

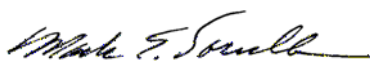
**USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY16 Final Performance Report
Due date: July 28, 2017**

Cover Page

Principle Investigator (PI):	Mark Sorrells
Institution:	Cornell University
E-mail:	mes12@cornell.edu
Phone:	607-255-1665
Fiscal Year:	2016
USDA-ARS Agreement ID:	59-0206-4-007
USDA-ARS Agreement Title:	Breeding and Genetics of FHB Resistant Soft Winter Wheat for the Northeastern U.S.
FY16 USDA-ARS Award Amount:	\$ 93,337
Recipient Organization:	Cornell University 341 Pine Tree Road Ithaca NY 14850
DUNS Number:	872612445
EIN:	15-0532082
Recipient Identifying Number or Account Number:	1498454 (OSP# 73066)
Project/Grant Reporting Period:	5/3/16 - 5/2/17
Reporting Period End Date:	05/02/17

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
BAR-CP	Interstate Spring 2-row Malting Barley Breeding.	\$ 15,466
VDHR-NWW	Genetics and Breeding of FHB Resistant Soft Winter Wheat for the Northeast U.S.	\$ 51,178
VDHR-NWW	Male Sterile Facilitated Recurrent Selection for FHB Resistance.	\$ 680
VDHR-NWW	Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials.	\$ 2,912
VDHR-NWW	Implementing Genomic Selection for FHB Resistance in Soft Winter Wheat (SWW).	\$ 23,101
	FY16 Total ARS Award Amount	\$ 93,337



24 July 2017

Principal Investigator

Date

* MGMT – FHB Management
 FST – Food Safety & Toxicology
 GDER – Gene Discovery & Engineering Resistance
 PBG – Pathogen Biology & Genetics
 EC-HQ – Executive Committee-Headquarters
 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: *Interstate Spring 2-row Malting Barley Breeding.*

1. What are the major goals and objectives of the project?

The overall goal of this project is to develop spring 2-row malting barley varieties with FHB resistance and adaptation to the northeastern U.S.

Specifically:

- 1) Evaluate FHB resistance in spring malting barley varieties in a Uniform Eastern Spring Malting Barley nursery coordinated by Richard Horsley at North Dakota State University,
- 2) Evaluate FHB resistance in malting barley varieties in the New York State Regional Spring and Winter Malting Barley testing program,
- 3) Evaluate FHB resistance and agronomic traits in our NY spring 2-row elite line training population, and
- 4) Use genomic selection to develop spring 2-row malting barley varieties with FHB resistance and adaptation to the northeastern U.S.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

- 1) major activities: Evaluation of all experimental lines, cooperative and regional trial entries for both winter and spring barley in our misted, irrigated FHB nursery.
- 2) specific objectives: In our misted, inoculated FHB nursery we evaluated all entries from the Winter Malting Barley Trial, Eastern Spring Malting Barley Trial, Cornell Regional Winter and Spring Malting Barley Trials, and potential new sources of resistance from the J. Innes Center. We also evaluated FHB for 700 new selections from our NY spring malting barley breeding program.
- 3) significant results: We collected replicated incidence and severity data on 90 JIC lines, 25 ESN lines, 36 Spring Malting Barley Regional entries, 350 advanced selections from our breeding program, 30 WMBT entries, 24 Winter Malting Barley Regional entries. Data analyses are in progress.
- 4) key outcomes or other achievements: Over the past 3 years, we have accumulated reliable FHB data for winter and spring malting barley varieties for New York. Also, we have been able to determine optimum application times for fungicides. This is critical information because before 2013 there was no malting barley grown in NY. The Farm Brewery Legislation created a new market for craft maltsters and brewers.

3. What opportunities for training and professional development has the project provided?

Daniel Sweeney is a PhD candidate who is in charge of the spring malting barley breeding program. Together we have designed a high intensity breeding program using the latest technologies to generate high quality breeding lines that are candidates for variety release in the shortest possible time. All of my grad students receive training in plant breeding methods and evaluation of FHB in our misted, inoculated nursery.

