U.S. WHEAT & BARLEY SCAB INITIATIVE

Fusarium Focus

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USWBSI Coping With Big Budget Reduction

Initiative Faces $1.5 Million Cut in ARS Funding

Along with others in the ag research community, leaders of the U.S. Wheat & Barley Scab Initiative (USWBSI) were sent reeling in early March when the USDA Agricultural Research Service (ARS) notified them of a dramatic cut in ARS support for fiscal year 2012. All told, ARS is cutting $21.6 million from extramural programs through an across-the-board 30% reduction to all cooperative agreements with universities and initiatives (such as USWBSI), based on FY 2011 funding levels.

For the Scab Initiative, a 30% cut translates into approximately $1.5 million out of a total annual budget of about $5 million. That $5 million is spread among 120 research projects designed to find solutions to Fusarium Head Blight (scab) and its resulting mycotoxin, deoxynivalenol (DON), in wheat and barley. USWBSI plays a major role in coordinating this research to avoid duplication and to ensure that the results of basic and applied research benefit stakeholders (farmers, crop advisors, millers and maltsters) as quickly as possible.

The ARS cuts have their roots in the fiscal year 2012 federal budget, finalized by Congress in November. The budget mandated that ARS close 12 laboratories, including nine research stations and three units within one large research station. Shutting down those facilities — and moving approximately 300 affected employees to different locations — carries a price tag of about $40 million. The $21.6 million reduction in extramural program funding constitutes a large part of ARS' answer to paying for those shutdowns and moving costs.

University of Kentucky wheat breeder and USWBSI co-chair Dave Van Sanford says the ARS announcement of the 30% funding cut definitely caught the Initiative by surprise. After the initial shock, however, USWBSI leaders understood that ARS needed to take some drastic measures to cover the $40 million closing/relocation price tag.

"While the large reduction in funding is disappointing and unfortunate, it's a reality — and we have to work with it," Van Sanford says. In response, the USWBSI Executive Committee is implementing the following six-point strategy:

1. ARS research projects being funded through the Initiative will continue to receive funding at FY11 levels because ARS indicated its scientists had already undergone significant budgetary stress up to this point (*e.g.*, vacant positions not being filled).

2. DON testing laboratories will be funded at the lower of FY11 or FY12 levels "because we regard those labs as an essential service performed by the Initiative," Van Sanford explains.

3. The FHB Risk Assessment (forecasting) Tool also will be funded at the lower of the FY11 or FY12 levels "since it is the heart of the FHB Alert System, which is an essential service for our stakeholders."

4. The budget of the USWBSI NFO (National Facilitating Office) was whittled down to an absolutely bare-bones level, Van Sanford reports.

5. A 30% reduction was instituted "for all remaining projects that had been funded in FY11 that we regarded as core, ongoing, productive projects" for FY12."

6. Even with the above budget-cutting steps, more was needed. So the decision was made to not fund any research projects that were new as of FY 2012 — even if those projects had received a "green light" following USWBSI's extensive review process.

Despite the setback represented by this cut in ARS funding, "our commitment to the mission of the Scab Initiative is not diminished in the slightest," Van Sanford emphasizes. "But a 30% budget reduction obviously means that for now, fewer breeding lines will be screened, fewer plots will be sprayed, and fewer gene constructs will be evaluated."

The Initiative received the final, official FY 2012 budget from ARS in early April and is currently working with PIs on finalizing their grant applications that in turn will be sent to ARS as the USWBSI's official FY12 Research Plan and Budget. ❖

— 2011 FHB Forum —

Attendance Tops 200 at FHB Event

Nearly 210 scientists, growers and wheat and barley industry representatives gathered on December 4-6 for the 2011 National Fusarium Head Blight Forum. The 14th FHB Forum took place at the Hyatt Regency St. Louis at the Arch, downtown St. Louis, Mo.

The event featured stakeholder and scientific invited speaker presentations, along with focused group discussions and evening breakout sessions. Numerous research posters were on display as well, with primary authors present to discuss the projects and their findings.

