

ORGANIC WHEAT

CONFERENCE 2019

Opportunity is Knocking: White Paper on Establishing an Organic Winter Wheat Breeding Pipeline In the Great Plains

I. Introduction

Heartland Plant Innovations, a for-profit company based in Manhattan, Kansas, along with collaborators, coordinated a conference to discover and document the opportunities and challenges of growing organic winter wheat in the Great Plains region. The goal of the conference held Jan. 29-30, 2019 and entitled “Identifying Priorities and Opportunities to Developing Organic Wheat Breeding in the Great Plains,” was for HPI to assess grower, miller and end-user needs and interest in developing a strategy to build an organic wheat breeding pipeline for the region.

The conference objectives were to: 1) Bring together key regional supply chain stakeholders to discuss the challenges and opportunities per industry segment; 2) Assess the feasibility of developing an independent breeding pipeline that delivers locally-adapted organic wheat varieties; 3) Develop a concise list of priority breeding targets and traits for organic wheat varieties; and 4) Establish a strategy to build an organic winter wheat breeding pipeline.

The conference and a pre-conference survey of organic wheat producers were supported by the Agriculture and Food Research Initiative Grant # 2019-67013-28961 from the USDA National Institute of Food and Agriculture.

This White Paper is the result of the conference and survey discussions and will serve as a roadmap for building a successful organic wheat breeding pipeline for the Great Plains region.

Conference Target Audience - HPI reached out to a broad cross section of organic wheat industry-related personnel, including those with an interest in producing, handling, and processing wheat for the organic market, particularly across states in the Great Plains. Conference presenters and attendees included wheat producers; university, U.S. Department of Agriculture and HPI wheat breeders; plant pathologists; flour mill representatives; extension professionals; and related industry personnel. More than 70 people attended the conference.

Heartland Plant Innovations - Heartland Plant Innovations (HPI) is a for-profit plant genetics company that drives innovation in wheat and other crops that are important to Kansas. HPI offers Advanced Plant Breeding services to public and private entities who focus on wheat and grain crop improvement. HPI employs highly skilled and trained researchers who are experts in the fields of genetics and breeding. The company was established in 2009 through a collaboration of Kansas wheat producers via Kansas Wheat Commission and the Kansas Association of Wheat Growers, Kansas State University, and many private companies. Its staff, laboratories and greenhouses are located in the Kansas Wheat Innovation Center in Manhattan, Kansas, the state's single-largest, farmer investment in wheat research. The center has state of the art office and meeting space, greenhouses, plant growth chambers, tissue culture and molecular biology laboratory facilities.

Currently, HPI applies advanced technology for gene discovery, trait validation and crop improvement to deliver new products and production platforms. HPI's core business is its wheat doubled haploid seed production, which develops genetically pure wheat lines in as little as one year. Wheat breeders in the United States and around the globe count on this technology to develop new wheat varieties up to five years faster than traditional breeding methods. HPI also offers genotyping, wide-crossing, trait development and proprietary contract research.

Expected Outcomes

HPI's January conference had two main goals:

1. Identify the top 5 priorities for breeding varieties to optimize organic wheat production, and
2. Identify the top 5 priorities to optimize the impact of varieties developed for organic wheat production.

II. Organic Wheat Situation

Opportunity awaits and the demand is there. Wheat covers more of the world's agricultural land than any other crop. But, in the United States, acreage of wheat grown with conventional methods, using chemical pesticides and fertilizer, has been declining for several years. Government reports put winter wheat planted area at a 110-year low (USDA, February 2019).

For years, the prevailing thought was how to get the most wheat possible from the acres of land available, relying on wheat genetics certainly, but also on chemical inputs including fertilizer, herbicides and pesticides. In recent years, however, due to a greater recognition and emphasis by the agriculture industry, food processors and consumers on growing crops with limited or no chemical inputs, production of organic wheat has grown.

According to a May 18, 2018 [survey](#) by the Organic Trade Association, organic sales of food and non-food products in the U.S. totaled \$49.4 billion in 2017, up 6.4 percent from the previous year. Organic food sales jumped 6.4 percent from the previous year to a record high \$45.2 billion. The OTA survey showed organic food at 5.5 percent of the food sold in U.S. retail channels.