FY16 Final Performance Report
PI: Sorrells, Mark
USDA-ARS Agreement #: 59-0206-4-007
Reporting Period: 5/3/16 - 5/2/17

4. How have the results been disseminated to communities of interest?

Each year we publish the results of our state regional trials for both spring and winter malting barley including FHB and malting quality data in hard copy and online.

Cornell Small Grains Performance Trials - 2016 Winter Malting Barley

<https://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/WMB%20Reg16%20Table%2BMaltQuality.pdf>

Cornell Small Grains Performance Trials - 2016 Spring Malting Barley

<https://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/SMB%20Reg16%20Table%2BMaltQuality%2BDON.xls.pdf>

Project 2: *Genetics and Breeding of FHB Resistant Soft Winter Wheat for the Northeast U.S.*

1. What are the major goals and objectives of the project?

The climate in the northeastern U.S requires that farmers grow FHB resistant wheat. FHB is the single greatest problem for successful production of soft white winter wheat in New York. We successfully commercialized Jensen and Medina soft white winter wheat varieties. Because most of the DON is in the bran, FHB resistance in white wheat is more important than for red because white wheat bran is widely marketed to the food industry for use as an additive in high bran food products. We are also developing FHB resistant soft red winter wheat varieties for this region and we have collaborated with Ohio State University to release Otsego and Erie soft red winter wheat varieties.

Our objectives are to:

1. Develop FHB resistant soft red and white wheat cultivars for the northeastern U.S. in collaboration with Gary Bergstrom, Department of Plant Pathology. Evaluate our elite lines in the Cornell University FHB Advanced Line nursery.
2. Pyramid FHB resistance genes by hybridizing elite lines with native FHB resistance to new sources of FHB resistance, both Asian and other sources.
3. Evaluate FHB resistant lines in New York regional trials for release, farmer recommendations, and seed increase.
4. Participate in the coordinated sharing of information from the above activities to generate a comprehensive source of information that can be used in forward breeding strategies.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

- 1) major activities: Breeding, FHB nursery evaluations, recurrent selection, genomic selection.
- 2) specific objectives; Breeding –28 new crosses made with 2B and 5A sources, 74 new general FHB crosses made from FHB nursery selections; 225 populations were screened for FHB resistance alleles at the 3B and 5A loci; 250 screening nursery plots were grown from the previous year's selections. In our advanced trials, we have 3 new soft red FHB lines and one second-year selection. In our soft white winter wheat advanced trial we have 6 new FHB lines and 6 second-year entries. In our Master nursery, we have 115 FHB selected entries. Twenty lines selected using genomic selection were evaluated in two trials.
- 3) significant results: Our breeding program is the only public wheat breeding program in the northeastern U.S. that is releasing soft white and red winter wheat varieties that have been selected for FHB resistance.
- 4) key outcomes or other achievements: Over the past 8 years we have released of 6 new soft winter wheat varieties with at least moderate FHB and preharvest sprouting resistance. Two of the varieties have fhb1 from marker assisted backcrossing and four

FY16 Final Performance Report
PI: Sorrells, Mark
USDA-ARS Agreement #: 59-0206-4-007
Reporting Period: 5/3/16 - 5/2/17

have native resistance. Except for branded varieties, all varieties marketed in NY have at least some moderate resistance to FHB. We advise farmers to not grow susceptible varieties.

3. What opportunities for training and professional development has the project provided?

Each season we train up to 8 graduate students, 1-2 post docs and 4-5 undergraduates how to plan, set up, maintain, and score a misted, inoculated FHB nursery. They receive training on the significance of the disease, sources of inoculum, biology of fusarium, and implications of developing resistant varieties. The graduate students and post docs are also taught how to analyze the data and prepare summaries.