Organized and hosted by the U.S. Wheat & Barley Initiative (USWBSI), the Forum provides a key venue for reports on the latest research findings on Fusarium Head Blight (scab) and deoxynivalenol (DON), the mycotoxin produced by scab infection in grains.

The USWBSI Steering Committee met following the Forum adjournment.

The following pages contain photos and narrative of excerpted highlights from the 2011 Forum. Full Forum proceedings are on USWBSI's website: www.scabusa.org. ❖

Above: Attendees at the 2011 FHB Forum represented a variety of scientific disciplines and commercial entities — from USDA and university research and extension personnel, to grain growers and agribusiness.

Below: With the Gateway Arch just across the street from the Forum hotel, some attendees took time for a ride to the top of the Arch. Skies were overcast, but the downtown view was still impressive.

Mark Your Calendar!

2012
National Fusarium Head Blight Forum

December 4-6

Wyndham Orlando Resort
Orlando, Fla.

— 2011 FHB Forum —

With the 2011 National Fusarium Head Blight Forum taking place in St. Louis, it was only fitting that the event kicked off with a presentation by an Anheuser-Busch official.

Ralph Judd III *(above)*, director of raw materials for ABInBev, was the meeting's keynote speaker. ABInBev is the world's leading brewer. The company has a global portfolio of more than 200 beer brands and holds the number-one or number-two market position in 19 countries.

Judd's presentation focused, appropriately enough, on barley. Specifically, his talk was titled, "What Is Happening to Barley, the Soul of Beer?" Noting that barley has been in a difficult battle for acreage in the United States for several years, he asked and answered the question of whether that was due to Fusarium Head Blight and the presence of its resulting mycotoxin, DON, in malt derived from barley. DON in malt used to make beer can cause gushing — "and the main thing brewers are not interested in is gushing," Judd affirmed. "We cannot make fine malt from inferior barley, and we cannot make fine beer from inferior malt."

His answer, in a nutshell, was "no," DON is not the big culprit behind declining barley acreage. The A-B executive pointed out that "if you have measurable DON in your barley, you (*i.e.*, maltsters and brewers) can actually wash it off" during the steeping segment of the malting process. "We're buying DON barley as a company," Judd affirmed. "We're dealing with it. We spend a little more on water, and we spend a little more on measuring (for DON). But it's not going to keep us from buying barley."

That doesn't mean progress against FHB and DON-infected barley is not important; far from it, he emphasized. "But it's not our big problem."

Are GMOs in other crops part of the problem behind declining barley acreage? Yes, Judd suggested. Crops like corn, soybeans and canola — with which barley competes for acres — enjoy an edge among farmers due to their GMO component.

'We spend a little more on water, and we spend a little more on measuring (for DON). But it's not going to keep us from buying barley.'

Is market demand for barley part of the problem? Again, yes, he said. Usage of barley for alcohol has been on a flat trend line for years, he noted. But, demand for barley as a livestock feed has declined significantly.

A lower level of malt demand also has played a pivotal role. The pounds of malt used per barrel of beer in the United States peaked in 2003 and has since trended downward, according to Judd. Why? There are several reasons:

- Brewers are able to achieve greater yield per bushel of malt, due to (1) newer malting barley varieties providing more extract per bushel of barley, and (2) quality improvements in the malting process.
- Sales trends toward more low-calorie (light) beers and more low-carb beers, both of which require less malt per barrel.
- Significant improvement in brewing performance and efficiency.
- An economic impact, as more "value" brand beer is bought and consumed, as opposed to "premium" beers.
- And finally, the flat trend in beer sales in recent years.

Despite this trend, "we still need barley to make beer," Judd stated. "And we're still going to make (about) 200 million barrels of beer in this country [per year]. So we need barley.

"We (barley) are a niche — and we have to be competitive." And that's where public and private research comes into play. Judd outlined the increasing commitment his company has made to barley breeding and field technology, and he affirmed the importance of the work carried out by the assembled FHB/DON researchers to help keep barley a competitive crop that farmers will want to grow. ❖

— 2011 FHB Forum —

Don Sullins, vice president of regulatory affairs and technical services for ADM Milling Company, spoke to the Forum on the economic implications of mycotoxin contamination from the milling industry perspective.