The results of the most recent USDA survey of organic agriculture (all crops) in the U.S. were released in 2016. At that time, respondents represented 86 farms and 54,208 acres, producing crops worth about \$50 million. Forty-nine respondents grew wheat organically, on 14,906 acres. They produced about 658,074 bushels worth about \$6 million of that \$50 million.

Extension specialists, flour mill representatives and other conference attendees said organic wheat production has been increasing, powered by demand for flour to be used in organic bread, pastries, snacks and more.

Organically-grown wheat commands prices two to three times more than conventionally-grown wheat, yet even with growing demand, there has been little research focused on which existing varieties grow well in organic environments or on determining if there is a need for new varieties developed specifically for organically-managed fields growing certified-organic wheat.

Producer survey

Prior to the Jan. 29-30, 2019 conference, HPI conducted a survey of producers who are growing organic wheat. The survey was sent to producers suggested by wheat breeders, extension agents, grower groups, conference panelists and others in several Plains states. HPI received 22 responses from five states: Texas, Kansas, Nebraska, South Dakota and Wyoming (the last received after summation). Responses indicated that organic wheat, both dryland and irrigated, yielded less wheat per acre than conventionally-grown wheat, both dryland and irrigated. Wheat curl mite in the field and weevils in storage were respondents' primary insect concerns, and bindweed and pigweed were the primary weed challenges. Rust diseases were by far the No. 1 disease concerns).

The survey included questions regarding common crop rotations; limitations in production (No. 1 response was nitrogen/fertility and No. 2 low protein); key differences in organic production versus conventional; characteristics demanded in organic varieties (No. 1 response was protein, No. 2 yield and No. 3 disease resistance).

In response to their plans for organic wheat production in the next five years, 39.1 percent said they plan to produce organic wheat and 60.9 percent said they already were producing organic wheat.

Survey respondents indicated the wheat varieties most widely-grown in organic systems were TAM 114, followed by Karl 92, Tatanka, Joe, Everest and TAM 113.

With the surging demand for organic food products, including breads, crackers and snacks produced with organic flour, with the double or triple price premium that organic wheat commands over conventionally-grown wheat, and with the potential environmental benefits of using less chemical inputs on their land, indications are there will be economic advantages for growers to expand their organic wheat acres for the foreseeable future.

III. Conference Discussion Summary

Day 1: Current Trends in Organic Wheat: Challenges/Opportunities in Individual Market Segments

Five separate panels were held and organized into market segments. Presentations and discussions focused on current market and industry segment trends. The goal of the first day was to identify challenges and opportunities within each market segment and frame the strategic planning process in Day 2.

Day 1 began with a keynote speaker who discussed trends in modern day agriculture. He noted that just 30 percent of the world's population is fed by large industrial farms. The other 70 percent is fed by small farmers. He also noted that solutions cannot be found with a "one-size-fits-all" approach. Because of different climates and soils, they have to be regional.

End-users discussion (Panel 1): Several millers who currently buy organic wheat agreed that the market will continue to grow. The challenges are the same as with conventionally-grown wheat but solutions are more limited. Millers are doing a lot of marketing, but not as much in research and development. Originally most people bought organic flour and products because they thought it tasted better, but now they're more concerned about the environment. Initially millers only sold organic flour to Whole Foods and small local food stores. Now bigger retailers are saying "MeToo" by devoting shelf space to organic flour and products. The margins and consumer response have been good. One challenge: Can supply keep up with demand? Eighty percent of U.S. households have bought an organic product.

Organic wheat producers (Panel 2): Because of climatological differences, a northeast Kansas grower encounters more problems with moisture, humidity and disease than his counterparts in western Kansas. Some organic wheat is being imported from other countries to supply our domestic organic market. Wheat is maturing earlier and earlier and flowering too early. A Texas grower said 95 percent of his crop is irrigated and that some growers have converted their Conservation Reserve Program (CRP) land to organic wheat. Growers in his area tend to grow TAM 113 and TAM 114.

