USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY12 Final Performance Report
July 16, 2013

Cover Page

PI:	Mark Sorrells
Institution:	Cornell University
Address:	Department of Plant Breeding 252 Emerson Hall Ithaca, NY 14853
E-mail:	mes12@cornell.edu
Phone:	607-255-1665
Fax:	607-255-6683
Fiscal Year:	FY12
USDA-ARS Agreement ID:	59-0206-9-059
USDA-ARS Agreement Title:	Genetics and Breeding of FHB Resistant Soft White Winter Wheat for the Northeastern U.S.
FY12 USDA-ARS Award Amount:	$ 47,787

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
VDHR-NWW	Genetics and Breeding of FHB Resistant Soft White Winter Wheat for the Northeastern U.S.	$ 27,575
VDHR-NWW	Coordinated Evaluation of FHB Resistance of Advanced Soft Winter Wheat Lines and Cultivars.	$ 3,418
VDHR-NWW	Improved Breeding for FHB Resistance by Advanced Genetic and Phenotypic Characterization of Soft Winter Wheat.	$ 16,112
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).	$ 682
	Total ARS Award Amount	**$ 47,787**

Mark E. Sorrells — June 15, 2013

Principal Investigator — Date

* MGMT – FHB Management
FSTU – Food Safety, Toxicology, & Utilization of Mycotoxin-contaminated Grain
GDER – Gene Discovery & Engineering Resistance
PBG – Pathogen Biology & Genetics
BAR-CP – Barley Coordinated Project
DUR-CP – Durum Coordinated Project
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Soft Winter Wheat Region
SWW – Southern Soft Red Winter Wheat Region

Project 1: *Genetics and Breeding of FHB Resistant Soft White Winter Wheat for the Northeastern U.S.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   In this project we are developing FHB resistant varieties for the northeastern U.S. Over the past several years we have fine-tuned our FHB screening and evaluation nurseries so that FHB testing is very efficient and accurate. A few years ago we expanded our irrigation capacity so that we have adequate space for our breeding program as well as our mapping and selection activities.
   With support from this project we have released 5 soft winter wheat varieties (4 white and 1 red) that have moderate resistance to FHB. The recent reduction in white wheat acreage in NY has created some problems because our white wheat varieties have less impact.. However to counteract this problem we have co-released a soft red winter wheat with Ohio State named Otsego which is currently in commercial production. In addition, we have received permission to release OH02-12686 that has even better FHB resistance. The problems continue with branded varieties whose FHB resistance is unknown before their sale to farmers. By the time we have adequate FHB data on them, they are gone and replaced with a new branded variety, often susceptible to FHB or other diseases in our region.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment:
   This year we made 135 crosses, most of which were between two FHB resistant parents. We grew 306 headrows from marker assisted selections that are homozygous for FHB resistance loci. In our replicated yield trials, we have 295 selections under evaluation. Of course our most important accomplishment has been the release of 5 new soft winter wheat varieties with FHB and preharvest sprouting resistance. Two of the varieties have fhb1 from marker assisted backcrossing and three have native resistance. Except for the branded varieties all varieties marketed in NY have at least moderate resistance to FHB.

   Impact:

   Because of the reduced interest in white winter wheat, our new varieties have only limited acceptance but certified seed is available for our most recent varieties. Both white and red soft winter wheat varieties are available in the northeastern U.S. Un-tested, branded varieties continue to reduce the impact of our new varieties. We are promoting the use of FHB resistant varieties and specifically identify susceptible varieties and do not recommend them. We are making progress in eliminating susceptible varieties.

Project 2: *Coordinated Evaluation of FHB Resistance of Advanced Soft Winter Wheat Lines and Cultivars.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   In this project we are evaluating the FHB-resistance in varieties and advanced lines in the northern winter wheat breeding programs. In our misted, inoculated nursery, we evaluated the NUWWSN, our Cornell Advanced Lines as well as those being marketed in New York (if permitted by the company). We are trying to get objective data on varieties that are, or will be marketed in NY.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment:

   We collected incidence, severity, FDK, and DON data on the cooperative nurseries and submitted the data for inclusion in the database. The data have been used in our regional trial summaries that are distributed to extension personnel, farmers, and seed companies and published on the internet.

   Impact:

   Cooperative nurseries are important for comparing advanced selections from different breeding programs, exchange of germplasm, and for assessing breeding progress. The NUWWSN is effective in accomplishing these goals.