4. How have the results been disseminated to communities of interest?

Each year I have presented results of FHB evaluation at three field days and at county agent training schools. I distribute the results of our FHB evaluations both electronically by email and on our web site (<http://smallgrains.cals.cornell.edu>) and by hard copy to other wheat breeders and to stakeholders in New York and surrounding states.

Project 3: *Male Sterile Facilitated Recurrent Selection for FHB Resistance.*

1. What are the major goals and objectives of the project?

The objective of this project is to advance male-sterile facilitated recurrent selection populations that have been developed to combine genes for FHB resistance from multiple sources in soft winter wheat backgrounds adapted to the eastern U.S. In addition, this project will develop several pools of adapted breeding lines with genes for FHB resistance derived from multiples sources.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

- 1) major activities: Intermating dominant male sterile lines with multiple sources of resistance, selection of resistant plants, evaluation of selections.
- 2) specific objectives: The specific objects are to develop soft winter wheat populations with multiple sources of FHB resistance and improve those populations by recurrent selection.
- 3) significant results: To initiate this project, the dominant male sterile population was allowed to intermate with entries in the NWWSN for two generations. The population was then intermated for a generation followed by half sib selection. Since then, the dominant male sterile population was planted as replicated half sib families in the misted, inoculated FHB nursery. Male sterile plants were tagged at anthesis and three weeks later each half sib family was scored for FHB incidence and severity. The most resistant 25% of the families were selected and within each family, male sterile plants that showed the fewest symptoms were selected and harvested. Those selected plants became the half sibs for the next generation. A bulk harvest of the selected half sibs were planted adjacent to the half sib families to serve as a pollen source for the male steriles. In addition, male fertile plants from the selected families were planted in a replicated trial to determine if there has been an increase in FHB resistance resulting from selection over the past 5 generations.
- 4) key outcomes or other achievements: Our population appears to have a high level of FHB resistance and is well adapted to northeastern growing conditions. These populations will be beneficial to regional and local breeding programs because they are an adapted population of multiple sources of FHB resistance in a soft winter genetic background. This project will provide breeding programs in the eastern region with germplasm from which to extract breeding lines that have the potential to have unique combinations of FHB resistance genes.

3. What opportunities for training and professional development has the project provided?

Each season we train up to 8 graduate students, 1-2 post docs and 4-5 undergraduates how to plan, set up, maintain, and score a misted, inoculated FHB nursery. They receive training on the significance of the disease, sources of inoculum, biology of *Fusarium*, and implications of developing resistant varieties. The graduate students and post docs are also taught how to analyze the data and prepare summaries.

4. How have the results been disseminated to communities of interest?

We have reported the results of this project to other members of the Northern Winter Wheat FHB community.

Project 4: *Coordinated Phenotyping of Uniform Nurseries and Official Variety Trials.*

1. What are the major goals and objectives of the project?

Fusarium head blight resistance must be combined with high yield to impact the Eastern U.S. wheat industry. Our breeding program generates breeding lines each year for advanced stages of development and testing. Multi-location testing is needed to determine the FHB resistance of these lines, as well as their yield, quality, agronomic value, and resistance to other diseases.

Objectives: 1) Phenotype advanced breeding lines that are candidates for release: 2) place FHB and other agronomic, disease resistance, and quality data in database: 3) report on purification and seed increase of the best lines.

2. What was accomplished under these goals? *Address items 1-4) below for each goal or objective.*

- 1) major activities: major activities – Each year we have collected incidence, severity, FDK, and DON data on the NUWWSN by evaluating it in a misted inoculated FHB nursery. We normally enter four experimental lines each year and enter the results of the NUWWSN in a coordinated database.
- 2) specific objectives: 1) Phenotype advanced breeding lines that are candidates for release: 2) place FHB and other agronomic, disease resistance, and quality data in database: 3) report on purification and seed increase of the best lines.
- 3) significant results: Advanced lines that perform well in this nursery are entered into our state regional trials to determine if they are suitable for variety release.