Banks are not always supportive of growers who want to convert to organic wheat and don't always understand the three-year certification process and marketing implications. Most growers switching to organic are younger. Another Kansas grower gets manure/fertilizer from a local feedlot. He typically seeds in mid-September, and his fields usually yield 40-80 bushels per acre. At harvest, he tests two spots for protein and test weight in every load, but indicated there's a lot of variability in protein. An Oklahoma grower uses sheep manure and fish as fertilizer, saying cattle manure brought in too many weed seeds. Storage after harvest is a challenge, and several growers found that smaller bins work best.

Agronomists/Extension specialist's (Panel 3): Extension has little data-driven and sometimes conflicting information about organic production to share with growers. A Kansas specialist cited USDA data from the latest (2016) organic crop production year, emphasizing that organic wheat production has grown since then. Those making the switch from conventional to organic wheat will be required to use proper soil management techniques. Other challenges include: marketable protein levels for the food market; a lack of organized extension activities centered on organic wheat; soil-test recommendations are inherently different for organic than conventional.

An Oklahoma extension specialist pointed out that seven certified organic processors/handling facilities exist in the state for milling/storing organic grains. Major challenges include: 1) weak communication for beginning growers to get information regarding organic certification; 2) incomplete or disorganized organic record keeping by growers; and 3) lack of internet based regional trainings for organic certification and production information.

University wheat breeders (Panel 4): Most do not conduct an independent organic wheat breeding program. Texas can replicate production conditions for most of the world because there are wheat breeding programs in different parts of the state.

Wheat variety development is a 10- to 15-year process that starts in the greenhouse by crossing one variety with another to produce progeny carrying the best traits. All wheat breeders are looking for rapid emergence, early vigor, rapid canopy closure (all to outcompete weeds), fall tillering, disease and insect resistance, and drought and cold tolerance. What does this have to do with organic wheat? Almost everything. Wheat produced on organically managed lands demands many of the same attributes. However, priorities may shift a bit when breeders focus on wheat for organic production.

Some are using wild relatives of wheat (ancestors of common wheat) in germplasm development. There is potential to develop organic lines that are even more healthful, including more protein. Challenges in organic wheat breeding are some of the same ones encountered in conventional wheat breeding, but accordingly heightened: disease and insect resistance in the context of a lack of chemical control; better soil nutrient utilization, especially nitrogen, with inadequacy of organic fertilizer inputs; weed competitiveness in the absence of chemical control; availability of land at research stations for testing with uniform manure applications and with various crop rotations; and convincing organic growers to purchase certified seed each year. Public and private breeding programs are built on royalties from certified seed sales to sustain their programs.

Disease threats are much the same in organic as conventional breeding; however, seed-borne fungi are an additional problem in organic production. If there is reluctance on the breeders' side, it's because organic wheat breeding might need to become a separate program with its own genetic pipeline, not necessarily as large as the current conventional programs. The majority of breeders did not believe establishing separate programs and/or pipelines in each state would be practical or even necessary. However, if there is an opportunity to work together through a collaborative effort, it would increase the likelihood of success in delivering high-quality organic wheat varieties to the marketplace.

Other organic crop perspectives (Panel 5): An organic sorghum grower/food processor/retailer said it's important to be branded as sustainable. Sorghum is the "camel of crops" for its ability to withstand dry periods. Breeders cannot focus on every trait but must prioritize the most important and pursue them aggressively. Organic production is audited every year. Another grower who raises Kamut Khorason, an ancient relative of durum wheat, built a trademark around it. He started with ½ acre in 1986 and now has 100,000 acres of it. In this particular program, nutrition comes first, yield second.

Day 2: Development of an Organic Wheat Breeding Pipeline: A Strategic Approach

Day 2 provided the opportunity for all stakeholders and conference participants to provide input into the strategic approach to develop an organic wheat breeding pipeline for the region. Conference attendees were divided into small discussion groups (7 groups of approximately 10 people per group). Each small group was tasked with discussing and prioritizing 2 key areas: 1) top priorities for breeding varieties to optimize organic wheat production; and 2) top priorities to optimize the impact of varieties developed for organic wheat production. Table 1 below summarizes these priorities in the 2 key areas.