Project 3: *Improved Breeding for FHB Resistance by Advanced Genetic and Phenotypic Characterization of Soft Winter Wheat.*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   This project attempts to implement and evaluate the efficacy of genomic selection (GS) for FHB resistance. Resistance to FHB has been well documented in Eastern US Soft Winter Wheat. Native resistance includes Type I & II as well as resistance to kernel infection (RKI) and toxin accumulation (RTA). In an earlier study, we found that the best approach to selecting against DON content was to use an index of incidence, severity, and FDK. This index was most predictive of varieties with grain containing low deoxynevalenol (DON) (Rutkoski et al 2012). Our earlier study also showed that there are many QTL with small effects. Because traditional marker assisted selection is ineffective in improving quantitative traits controlled by many QTL, we are using genomic selection to resolve this problem.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment:

   We have contributed resistant parents and lines with varying FHB resistance from multiple crosses involving resistant and susceptible parents. These were evaluated in our FHB screening nursery for incidence, severity, FDK and DON for the past three years.
   We presented results from our GS work on cooperative nurseries at the USWBSI Forum and published a paper (Rutkoski et al 2012) describing the utility of GS using cooperative FHB nursery data (see citation). Cross validation of genomic estimated breeding values compared to phenotypic values resulted in correlations ranging from 0.3 to 0.7.

   Impact:

   There are limitations to traditional mapping and MAS approaches to breeding for FHB resistance. GS complements marker assisted selection and takes advantage of the potentially large number of unique resistance sources. This project, combined with the information in our earlier study on GS have set the stage for greatly enhancing the rate of genetic gain from selection for FHB resistance using genomic and marker assisted selection methods.

Project 4: *Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).*

1. **What major problem or issue is being resolved relevant to Fusarium head blight (scab) and how are you resolving it?**

   Because FHB resistance is a complex trait, we need to develop new breeding methodologies and germplasm to enhance improvement of FHB resistance and to efficiently introgress effective resistance genes into breeding germplasm. Recurrent selection is a proven method for accumulating favorable alleles and raising their frequency in a population. Our dominant MS population has now been selected for FHB resistance for three generations. This population was intermated with FHB resistant entries in the NUWWSN in the first two years to incorporate multiple sources of resistance. This summer we have 360 half sib families in our misted, inoculated nursery. Those families have been evaluated and MS plants in the best families have been tagged. At harvest, the most resistant MS plants will be harvested and the process repeated. We experienced few issues with the MSFRS populations. They flowered slightly later than most of the entries in our FHB nurseries but we simply added an additional spray inoculation to catch the later flowering types. Our goal is to develop a soft winter wheat population with a high frequency of FHB resistant segregates.

2. **List the most important accomplishment and its impact (i.e. how is it being used) to minimize the threat of Fusarium head blight or to reduce mycotoxins. Complete both sections (repeat sections for each major accomplishment):**

   Accomplishment:

   We have continued the development of the FHB resistant dominant MS population using recurrent half sib selection. We have tagged the resistant male sterile plants and will harvest those plus a random sample of this base population for future evaluations. These samples will allow us to estimate heritability and gain from selection.

   Impact:

   The impact of this project will be realized after several cycles of selection and evaluation of the derived lines by providing a mechanism to accumulate genes for FHB resistance from diverse sources in locally adapted backgrounds. These populations are beneficial to regional and local breeding programs by providing the opportunity for individual breeding programs to select genotypes with favorable local adaptation and the region-wide opportunity to re-composite and recombine local selections into an improved regional pool. This project will provide breeding programs in the eastern region with germplasm from which to extract breeding lines that will have the potential to have unique combinations of FHB resistance genes.

Include below a list of all germplasm or cultivars released with full or partial support of the USWBSI. List the release notice or publication. Briefly describe the level of FHB resistance.

Jensen Soft White Winter Wheat - Crop Science Registration manuscript in preparation. A release notice has been distributed through the Cornell Cooperative Extension Network. FHB resistance is moderate and native in origin.

Saranac Soft White Winter Wheat - Crop Science Registration manuscript in preparation. A release notice has been distributed through the Cornell Cooperative Extension Network. FHB resistance is moderate and Chinese in origin.

Hopkins Soft White Winter Wheat - Crop Science Registration manuscript in preparation. A release notice has been distributed through the Cornell Cooperative Extension Network. FHB resistance is moderate and Chinese in origin.

Medina Soft White Winter Wheat - Crop Science Registration manuscript in preparation. A release notice has been distributed through the Cornell Cooperative Extension Network. FHB resistance is moderate and native in origin.

Otsego Soft Red Winter Wheat - Crop Science Registration manuscript in preparation. A release notice has been distributed through the Cornell Cooperative Extension Network. FHB resistance is moderate and native in origin.

All of these varieties have been made available for licensing and Foundation seed quantities are adequate. Jensen has been licensed for sale by 4 seed companies, Hopkins has been licensed by 2, and Medina by 1.

Include below a list of the publications, presentations, peer-reviewed articles, and non-peer reviewed articles written about your work that resulted from all of the projects included in the grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Sorrells, M.E. Bishop-Tran, A., Rutkoski, J., Benson, J., Guedira-Brown, G., and Heffner, E. 2010. Genomic Selection for Fusarium Head Blight Resistance in Wheat. Abstract – USWBSI, December 2010.

Rutkoski, J., J. Benson, Y. Jia, G. Brown-Guedira, J-L. Jannink, and M.E. Sorrells. 2012. Evaluation of genomic prediction methods for fusarium head blight resistance in wheat. The Plant Genome 5:51-61.

Registration articles are in preparation.