USDA-ARS/
U.S. Wheat and Barley Scab Initiative
FY08 Final Performance Report (approx. May 08 – April 09)
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Cover Page

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Fiscal Year:	2008
USDA-ARS Agreement ID:	59-0790-4-100
USDA-ARS Agreement Title:	Mapping and Pyramiding Resistance Genes and Developing Hard Red Spring Wheats Resistant to FHB.
FY08 USDA-ARS Award Amount:	$ 133,207

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Adjusted Award Amount
VDHR-SPR	Development of Adapted Hard Red Spring Wheat Cultivars and Germplasm Resistant Scab Disease.	$115,285
VDHR-SPR	Screening Newly Introduced Spring Wheat Germplasm for Novel Sources of Resistance to Scab.	$ 17,922
	Total Award Amount	**$ 133,207**

Mohamed Mergoum 07/14/2009

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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
HWW-CP – Hard Winter Wheat Coordinated Project
VDHR – Variety Development & Uniform Nurseries – Sub categories are below:
SPR – Spring Wheat Region
NWW – Northern Winter Wheat Region
SWW – Southern Sinter Wheat Region

Project 1: *Development of Adapted Hard Red Spring Wheat Cultivars and Germplasm Resistant Scab Disease.*

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

Fusarium head bight (FHB) or scab still remains a major threat to wheat production and industry in the Northern Central Plains of the US. The disease is complex and causes significant reduction in grain yield and impacts negatively the wheat quality. In North Dakota, FHB disease had tremendous implications, particularly on HRSW producers; users; and export market. This problem is being addressed by the NDSU hard red spring wheat (HRSW) wheat breeding program by the development of elite and adapted genotypes/ lines/cultivars and breeding populations that incorporate diverse genetic resistance with desired agronomic and quality traits. Our strategy is based on pyramiding several types of genetic resistance to FHB from diverse sources into adapted cultivars using classical breeding methods and appropriate novel technologies such as selected molecular markers. Based on our accomplishments in this area, we strongly believe that genetic resistance is/will provides a strategic long-term, economically, and environmentally sound solution to the problem. During the 2008-09 growing cycle, our efforts have continued to develop elite HRSW germplasm and cultivars that are adapted to ND in particular, and spring wheat region, in general. Significant accomplishments have been achieved and are listed bellow.

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):

Accomplishments:

The HRSW breeding program at NDSU has many significant accomplishments. These are illustrated in the release of many HRSW cultivars and germplasm that are hallmark of wheat production in the spring wheat region in particular and in the US as a whole. These varieties are grown on large scale in ND and the entire Northern plains (ND, MN, SD, and MT) generating hundreds of millions of dollars of benefits for the growers, the industry and export market. These cultivars are the following:

- The most recent release **(2009)** by our HRSW program is **'Barlow'**. Before its release, Barlow was tested under **ND 809** experimental line for many years in different nurseries in our breeding program and in the regional nurseries, including URN and URSN. Barlow is also a derivative cultivar of Sumai3. Hence it has medium resistance to FHB is based on *fhb1* from Sumai3. The level of resistance of Barlow is close to Alsen and Faller, very popular HRSW cultivars in the spring region. However, Barlow has high yield than Alsen and Glenn, the number one cultivar in the spring region, very good leaf disease package compared to Glenn, and excellent quality attributes. Barlow has wide adaptation. It performs very well in all ND environments, including the Western dry land regions of ND.
- Prior to the release of Barlow, in **2007**, **Faller (ND805)** a derivative cultivar of Sumai3. Hence it has medium resistance to FHB, similar to Alsen. Faller is a very high yielding

cultivar with very good leaf disease package compared to Glenn and medium protein content. Faller is recommended for high rainfall and FHB prone spring wheat regions. It is the first NDSU cultivar with such high yield potential. Faller is becoming very popular in ND and MN. In 2009, Faller has become the second cultivar in wheat acreages after Glenn in ND.

