

**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY13 Final Performance Report
July 15, 2014**

Cover Page

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Fiscal Year:	FY13
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.
FY13 USDA-ARS Award Amount:	\$ 46,202

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.	\$ 27,548
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance (MPI-5).	\$ 633
VDHR-NWW	Improved Breeding for FHB Resistance by Advanced Genetic and Phenotypic Characterization of Soft Winter Wheat.	\$ 14,606
VDHR-NWW	Coordinated Evaluation of FHB Resistance of Advanced Soft Winter Wheat Lines and Cultivars.	\$ 3,415
	FY13 Total ARS Award Amount	\$ 46,202


 _____ 10 July 2014
 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. Our FHB screening and evaluation nurseries are well developed so that our FHB testing is very efficient and accurate. We currently have enough irrigation capacity to cover approximately 3000 plots which is sufficient for all of our evaluation activities.

With support from this project we have released 6 soft winter wheat varieties (4 white and 2 red) that have moderate resistance to FHB. Recently, the soft white wheat acreage in NY has declined which means that our white wheat varieties have less impact.. However, in collaboration with Ohio State, we have co-released two soft red winter wheat varieties named Otsego and Erie. Otsego has been produced commercial for three years and Erie will go into commercial production next year. Our 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 accomplishments and their impact (i.e. how are they 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 181 crosses involving FHB resistant parents. We grew 170 screening nursery plots that were selected using markers for FHB resistance loci. In our misted nursery, we have 240 selections under evaluation. We also screened 20 F3 individuals each from 13 crosses that were segregating for fhb1 or 5A resistance loci. Seven new crosses were made to combine 3BS with 5A and 400 F2 individuals were screened from each of 2 crosses. In our advanced trials, we have 8 new soft red FHB lines and 12 new soft white FHB lines selected by MAS. In our Master nursery we have 49 new FHB entries and 40 repeat entries. Of course our most important accomplishment has been the release of 6 new soft winter wheat varieties with FHB and preharvest sprouting resistance. Two of the varieties have fhb1 from marker assisted backcrossing and four 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 soft 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. Because there is no

variety survey in NY, it is difficult to assess the impact of our varieties and companies do not release sales records.

Project 2: *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?

FHB resistance is a complex trait requiring new breeding methods that improve quantitative traits. These new breeding methodologies can improve the efficiency of introgressing 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 four generations. This population was intermated with FHB resistant entries in the NUWWSN in the first two years to incorporate multiple sources of resistance. Subsequently, they were grown as half sib families for FHB evaluation. This summer we again have 360 half sib families in our misted, inoculated nursery. Those families have been evaluated for FHB and MS plants and the best 25-30% of the families have been tagged for harvest and planting back this fall. We experienced few issues with the MSFRS populations. They flowered later than most of the entries in our FHB nurseries because they have to be space planted 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 that can be used directly in breeding programs.

2. List the most important accomplishments and their impact (i.e. how are they 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. This breeding procedure provides a mechanism to accumulate genes for FHB resistance from diverse sources in locally adapted backgrounds. These populations will be beneficial to regional and local breeding programs because they are an adapted source of FHB resistance. 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.

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 has the goal of implementing and evaluating the efficacy of genomic selection (GS) for FHB resistance. Native resistance to FHB has been well documented in Eastern US Soft Winter Wheat and it includes Type I & II as well as resistance to kernel infection (RKI) and toxin accumulation (RTA). Previously, we reported that the best approach to selecting against deoxynivalenol (DON) content was to use an index of incidence, severity, and FDK. This index was most predictive of varieties with grain containing low DON (Rutkoski et al 2012). That study indicated that many QTL with small effects are involved in resistance. Traditional marker assisted selection is less effective in improving quantitative traits controlled by many QTL, consequently we are using genomic selection to resolve this problem.

2. List the most important accomplishments and their impact (i.e. how are they being used) to minimize the threat of Fusarium Head Blight or to reduce mycotoxins. Complete both sections; repeat sections for each major accomplishment:

Accomplishment:

Our breeding program has contributed resistant parents and lines with varying FHB resistance from multiple crosses involving resistant and susceptible parents. We evaluated those lines in our FHB screening nursery for incidence, severity, FDK and DON for the previous three years. We have now initiated the first cycle of selection by assisting with the intermating of the selected parents from this work.

In 2011 we presented the 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. Cross validation of genomic estimated breeding values compared to phenotypic values resulted in correlations ranging from 0.3 to 0.7 suggesting that GS for FHB would be successful.

Impact:

The limitations to traditional mapping and MAS approaches to breeding for FHB resistance indicate that an alternative breeding method is needed. 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 and variety development from selection for FHB resistance using genomic and marker assisted selection methods.

Project 4: *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?

We are evaluating the FHB-resistance in varieties and advanced lines in the northern soft winter wheat breeding programs. In our misted, inoculated nursery, we evaluated the Northern Uniform Winter Wheat Scab Nursery (NUWWSN) and our Cornell Advanced Lines as well as those being marketed in New York (if permitted by the company). We are generating objective data on varieties that are, or will be marketed in NY so that the farmer can make informed choices of varieties.

2. List the most important accomplishments and their impact (i.e. how are they 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 collected incidence, severity, FDK, and DON data on the cooperative nurseries and submitted the data for inclusion in the FHB 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 essential for comparing advanced selections from different breeding programs, exchange of germplasm, and for assessing breeding progress. The NUWWSN is effective in accomplishing these goals and is a critical cooperative activity.

Include below a list of all germplasm or cultivars released with full or partial support of the USWBSI during the FY13 award period. List the release notice or publication. Briefly describe the level of FHB resistance.

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.

Erie 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.

Both of these varieties have been made available for licensing and Foundation seed quantities are adequate. Otsego has been licensed for sale by 4 seed companies. Erie seed stocks will be available for sale in 2015.

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 FY13 grant. Please reference each item using an accepted journal format. If you need more space, continue the list on the next page.

Presentations:

New World Foundation – July 26, 2013
Extension Agent Training School – November 19, 2013
New York Crops Expo – January 23, 2014
Wheat Management Field Day – June 6, 2014
Hudson Valley Field Day – June 23, 2014
Seed Growers' Field Day – June 24, 2014

Extension Publication:

Cornell Small Grains Performance Trials – Extension Publication 2013-14

2013 Soft White Winter Wheat Summaries -
[http://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/documents/small grains/20131004jt27-2013SWWW.pdf](http://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/documents/small%20grains/20131004jt27-2013SWWW.pdf)

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[http://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/documents/small grains/20131004jt27-2013SRW.pdf](http://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/documents/small%20grains/20131004jt27-2013SRW.pdf)