In addition to RWA, we also are aggressively pursuing wheat stem sawfly (WSS) resistance as a breeding objective. With one month of salary support from our program, Terri Randolph (Frank Peairs' team) coordinated solid stem evaluations of segregating populations at Fort Collins. We also have generated a group of 300 DHs from crosses with Byrd and Antero and the solid-stemmed Montana cultivar Bearpaw. We have completed DNA marker analysis for WSS-associated markers in these DHs and are hopeful that some of the DHs will be advanced to yield trials in 2016. In 2014, we added a field site near New Raymer for evaluation of wheat WSS response, and we believe that we have some form of non solid-stem resistance in our germplasm. One DH line (CO11D1397, pedigree: CO050337-2/Byrd) showed very good yield at New Raymer and other locations, low WSS damage, and low larvae counts in the stubble after harvest. This line is in the 2015 UVPT and IVPT and is under Breeder seed increase for potential Foundation seed production and release in 2016.

Personnel updates. CSU wheat breeder Scott Haley completed a six-month sabbatical leave in Europe from December 2013 to May 2014. The focus of the sabbatical was to learn new ideas and new techniques at the interface of crop genomics and wheat breeding. In December 2014, Ph.D. student Sue Latshaw accepted a position in wheat breeding with Bayer CropScience in Lincoln, NE, and will work to complete her Ph.D. in spring 2015. In November 2014, Ph.D. student Jessica Cooper successfully completed her degree program, focusing on genomic selection for end-use quality traits (including preharvest sprouting tolerance), and accepted a position in canola breeding with Cargill in Fort Collins. Our Ph.D. student Craig Beil completed his first year in our program in summer 2014 conducting research to leverage next-generation sequencing technologies (i.e., genotyping by sequencing) to more efficiently exploit winter wheat germplasm from the CIMMYT–ICARDA International Winter Wheat Improvement Program based in Turkey. Craig is currently spending three months with CIMMYT in Mexico (February to May 2015) participating in their international training program. Craig is only the 5th U.S. trainee to participate in this program since the 1960s. In autumn 2014, Ben Conway joined our program (co-advised by Pat Byrne) to work on a Ph.D. focusing on research to improve genomic selection models in wheat using climatological and other covariates. Ben joined us following completion of an M.S. degree in wheat breeding at the University of Maryland.

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Chemical properties of soil with winter cover crops.

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In Kansas, winter cover crops have a new interest with the development of summer crops for biofuel. When a crop is harvested for bioenergy, the residue is removed leaving the soil prone to erosion during the winter fallow period. Winter cover crops may allow maximum biomass harvest by protecting the soil from wind and water erosion. Therefore, the objective of the research reported by Freeman (2014) was to determine the effect of two winter cover crops on the growth of two biofuel crops, corn (*Zea mays* L.) and forage sorghum (*Sorghum bicolor* (L.) Moench) in a corn–forage sorghum rotation. The two rotations, established in 2009, were continuous forage sorghum and corn–forage sorghum. In the corn–forage sorghum rotation, the 2009 plots with corn grew forage sorghum in 2010 and corn in 2011; the 2009 plots with forage sorghum grew corn in 2010 and forage sorghum in 2011. The two cover crops were a legume, Austrian winter pea (*Pisum sativum* var. *arvense* Poir.), and winter wheat. Control plots were fallowed. The experiment was done for two years in Manhattan and Tribune, KS, with harvests of the winter cover crops in the springs of 2011 and 2012. Two levels of nitrogen were added to the soil: 0 and 101 kg/ha N. The main results for both locations were 1) nitrogen increased yield of both corn and sorghum. 2) growth of the winter cover crops did not decrease the yield of the summer crops. and 3) winter wheat produced more biomass than Austrian winter pea. The Austrian pea winter killed in the second year of the study at Manhattan, KS. The results showed that winter wheat is a better winter cover crop than Austrian winter pea, because of its ability to grow well during the off-season of the bioenergy crops and to provide soil cover during winter.

In the study of Freeman (2014), soil data were not reported, although soil was sampled. Here we report the soil data for Manhattan, KS. Soil samples were taken in the autumn of 2010 after harvest of the forage sorghum and corn and at the time of the planting of the cover crops. Soil was sampled again in the spring of 2011 after the cover crops were harvested and before the corn and sorghum were planted. The soil was analyzed for four chemical characteristics (pH, organic matter, nitrogen, and carbon) using standard methods practiced in the Soil Testing Laboratory of Kansas State University, Manhattan, KS.

Table 1. Properties of a silt loam soil at Manhattan, KS, before two winter cover crops were planted in the autumn of 2010 and after their harvest in the spring of 2011. The two cover crops were winter wheat and Austrian winter pea. Plots also were fallowed during the winter. The summer crops were forage sorghum and corn, and they were grown in two rotations established in 2009: continuous forage sorghum and corn-forage sorghum. In the corn–forage sorghum rotation, the 2009 plots with corn grew forage sorghum in 2010 and corn in 2011; the 2009 plots with forage sorghum grew corn in 2010 and forage sorghum in 2012. Half the plots were fertilized with 101 kg/ha nitrogen and half the plots received no fertilizer nitrogen. The values are the means and standard deviations of four replications.