"Mycotoxin outbreaks occur from year to year, and we as processors, ingredient manufacturers and food companies, have to be extremely careful not to permit these compounds into our food products and ultimately reaching the consumer," Sullins emphasized. He noted that the European Union has in place specific regulations for deoxynivalenol (DON) and for Ochratoxin A in food systems. Canada has DON standards for soft wheat, but none at present for hard red winter or spring wheats. Meanwhile, "the United States has standards for aflatoxin in corn, guidelines for DON in wheat products only (*i.e.*, bran, germ, flour) and none for Ochratoxin in food products.

"With the recent food recalls, the Food Safety Modernization Act and consumer demands for safer foods, the pressure is on us — the processing industry — to remove all concerns regarding potential contaminants and food safety for the consumer," Sullins stated. For the processor, that endeavor begins with the initial determination of whether to accept an in-bound commodity based solely on its mycotoxin levels. The required technology, time and labor to do so can add a significant cost — but has become more important then ever, given the more-aggressive surveillance by regulatory agencies and the need to assure consumers of the safety of their food. Another element coming into play is the need of a mill — should local grain not be acceptable — to source its supply from more-distant areas, which adds significant transportation costs.

"As a processor, we would encourage even-greater research efforts to develop resistant varieties that provide the producer a better-quality crop, the processor a raw material that is more consistent year-to-year for quality — and the consumer a quality retail product mitigating rising food prices," Sullins told the Forum audience. ❖

Speaker Don Sullins (right) visits with USWBSI Co-Chair Dave Van Sanford.

Left: Harold Trick, Kansas State University plant pathologist, provided an overview of wheat transformation at KSU. "More than half of the research projects at Kansas State University's Plant Transformation Facility are now focused on transgenic wheat," Trick reported.

Right: Xiwen Cai, wheat genetics and cytology, North Dakota State University, gave an update on recent progress and ongoing challenges in breeding for FHB resistance in durum wheat.

— 2011 FHB Forum —

"A New Understanding of DON's Mechanisms of Action" was the topic for **James Pestka**'s *(right)* address to the 2012 Forum. Pestka, professor of food science and human nutrition at Michigan State University, pointed out that DON is a "very frequent contaminant of cereal-based foods throughout the world." DON's capacity to cause grower suppression and emesis (vomiting) in animals has been confirmed in numerous animal experiments. Now, biomarker studies have confirmed "that human exposure to this toxin is relatively common and closely correlated with grain consumption," Pestka noted.

The problem has been exacerbated, he added, by recent changes in global climate and agricultural practices that have increased fusarial blight. "The inherent challenge of balancing risks (human growth stunting and acute illness) and benefits (availability of essential dietary staples) associated with consuming DON-containing grains has created a public health dilemma," Pestka stated.

The MSU researcher pointed out that DON's anorexic and emetic effects are very consistent with aberrant hormonal and neuronal signaling within the "gut-brain" axis that is responsible for appetite control. However, the underlying mechanisms for such dysregulation remain, as yet, undetermined.

"We propose that DON induces anorexia and emesis by aberrantly inducing secretion of gut satiety hormones by enteroendocrine cells," Pestka explained. That hypothesis is based on the his research group's own studies of plasma levels of the gut satiety hormones cholecystokinin (CCK) and/or peptide YY (PYY) in mice and mink. In addition, other research has demonstrated that in animals *and* humans, CCK and PYY induce appetite suppression at low doses, but nausea/emesis at high doses. (Interestingly, both gut satiety hormones and DON analogues are being studied for their potential beneficial effects in curbing appetite in obese patients.)

"Once it is known how DON disrupts regulation of the gut-brain axis, it will enable the rational design of targeted cell, animal and epidemiological studies to better understand the potential for adverse chronic and acute effects in individuals who consume this and related trichothecene mycotoxins," Pestka observed. A better understanding of trichothecene-induced anorexia and emesis relative to critical initiating events, hormonal mediators, neuronal targets and effect longevity should result.