Table 1: Top 10 Priority List for Organic Breeding and Variety Optimization

Priority Ranking	Breeding Priorities	Optimization of Varieties
1	Protein Content	More Certification Agencies in states
2	Uniform Kernel Size (1000kw)	Funding mechanism for research/breeding
3	Disease Resistance: Leaf and Stripe Rusts, Wheat Streak Mosaic Virus (WSMV), Bunt	Regional organic wheat evaluation program
4	Baking/End-Use Quality	Certified organic wheat seed production system
5	Yield Per Acre	Crop insurance adjustments for transitioning and new organic farmers
6	Nitrogen Use Efficiency (for quality & yield)	Uniform Interpretation/Enforcement of Certification Standards
7	Improved infrastructure (storage, handling, traceability and marketing)	Risk management tools for buyers and sellers
8	Heat and Drought Stress	Transparency/Information throughout wheat chain
9	Long Coleoptile/Tillering/Early Season Vigor/Weed Control/Competitiveness/ Allelopathy	Consumer education
10	Plant height/Standability/Canopy	

IV. Conclusions and Next Steps

More than 70 people attended the conference, including producers, breeders, grain handlers, millers and key regional supply chain stakeholders to discuss the challenges and opportunities per industry segment. A reasonable list of priority breeding targets and traits for organic wheat varieties was agreed upon. How to feasibly develop an independent breeding platform that delivers locally-adapted organic varieties was discussed and a strategy to build an organic breeding platform was outlined.

This 2-day conference allowed the attendees to meet with representatives from the complete value chain, and learn and openly address key challenges and opportunities faced by each segment. The small group discussions on Day 2 were particularly powerful because they produced a list of prioritized goals for the organic wheat industry in the regions. These goals are summarized in Table 2 below.

Table 2: Great Plains Organic Wheat Industry Goals	
Priority Ranking	Great Plains Organic Wheat Industry Goals
1	Test advanced lines and modern cultivars on real organic farms, alongside organic farmer-accepted varieties. Identify lines which work well in organic wheat productions systems and determine the strengths to build upon and weaknesses to address.
2	Establish a foundational organic wheat breeding pipeline (early-generation to candidate varieties) for the winter wheat region in the Great Plains.
3	Accelerate the development of pest-proof wheat cultivars utilizing the expertise of HPI in the application of marker assisted breeding (MAB) and doubled haploid (DH) technology.
4	Improve nitrogen use efficiency (NUE) of wheat cultivars for organically managed lands.
5	Enhance the competitive and natural weed suppression (allelopathic) ability of organic wheat cultivars.
6	Develop wheat cultivars with consistently acceptable end-use quality for the organic milling and baking industry.
7	Develop standard practices and protocols for commercial release of organic cultivars.
8	Provide education and outreach to all stakeholders related to organic agriculture.

V. Post Conference Survey

HPI distributed a post conference survey to all attendees. Participants were asked to rank separate aspects of the conference on a scale of 1-5, with 1 being poor and 5 being excellent. They also had several opportunities to comment in writing about the quality and timing of the overall conference quality of topics discussed and speakers and add where they would like to see improvements. At the time of this writing, 15 responses have been received, each with valuable input. A summary of these survey responses is provided below in Table 3.

Table 3. Summary of Post Conference Survey	
Topic	Average Ranking (1 to 5)
Conference Quality (time of year, venue, food & beverage)	4.55
Day 1: Quality of topics discussed	4.29
Day 1: Quality of speakers	4.12
Day 2: Small group discussions	4.23
Likelihood of attending future HPI events	4.46
Panels/Small group discussions comments/suggestions	
<ul style="list-style-type: none"> • More small group discussion time was needed • Insert small group discussion in between panels on Day 1 to break up presentations • Speakers/Panelists joining remotely was not ideal; difficult to hear some speakers • Need to limit presentation time for panelists in exchange for more Q&A and discussion • Rotate group members for small group discussions • Interaction in the small group discussions was very useful; perhaps more discussion from all of the groups 	
What was liked most about the conference?	
<ul style="list-style-type: none"> • Designing methods for organic production to give farmers more opportunity to participate • Small group discussions • Identifying opportunities for growth • Opportunity to interact with people across the entire value chain; networking • Producer engagement in the conference • Willingness of plant breeders to consider organic • Gaining a new and different perspective 	
What was liked least about the conference?	
<ul style="list-style-type: none"> • Comments that conventional production was not sustainable • Learning about imported organic products into the United States • Anti-organic bias • Speakers who joined remotely; little engagement in discussion 	