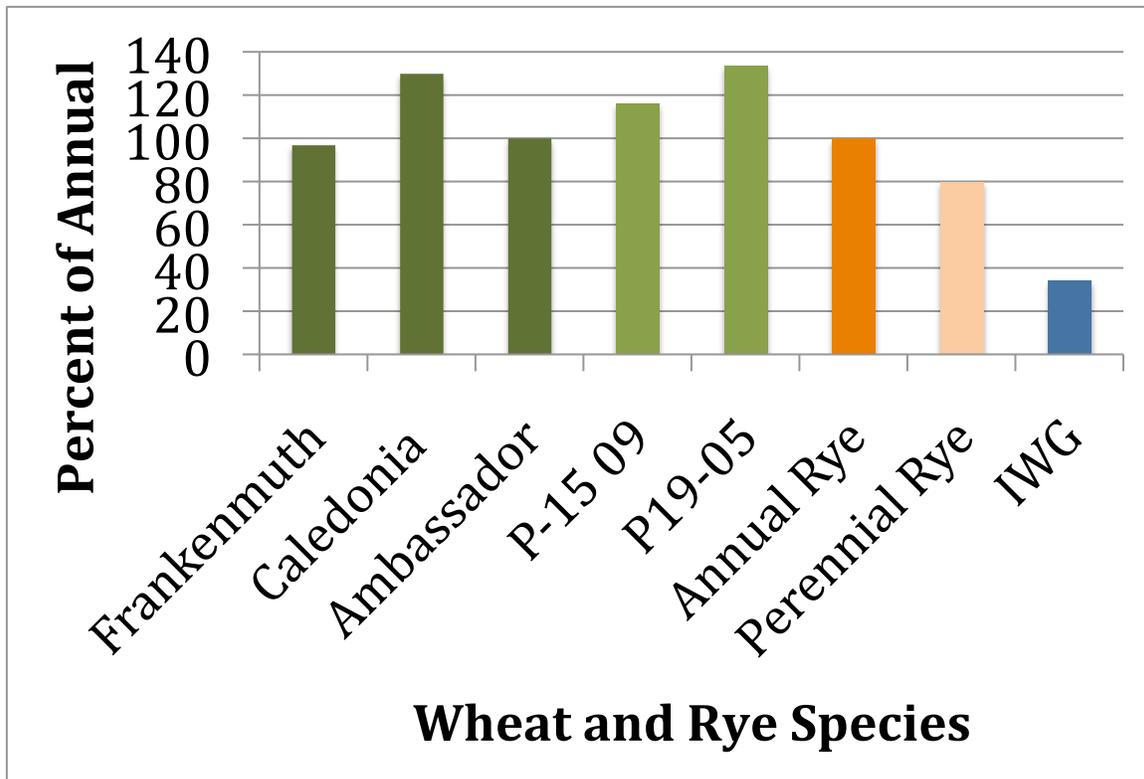
1. Pasture and some feed grain
2. Milling for baking flour
3. Wheat berries as a whole food (baking and wheat grass)
4. Multipurpose use of the perennial grain (pasture and grain)

<b>Grain</b>	<b>Characteristics</b>
Red Devil	Red Annual-New for organic
Frankenmuth	White Annual-Old stand by for organic
Hopewell	White Annual
Intermediate wheat grass	Selected for grain size
P15-Perennial Wheat Line	Strongest regrowth
P 19-Perennial Wheat line	Intermediate size and regrowth

**Actual Yields (percent of annual wheat, first growth). Yields were not measurable on two farms due to weed infestation and lack of regrowth.**

<b>Location</b>	<b>P15</b>	<b>P19-05</b>	<b>Intermediate Wheatgrass</b>	<b>Hopewell</b>	<b>Frankenmuth</b>	<b>Red Devil</b>
<b>KBS</b>	38%	20%	22%	100%	87%	90%
<b>Farmer 4</b>	40%	25%	20%	105%	85%	95%

Above is preliminary, as seed is still being threshed and final yields will be available in the near future. The plant stand was poor for perennials, so below is a figure from the KBS site that shows yield per tiller basis the perennials did better than on a yield (per area) basis.



Overall it is clear that perennial wheat varieties are not yet ready for field production, they do not regrow even on high quality soil with sufficient organic matter – this must be a genetics challenge. Also the lines of perennial wheat and Intermediate wheatgrass available from Washington State University and The Land Institute (Salina, Kansas) are not homogenous, the heads are different sizes and some very ‘grass like’ while others produce grain that is closer to (annual) wheat in size and shape. Therefore we plan to continue to grow intermediate wheat grass which at least is a strong perennial as it does regrow well after the first year harvest and continues to tiller, helping suppress weeds. The grain shows some potential for specialty markets and is being grown by a few farmers at field scale in Minnesota and in Kansas. More development of the grain size of IWG is urgently needed. This is the real bottleneck in developing these new crop options for Midwest organic farmers.

Field trials of perennial grains, intermediate wheatgrass and perennial wheat.

