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

Cover Page

Principle Investigator (PI):	Erick De Wolf
Institution:	Kansas State University
E-mail:	dewolf1@ksu.edu
Phone:	785-532-3968
Fiscal Year:	2016
USDA-ARS Agreement ID:	59-0206-6-015
USDA-ARS Agreement Title:	Prediction Models and Improved Pre-Harvest Estimates of Deoxynivalenol.
FY16 USDA-ARS Award Amount:	$ 86,424
Recipient Organization:	Kansas State University 10 Andrerson Hall Manhattan, KS 66506
DUNS Number:	929773554
EIN:	48-0771751
Recipient Identifying Number or Account Number:	AR9851 / GAPP603919
Project/Grant Reporting Period:	6/7/16 - 6/6/17
Reporting Period End Date:	06/06/17

USWBSI Individual Project(s)

USWBSI Research Category*	Project Title	ARS Award Amount
MGMT	Continued Deployment of Prediction Models for Fusarium Head Blight.	$ 12,378
MGMT	Functional Analysis for Getting Better Weather-based Predictors of Fusarium Head Blight.	$ 33,512
HWW-CP	Development of Scab Resistant Wheat Cultivars for Kansas.	$ 40,534
	FY16 Total ARS Award Amount	**$ 86,424**

Erick D. DeWolf 7/28/17
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

FY16 Final Performance Report
PI: De Wolf, Erick
USDA-ARS Agreement #: 59-0206-6-015
Reporting Period: 6/7/16 - 6/6/17

Project 1: *Continued Deployment of Prediction Models for Fusarium Head Blight.*

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

1. Continued deployment of the disease prediction models in 30 states including the support of the state commentary tools, FHB Alerts and the web-page information explaining the models. **2**. Continued support of the new back-up system for improved system stability. **3**. Refine a version of the FHB Prediction Center for use with mobile devices (cellular-based mobile/"smart" phones and tablets). **4.** Redesign of the expert tools to allow disease specialists to record and display disease observations – for refinement in the delivery of the current and experimental models. **5.** Develop training modules to help state specialists learn to use the prediction tools more effectively. **6.** Verify model inputs and improved capacity for site-specific predictions. **7.** Implement a user survey to document value of the prediction system and its impact on stakeholders.

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

1) major activities
   i. Disease prediction models were delivered to stakeholders in 30 states via web-based tools including. This effort included support for state commentary feature that enables local disease experts to post the assessment of disease risk and recommendations for control. This commentary is also sent to stakeholders via the FHB Alert system**.**
   ii. Continued support and development "behind the scenes" that enhances the stability of the web-based tools and reliability of the forecasts. This includes refinements of a new back-up system for weather information used to develop the disease risk maps.
   iii. Implemented a new protocol that uses additional sources of weather data that improve the accuracy and reliability of the disease risk maps in the US.

2) specific objectives
   i. Continued support of mobile version of the FHB Prediction Center for use with cellular-based mobile/"smart" phones and tablets
   ii. Refined expert tools that allow disease specialists to evaluate the next generation of prediction models prior to deployment were also developed this year. These tools were used extensively to develop case studies that compared current models to new models that were candidates for public use.
   iii. Developed case studies on new predictive models as training modules for disease experts in the US. These were presented to wheat disease specialist at scientific meetings and via conference calls to help state specialists learn to use the prediction tools more effectively.

3) significant results
   i. Disease prediction models were delivered to stakeholders in 30 states via web-based tools including.
   ii. FHB Alerts distributed timely information regarding disease risk and management recommendations in key areas affected by FHB.

4) key outcomes or other achievements

This forecasting system uses web-based tools to provide daily estimates of disease risk for 30 states with a history of Fusarium head blight. More than 4,300 users use the system annually. A survey of these users indicates that the annual impact of the Fusarium predictive models exceeds $65 million annually.

User surveys indicate that the information provided by the disease forecasting effort and FHB Alerts influence disease management decisions on 3,000,000 acres of wheat and barley.

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

The training modules and case studies supported by this project were used to improve the skill of disease experts in the states involved in the disease forecasting effort and commentary tools. These presentation and discussion sessions were presented at multiple venues and involved more than 20 wheat disease experts.

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

Disease prediction models were delivered to thousands of stakeholders in 30 states via web-based tools including. This effort included support for state commentary feature that enables local disease experts to post the assessment of disease risk and recommendations for control. This commentary is also sent to stakeholders via the FHB Alert system**.**

Project 2: *Functional Analysis for Getting Better Weather-based Predictors of Fusarium Head Blight.*

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

The specific objectives for this project include: (1) Coordinate the collection of new observations from the IM-CP used in developing and testing future models; (2) Conduct quality checks on the new observations before including them in the expanded dataset; (3) Improve the prediction accuracy of models for FHB and DON by (i) including predictors from time periods not considered by the current models, and (ii) by using functional data analysis to identify signal locations within the expanded time series; (4) Evaluate the potential value of prediction models as part of the integrated management program for FHB and DON using Bayesian decision theory.