FY16 Final Performance Report
PI: Sorrells, Mark
USDA-ARS Agreement #: 59-0206-4-007
Reporting Period: 5/3/16 - 5/2/17

- 4) key outcomes or other achievements: The results are included in our regional trial summaries that are distributed to extension personnel, farmers, and seed companies and published on the Internet. We also contribute to the T3 public database.

3. What opportunities for training and professional development has the project provided?

Each season we train up to 8 graduate students, 1-2 post docs and 4-5 undergraduates how to plan, set up, maintain, and score a misted, inoculated FHB nursery. They receive training on the significance of the disease, sources of inoculum, biology of fusarium, and implications of developing resistant varieties. The graduate students and post docs are also taught how to analyze the data and prepare summaries.

4. How have the results been disseminated to communities of interest?

Each year I have presented results of FHB evaluation at three field days and at county agent training schools. I distribute the results of our FHB evaluations both electronically by email and on our web site (<http://smallgrains.cals.cornell.edu>) and by hard copy to other wheat breeders and to stakeholders in New York and surrounding states. We also reported the results of this project to other members of the Northern Winter Wheat FHB community and uploaded the data into the FHB database.

Project 5: Implementing Genomic Selection for FHB Resistance in Soft Winter Wheat (SWW).

1. What are the major goals and objectives of the project?

The primary goal is to determine if genomic selection for FHB resistance is effective. Genomic selection uses a training population of lines that is phenotyped and genotyped. A prediction model is built using the phenotypic and genotypic data from the training population. That model can then be used to predict the value of other genotyped individuals that are related to the training population.

Objectives:

- 1) To implement GS for FHB resistance in soft winter wheat.
- 2) Initiate evaluation of the effectiveness of GS for FHB resistance in soft winter wheat lines.

2. What was accomplished under these goals? Address items 1-4) below for each goal or objective.

1) major activities: Genotyping advanced lines and phenotyping them for model training, line selection and crossing

2) specific objectives: Objectives:

- 1) To implement GS for FHB resistance in soft winter wheat by completing two cycles of GS.
- 3) Initiate evaluation of the effectiveness of GS for FHB resistance in soft winter wheat lines.

(Form – FPR16)

FY16 Final Performance Report
PI: Sorrells, Mark
USDA-ARS Agreement #: 59-0206-4-007
Reporting Period: 5/3/16 - 5/2/17

3) significant results: The results of the third cycle of selection are currently being analyzed and will be reported this winter and in a publication.

4) key outcomes or other achievements: Over the past three years we have phenotyped a training population of 649 lines. This includes 600 RILs (100 from each of six breeding programs, each phenotyped at the breeder's location) and 49 checks that were phenotyped by all six breeders at all locations and years. The lines selected using GS are currently being evaluated to measure gain from selection

3. What opportunities for training and professional development has the project provided?

Each season we train up to 8 graduate students, 1-2 post docs and 4-5 undergraduates how to plan, set up, maintain, and score a misted, inoculated FHB nursery. They receive training on the significance of the disease, sources of inoculum, biology of fusarium, and implications of developing resistant varieties. The graduate students and post docs are also taught how to analyze the data and prepare summaries.

4. How have the results been disseminated to communities of interest?

The results of this project are currently being analyzed and will be reported this winter at the Scab Forum and in a publication.

FY16 Final Performance Report
PI: Sorrells, Mark
USDA-ARS Agreement #: 59-0206-4-007
Reporting Period: 5/3/16 - 5/2/17

Training of Next Generation Scientists

Instructions: Please answer the following questions as it pertains to the FY16 award period. The term “support” below includes any level of benefit to the student, ranging from full stipend plus tuition to the situation where the student’s stipend was paid from other funds, but who learned how to rate scab in a misted nursery paid for by the USWBSI, and anything in between.

1. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their MS degree during the FY16 award period?** No

If yes, how many?

2. **Did any graduate students in your research program supported by funding from your USWBSI grant earn their Ph.D. degree during the FY16 award period?** Yes

If yes, how many? 4

3. **Have any post docs who worked for you during the FY16 award period and were supported by funding from your USWBSI grant taken faculty positions with universities?** Yes

If yes, how many? 1

4. **Have any post docs who worked for you during the FY16 award period and were supported by funding from your USWBSI grant gone on to take positions with private ag-related companies or federal agencies?** No

If yes, how many?