- Prior to the release of Faller, **'Howard'** (**ND 800**) HRSW wheat variety was released in **2006** with good FHB resistance level comparable to Steele-ND. Both Howard and Steele-ND have FHB resistance different from Alsen (Sumai3). Howard has wide adaptation and recommended mainly, for the regions where Reeder and Alsen are grown because of its high yield level and good leaf diseases resistances package. Howard main attributes are FHB resistance, high yield and quality, and excellent leaf disease package compared to Alsen and Reeder. Howard has been grown on more than 5% of ND wheat acreages.
- **Glenn** (ND747) released in **2005** is now **The LEADING** HRSW cultivar in the spring wheat region replacing Alsen that dominated the wheat production for the last 5 years. Glenn with parentages involving both Sumai-3 and Steele-ND has higher FHB resistance level (better than Alsen variety**)**. In addition Glenn has excellent quality attributes allowing it to be the quality standard by the Wheat Quality Council and the industry in the USA. Based on the US-Wheat Associates survey (OVA), Glenn is now the most preferred cultivar by the wheat importers worldwide. Glenn is expected to dominate the wheat production for some years. In 2008, Glenn was grown on 29% (about 1.9 millin acres) of ND wheat acreages. In MN, Glenn was among the 3 top wheat cultivars.
- The **2004** HRSW release, **Steele-ND (ND 741)** has good FHB resistance level and wide adaptation is now a major grown cultivar in the spring wheat region. Steele-ND has been grown on more than 9% of ND acreages in the past two years. It is recommended mainly, for the regions where Reeder and Alsen are grown because of many attributes including high yield level. It expected that Steele-ND will replace significant acreages of Alsen and Reeder across all the State and probably other cultivars in the region.
- In 2007, we have released **ND 756** as a germplasm with FHB resistance (see publications). Prior to that, we have released several key sources of FHB resistance wheat germplasm including, ND 2710, ND 744, and ND 751 (See Crop Sciences).

Impact:

- In the past 5 years, about 60% (3.5-4 million acres) of ND spring wheat have been grown to NDSU cultivars. Among these common grown NDSU cultivars, **Alsen, Steele-ND, Glenn, Howard, and Faller HRSW cultivars have resistance to FHB** and excellent agronomic/quality traits contribute. These five cultivars have occupied more than 50% (>3 million acres) of wheat grown in ND. These figures show that **the impact** on wheat business (growers, industry and export market) of the FHB resistant HRSW cultivars developed by this program using partly, the USWBSI initiative funds **is phenomenal**.
- In addition, the NDSU HRSW cultivars are also grown in neighboring states (MN, SD, and MT) where spring wheat is a major crop and FHB is a threat. This is an important impact that should be factored in as well. For example, Glenn was third most grown cultivar in MN in 2008. In 2009, Glenn, Faller, Steele-ND, and Howard are very popular in MN, SD, and MT as well.

- Releasing superior and very high quality HRSW cultivars with improved **FHB resistance** has allowed ND growers to be competitive in the wheat market at the national and international levels.
- The HRSW germplasm with FHB resistance that we have released is well known and extensively used in the breeding program nationally and worldwide. Our HRSW breeding program is now a **'Center of excellence'** for wheat germplasm with high quality and **good sources of FHB** resistance.

Project 2: *Screening Newly Introduced Spring Wheat Germplasm for Novel Sources of Resistance to Scab.*

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

Fusarium head blight (FHB) or scab is a major wheat disease in the spring wheat region. Combating this disease while protecting our environment by growing genetically resistant and adapted cultivars is the soundest, efficient, economical, and safe strategy. Recently developed HRSW cultivars by NDSU breeding program (Faller, Howard, Glenn, Steele-ND, and Alsen) with moderate FHB resistance are being grown extensively in ND. These cultivars were grown on about 52% of North Dakota 6.8 million acres in 2008. Similar acreages were grown to NDSU FHB resistant cultivars in the past 5 years. However, new adapted cultivars with different and/or higher resistance levels, combining different sources of resistance to FHB and other diseases are needed. NDSU and other wheat breeding programs in the region main objective is to develop better wheat cultivars for the growers and end users in the US and international export markets. Previous studies have summarized the Fusarium head blight (FHB) sources of resistance in very few genotypes including Sumai 3, Ning 7840, Frontana, Nobeokabouza, 2375, Ernie, and Freedom. So far, Sumai3 is probably, one the most used germplasm for FHB resistance worldwide. In the spring wheat region, most released cultivars with FHB resistance are from the Chinese source. Genetic diversity is a major component of a successful breeding program. Hence, novel sources of resistance to FHB are needed today more than ever. The search for sources of resistance is essential to insure the development of FHB resistant spring cultivars.