	0 kg/ha nitrogen			101 kg/ha nitrogen		
	Winter cover crop			Winter cover crop		
Soil property	Wheat	Pea	Fallow	Wheat	Pea	Fallow
At cover crop planting in autumn 2010 in the forage sorghum–forage sorghum rotation						
pH	6.03±0.19	6.08±0.29	6.10±0.23	6.33±0.19	6.00±0.37	6.13±0.39
Organic matter, %	1.48±0.05	1.33±0.26	1.25±0.41	1.55±0.13	1.30±0.37	1.33±0.15
Nitrogen, %	0.10±0.01	0.09±0.02	0.08±0.02	0.10±0.02	0.09±0.02	0.09±-0.02
Carbon, %	0.95±0.16	0.79±0.14	0.72±0.16	0.94±0.17	0.78±0.16	0.80±0.12
At cover crop planting in fall 2010 in corn-forage sorghum rotation after sorghum harvest						
pH	6.08±0.38	5.85±0.36	6.20±0.28	6.10±0.26	6.08±0.39	6.00±0.35
Organic matter, %	1.03±0.49	1.03±0.28	1.10±0.29	1.05±0.47	1.03±2.38	1.05±0.27
Nitrogen, %	0.08±0.03	0.08±0.03	0.09±0.02	0.08±0.03	0.07±0.02	0.08±0.02
Carbon, %	0.66±0.23	0.62±0.16	0.65±0.12	0.62±0.21	0.57±0.14	0.62±0.13
At cover crop planting in autumn 2010 in corn–forage sorghum rotation after corn harvest						
pH	5.83±0.16	6.08±0.28	6.00±0.25	6.10±0.08	6.10±0.29	6.08±0.31
Organic matter, %	1.15±0.35	1.08±0.33	1.13±0.43	1.05±0.19	1.20±0.55	1.00±0.39
Nitrogen, %	0.08±0.02	0.09±0.03	0.09±0.01	0.09±0.02	0.09±0.02	0.08±0.02
Carbon, %	0.66±0.28	0.65±0.21	0.71±0.18	0.71±0.70	0.68±0.22	0.64±0.19
After cover crop harvest in spring 2011 in forage sorghum–forage sorghum rotation						
pH	6.08±0.30	5.85±0.49	6.13±0.34	5.95±0.45	5.90±0.35	6.18±0.15
Organic matter, %	1.38±0.25	1.15±0.21	1.40±0.24	1.23±0.15	0.98±0.49	1.30±0.27
Nitrogen, %	0.08±0.01	0.07±0.01	0.08±0.01	0.07±0.01	0.06±0.01	0.07±0.01
Carbon, %	0.93±0.14	0.81±0.11	0.91±0.05	0.82±0.10	0.71±0.18	0.88±0.10
After cover crop harvest in spring 2011 in corn–forage sorghum rotation before sorghum planting						
pH	6.15±0.17	5.88±0.10	5.98±0.17	6.25±0.13	5.88±0.36	6.08±0.30
Organic matter, %	0.95±0.48	0.93±0.22	1.15±0.31	0.93±0.49	0.98±0.26	1.03±0.46
Nitrogen, %	0.06±0.03	0.06±0.02	0.07±0.02	0.06±0.03	0.06±0.02	0.06±0.02
Carbon, %	0.72±0.28	0.65±0.15	0.74±0.27	0.71±0.28	0.67±0.19	0.70±0.24
After cover crop harvest in spring 2011 in corn–forage sorghum rotation before corn planting						
pH	6.05±0.24	6.15±0.35	6.84±0.29	6.03±0.38	6.05±0.24	6.15±0.10
Organic matter, %	0.83±0.26	0.90±0.34	0.88±0.21	0.78±0.28	0.88±0.34	0.91±0.26
Nitrogen, %	0.09±0.02	0.09±0.03	0.09±0.02	0.09±0.02	0.09±0.02	0.08±0.02
Carbon, %	0.65±0.22	0.66±0.25	0.59±0.18	0.60±0.14	0.62±0.18	0.62±0.21

The soil data provided information about the change in soil properties after a winter season with the cover crops (Table 1, p. 69). The pH, organic matter, nitrogen, and carbon were not changed by the presence of either of the cover crops. Values before planting of the cover crops were similar to those after their harvest. Nitrogen in the soil was not increased by the presence of the peas. The results showed that there is no advantage of increased nitrogen in the soil, if winter pea is a cover crop. They reinforced the fact that the winter cover crop in Manhattan, KS, should be wheat.

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Mining novel genetic diversity in Aegilops tauschii, the D-genome progenitor of hexaploid wheat.

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Wheat production is threatened by depleting resources, increasing cost of production and climate change. An estimated 60% increase in wheat production is needed by 2050 to feed the projected population of 9 billion. Hexaploid wheat, like many other crops, has undergone bottlenecks during polyploidization and domestication resulting in narrow genetic base. *Aegilops tauschii* the D-genome progenitor of bread wheat, has remained genetically diverse and is an excellent source for broadening the genetic base of wheat. With this vision, we assessed the diversity in the *Ae. tauschii* collection at the Wheat Genetics Resource Center at Kansas State University and developed PowerCore and MiniCore sets. We genotyped 551 accessions representing the world collection by genotyping-by-sequencing (GBS). More than 120K SNPs were discovered using TASSEL pipeline. SNPs with less than 50% missing data were filtered, and a random subset of 15K SNPs was selected to identify a PowerCore consisting of 144 accessions retaining most of the genetic diversity and maintaining frequency of alleles in core set similar to the entire collection. The PowerCore was optimized based on genetic distance to represent the major clusters of phylogenetic tree. A MiniCore set of 52 accessions was selected from the PowerCore set to represent all the major clusters in the phylogenetic tree. The MiniCore set of 52 accessions will be crossed to elite wheat cultivars to produce wheat–*Ae. tauschii* amphiploids. These amphiploids will be selfed and backcrossed to elite wheat lines to enhance the diversity of bread wheat.