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

1) major activities
Coordinated the collection of new observations from the 2016 and preliminary results from the 2017 growing season with cooperators from Ohio State University and members of the IM-CP.

Combined these new observations with weather data and conducted quality checks on the new observations before including them in the expanded dataset used in disease modeling.

2) specific objectives
Improve the prediction accuracy of models for FHB and DON by (i) including predictors from time periods not considered by the current models, and (ii) by using functional data analysis to identify signal locations within the expanded time series. (iii) develop journal publications of modeling effort to document progress of scientific community.

3) significant results
The expanded data sets and functional data analysis has identified that it may be possible to identify FHB epidemics 3 to 4 weeks prior to the crop growth stages critical disease management. This is significantly earlier that the current prediction models that make predictions just days prior to the critical growth stages. We are now in the process of developing and testing models based on these extended time periods.

4) key outcomes or other achievements
These results will serve as the foundation for improved disease prediction models that could provide more timely estimates of disease risk for stakeholders. This information will enable growers to better determine when and if fungicide applications are needed to suppress the risk of FHB and DON.

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

Nothing to report

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

Presentations and posters and scientific meetings and stakeholders. Prediction models currently in use by Fusarium Prediction Center deliver forecasting models to thousands of wheat and barley producers in the US.

Project 3: *Development of Scab Resistant Wheat Cultivars for Kansas.*

1. **What are the major goals and objectives of the project?**
   The long-term goal of this research is to develop hard red and hard white winter wheat cultivars adapted for Kansas with improved resistance to scab. Short term objectives are to: 1) test existing local cultivars for resistance, 2) test advanced breeding lines for resistance, 3) test exotic germplasm lines for resistance, 4) test the Hard Winter Wheat Scab Nursery (Kansas, Nebraska, South Dakota, North Dakota) for reaction to scab, and 5) incorporate new sources of scab resistance into the Kansas wheat breeding program. Testing will be done in misted field nurseries using soil-applied infested corn grain inoculum and in the greenhouse using single-floret inoculations. Visual disease evaluation methods will be used to rate the percentage spikelets killed by the pathogen and ground grain samples will be analyzed for the toxin DON.

2. **What was accomplished under these goals?** *Address items 1-4) below for each goal or objective.*
   1) major activities.
      Until involvement in the USDA Scab Initiative, there was virtually no effort to identify sources of scab resistance in Kansas breeding programs. The Initiative has resulted in the development of accurate and efficient greenhouse and field testing nurseries that are providing useful ratings for current cultivars in Kansas and advanced breeding lines, and allow participation in the regional scab nurseries.

   2) specific objectives.
      The FHB phenotyping nurseries allow dissemination of information to growers on the reaction of current commercial cultivars, selection by breeders for scab resistance in their breeding lines, and identification of additional sources of resistance from other breeding efforts in the region that can be incorporated into Kansas breeding lines. Kansas has also taken the lead in organizing a Hard Winter Wheat Scab Screening Nursery for the hard winter wheat breeding programs of Kansas, Nebraska, South Dakota, and North Dakota. This latter nursery provides valuable data on the reaction of hard winter wheat cultivars to scab in their area of adaptation. The long-term goal of the research is to develop, deploy, and advertise winter wheat cultivars adapted for Kansas with improved levels of resistance to scab.

   3) significant results.
      Two commercial cultivars in Kansas (Hondo and Heyne) were identified in 2000 (and confirmed in later years) as having good levels of scab resistance (3 and 4 on the 1-9 scale where 1=immune and 9=highly susceptible). These cultivars averaged only 12 and 15% scab, respectively compared with about 50% in susceptible cultivars. Similarly, the cultivar Lakin has shown moderate levels of resistance with 22-34% scab. Six other commercial cultivars have also displayed moderate levels of resistance equal to, or better than, Lakin. Therefore, we have identified a few sources of scab resistance already present in cultivars adapted to Kansas that can be used by producers and may be potential sources of "native" resistance for the development of future cultivars. Both KSU wheat breeders and the USDA wheat geneticist have been involved in the project by having

their breeding lines evaluated for resistance to scab. Several breeding "populations" are tested each year from which the breeders make selections of promising lines showing resistance. Also, there are approximately 40 advanced breeding lines (The Kansas Intrastate Nursery) that are tested each year. In 2009, Kansas State University released the first hard red winter wheat cultivar adapted to Kansas selected for improved levels of resistance to scab. This variety "Everest" is still the top variety in KS representing more than 60% of the acres planted in regions most prone to FHB. KSU released a new variety with moderate levels of resistance to FHB in 2016, several private companies also have recent releases with improved resistance to FHB.