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):

<u>Accomplishment:</u>

About 220 new genotypes along with the mostly resistant cultivars or genotypes are being screened for FHB. The germplasm includes 186 genotypes developed by CIMMYT using the funds from the USWBSI to introgress novel FHB sources of resistance into the US wheat germplasm and 36 genotypes received from East Europe. The screening is being continued in 2009 under field conditions. The field screening is being conducted at Prosper, ND using the Scab nursery. The nursery is equipped with a misting system to keep humidity at the optimum level for disease development. The greenhouse screening will be conducted in the

fall of 2009 and will include only genotypes that showed good levels of FHB resistance in the field tests. Plants will be misted periodically to maintain the proper relative humidity for disease development. The 2008 screening nurseries were very successful. The results showed excellent FHB infection levels which allowed us good discrimination among genotypes. The screening nurseries are being repeated in 2009. Final selection and data analysis over the two years project period will be done in Fall 2009. However, preliminary results showed very few genotypes among 220 that have some FHB resistance.

Impact:

Divers sources of FHB resistance are paramount to the wheat breeding programs in the region where scab is a major limiting factor. These different sources allow our breeding programs to develop cultivars with high and durable FHB resistance. The NDSU HRSW breeding program has released several wheat cultivars with FHB resistance. This has allowed the US wheat growers in the spring region to grow once again, on a large scale (3-4 million acres), wheat in scab prone regions. This obviously, has been generating for the growers, hundreds of millions of dollars annually. Similarly, the wheat industry is having better wheat quality for their products, particularly during the scabby years. In addition, as more than 50% of total HRSW is exported worldwide for its superior quality, the NDSU HRSW cultivars with high quality and scab resistance has allowed our export market to be more competitive at the international level. Hence, substantial financial impact on wheat industry and export market due to NDSU HRSW cultivars has been generated. Finally, NDSU germplasm with FHB resistance and high quality is being used nationally and internationally in the research improvement program as a hallmark sources for these traits. Therefore this project has a tremendous potential impact.

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.

Mergoum, M., R. C. Frohberg, T. Olson, T. L. Friesen, J. B. Rasmussen, and R. W. Stack. **2008.** Registration of 'Faller' spring wheat. **Journal of Plant Registrations Vol 2, No. 3:224-229.**

Mergoum, M., R. C. Frohberg, and R. W. Stack. **2008**. Registration of spring wheat germplasm ND 756 combining resistances to Fusarium head blight, leaf spotting, and rusts diseases. **Journal of Plant Registration Vol. 2, No.1:61-64.**

Mergoum, M., P. Singh, R. C. Frohberg, S. Kianian, S. Simsek. **2009**. Registration of the Steele-ND/ND 735 Recombinant Inbred Lines Mapping Population. **Journal of plant Registration *(Accepted).***

If your FY08 USDA-ARS Grant contained a VDHR-related project, include below a list 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. If this is not applicable (i.e. no VDHR-related project) to your FY08 grant, please insert 'Not Applicable' below.

Mergoum, M., R. C. Frohberg, T. Olson, T. L. Friesen, J. B. Rasmussen, and R. W. Stack. **2008.** Registration of 'Faller' spring wheat. **Journal of Plant Registrations Vol 2, No. 3:224-229.**

Mergoum, M., R. C. Frohberg, and R. W. Stack. **2008**. Registration of spring wheat germplasm ND 756 combining resistances to Fusarium head blight, leaf spotting, and rusts diseases. **Journal of Plant Registration Vol. 2, No.1:61-64.**

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