FY16 Final Performance Report
 PI: Sorrells, Mark
 USDA-ARS Agreement #: 59-0206-4-007
 Reporting Period: 5/3/16 - 5/2/17

Release of Germplasm/Cultivars

Instructions: In the table below, list all germplasm and/or cultivars released with full or partial support through the USWBSI during the FY16 award period. All columns must be completed for each listed germplasm/cultivar. Use the key below the table for Grain Class abbreviations. *Leave blank if you have nothing to report or if your grant did NOT include any VDHR-related projects.*

Name of Germplasm/Cultivar	Grain Class	FHB Resistance (S, MS, MR, R, where R represents your most resistant check)	FHB Rating (0-9)	Year Released

Add rows if needed.

NOTE: List the associated release notice or publication under the appropriate sub-section in the ‘Publications’ section of the FPR.

Abbreviations for Grain Classes

- Barley - BAR
- Durum - DUR
- Hard Red Winter - HRW
- Hard White Winter - HWW
- Hard Red Spring - HRS
- Soft Red Winter - SRW
- Soft White Winter - SWW

FY16 Final Performance Report
PI: Sorrells, Mark
USDA-ARS Agreement #: 59-0206-4-007
Reporting Period: 5/3/16 - 5/2/17

Publications, Conference Papers, and Presentations

Instructions: Refer to the FY16-FPR_Instructions for detailed instructions for listing publications/presentations about your work that resulted from all of the projects included in the FY16 grant. Only include citations for publications submitted or presentations given during your award period (5/3/16 - 5/2/17). If you did not have any publications or presentations, state 'Nothing to Report' directly above the Journal publications section.

Journal publications.

None

Books or other non-periodical, one-time publications.

Rutkoski, J.E., J. Crain, J. Poland, M.E. Sorrells. 2017. Genomic Selection for Small Grains Improvement. In: Genomic Selection for Crop Improvement. Springer International Publishing DOI: 10.1007/978-3-319-63170-7.

Other publications, conference papers and presentations.

Field days and Public Presentations Reporting FHB Information:

Extension Agent Training School – November 1, 2016

Wheat Management Field Day – June 8, 2016

Hudson Valley Field Day – June 12, 2016

Seed Growers' Field Day – July 6, 2016

NY State Legislature presentation – January 24, 2016

Status: Presented

Acknowledgement of Funding Support: Yes

Extension Publications

Cornell Small Grains Performance Trials – Hard copy mailed and pdf emailed to about 200 people.

Cornell Small Grains Performance Trials - 2016 Soft White Winter Wheat

<https://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/SWWW%20Reg16%20table.pdf>

Status: Published

Acknowledgement of Funding Support: Yes

Cornell Small Grains Performance Trials - 2015 Red Winter Wheat

<https://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/SRW%20Reg16%20Table.pdf>

Status: Published

Acknowledgement of Funding Support: Yes

FY16 Final Performance Report
PI: Sorrells, Mark
USDA-ARS Agreement #: 59-0206-4-007
Reporting Period: 5/3/16 - 5/2/17

Cornell Small Grains Performance Trials - 2016 Winter Malting Barley
[https://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/WMB%20Reg16%20T
able%2BMaltQuality.pdf](https://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/WMB%20Reg16%20T
able%2BMaltQuality.pdf)

Status: Published

Acknowledgement of Funding Support: Yes

Cornell Small Grains Performance Trials - 2016 Spring Malting Barley
[https://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/SMB%20Reg16%20Ta
ble%2BMaltQuality%2BDON.xls.pdf](https://plbrgen.cals.cornell.edu/sites/plbrgen.cals.cornell.edu/files/shared/SMB%20Reg16%20Ta
ble%2BMaltQuality%2BDON.xls.pdf)

Status: Published

Acknowledgement of Funding Support: Yes