The screening nurseries were essential in the development of these varieties.

4) key outcomes or other achievements
Because of the scab testing efforts, a new column for reaction to "Head Scab" was added to the popular KSU extension publication *Wheat Variety Disease and Insect Ratings* for the fall, 2000 issue and has been updated in each subsequent year. For the first time, this has allowed producers in Kansas to use the reaction to scab to help select cultivars for planting. Similarly, data produced from nurseries funded by the Scab Initiative have been incorporated into another popular extension publication (*Kansas Performance Tests with Winter Wheat Varieties*). Both publications are available as "hard copy" or online. The involvement of breeders has resulted in significant progress to improve the level of resistance to scab in future commercial wheat cultivars. This research has resulted germplasm releases in 2004 and 2014 from Kansas State University with resistance to scab. It normally takes 10-12 years to produce a new wheat cultivar from the time initial crosses are made. Right on schedule, the first Kansas scab-resistant cultivar (Everest) produced directly from the activity of the Initiative was released in Fall 2009, 10 years after beginning to receive funding from the Initiative. It has increased in popularity so that it is now is the number one planted cultivar in Kansas. The adoption of this cultivar has significantly lowered the susceptibility of the state's wheat crop to scab; 22% lower statewide and 40% lower in the eastern part of the state where scab is prevalent.

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

None to report

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

Reports of the phenotyping nurseries are sent to all cooperating breeding programs. These include the public wheat breeding efforts in Kansas, Nebraska, South Dakota, and North Dakota. Similar reports are sent to the breeding efforts in participating private companies (AgriPro, Limagrain, and West Bred). As noted above, the extension publications *Wheat Variety Disease and Insect Ratings* and *Kansas Performance Tests with Winter Wheat Varieties* are updated each year for access online or via paper copies by wheat producers, county agents, and crop consultants.

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?**
   None to report

   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? One

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?**
   None to report

   If yes, how many?

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?**
   None to report

   If yes, how many?

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**
Zenda	HRW	MR	4	2016

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

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 (6/7/16 - 6/6/17). 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.
None

Other publications, conference papers and presentations.

Hollandbeck, G., De Wolf, E., Todd, T. and Bockus, W. 2016. Kansas Cooperative Plant Disease Survey Report: Preliminary 2016 Kansas Wheat Disease Loss Estimates. https://agriculture.ks.gov/docs/default-source/pp-disease-reports-2012/2016-ks-wheat-disease-loss-estimatesd150db002e6262e1aa5bff0000620720.pdf?sfvrsn=0
Status: Published, Technical report
Acknowledgement of Federal Support: No, technical report

Lingenfelser, J., Bockus, W., De Wolf, E., Fritz, A., Knapp, M., Lollato, R., Miller, R., Whitworth, J., Adee, E., Cramer, G., Esser, A., Kimball, J., Evans, P., Mengarelli, L., Schlegel, A., Seaman, Zhang, G., C., Chen, M., Chen, R., Knapp, L., Knopf, J., Bohnert, C. 2016. Wheat Performance Tests with Winter Wheat Varieties: Report of Progress. Kansas Agricultural Experiment Station; No. 1128.
Status: Published Technical Report
Acknowledgement of Federal Support: No

Bockus, W.W., De Wolf, E. D. and Wegulo, S. N. 2016. Effect of Prosaro® fungicide application on Fusarium head blight in seven winter wheat cultivars, 2015. *Plant Disease Management Reports* 10:CF042.
Status: Published Technical Report
Acknowledgement of Federal Support: Yes

De Wolf, E. D., Lolatto, R. and Whitworth, J. R. 2016. Wheat variety disease and insect ratings, 2016. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Pub. No. MF991.
Status: Published extension publication
Acknowledgement of Federal Support: No

De Wolf, E. D. 2016. Foliar fungicide efficacy ratings for wheat disease management, 2016. Kansas State University Agricultural Experiment Station and Cooperative Extension Service. Pub. No. EP130.
Status: Published extension publication
Acknowledgement of Federal Support: No

DeWolf, E., Knapp, M. and Lollato, R. 2016. Risk of Fusarium head blight (scab) in wheat. Agronomy eUpdate No. 566.
Status: Published extension newsletter
Acknowledgement of Federal Support: No