The findings will be an "initial step in the path to predicting the specific thresholds of DON and other food-borne toxins for eliciting adverse human effects, as well as the persistence and reversibility of these effects," he concluded. That, in turn, will facilitate more "science-based safety assessment" and will result in better management strategies for reducing the risk of food-borne illness from DON and other trichothecenes while simultaneously helping to assure food security. ❖

Right: The traditional poster sessions again were a popular venue at the FHB Forum in St. Louis. There were 95 posters available for attendees to review at various times during the Forum, with most authors also present for questions and discussion. There were 16 posters under the Gene Discovery and Engineering Resistance research area; nine under Pathogen Biology and Genetics; 24 under FHB Management; 41 under Variety Development and Host Resistance; and five posters under Food Safety, Toxicology and Utilization.

— 2011 FHB Forum —

Invited speaker **Carl Bradley**'s *(right)* presentation focused on assessing the best fungicide application timing for Fusarium Head Blight and mycotoxin management. The University of Illinois plant pathologist noted that current recommendations for the use of products like Caramba® and Prosaro® call for application at the beginning of anthesis (Feekes growth stage [FGS] 10.5.1). However, in the "real world," producers may not be able to time a fungicide application to fit the "perfect" growth stage, due to factors like unfavorable weather, inability to obtain a professional applicator's services at that specific time, or variability in wheat growth and development within a field.

Bradley reported on 2010 multi-state research (funded by the U.S. Wheat & Barley Scab Initiative) that looked at the efficacy of Caramba and Prosaro when applied at three different growth stages: FGS 10.5 (heading complete), FGS 10.5.1 and five days following 10.5.1. Across all locations combined, mean control of FHB with Caramba was

43%, 54% and 41% for FGS 10.5, 10.5.1 and five days following 10.5.1, respectively. For Prosaro, the mean control for those three times was, respectively, 28%, 53% and 42%. For DON, the mean control with Caramba at the three timings was 15%, 45% and 41%, respectively. Mean control of DON with Prosaro was 34%, 25% and 45%, respectively.

A separate 2011 University of Illinois study evaluated the efficacy of Prosaro or Caramba applied to wheat at FGS 10.5.1, at three days after 10.5.1 and at six days following 10.5.1. Wheat heads were inoculated with *Fusarium graminearum* at FGS 10.5.1 (about six hours following the 10.5.1 fungicide treatment). FHB was significantly reduced by all fungicide treatments compared to the non-treated control. "However, Caramba and Prosaro applied at FGS 10.5.1 provided the greatest control of FHB (93.7% and 93.4%, respectively)," Bradley reported. But none of the treatments significantly reduced DON in comparison to the study's non-treated control.

The bottom line, Bradley concluded, is that "in general, FGS 10.5.1 appears to be the most effective timing for control of FHB and DON; but applications made a few days after FGS 10.5.1 may also provide a benefit in reducing FHB and DON levels." ❖

University of Minnesota barley breeder **Kevin Smith** *(right)* updated 2012 National Fusarium Head Blight Forum participants on his work with genomic selection for Fusarium Head Blight resistance in barley.

Smith explained that FHB resistance in barley is especially challenging since it has relatively low heritability, is difficult and expensive to phenotype in the field, and is correlated with such unfavorable traits as late flowering, tall plant height and high grain protein concentration.

"Phenotypic breeding efforts have produced advanced breeding lines and one new variety ("Quest") with improved resistance," Smith noted. "However, these efforts required a minimum of three breeding cycles from the exotic source of resistance to produce an acceptable variety."

Association mapping studies with elite germplasm have indicated that multiple QTLs with relatively small effects are segregating in breeding populations, Smith said. That suggests genomic selection (GS) "may be more effective than traditional MAS."

Adding to the attractiveness of GS is the existence now of inexpensive and

high-throughput genotyping platforms.

The primary advantage of genomic selection is the ability to select parents much sooner in the breeding process, Smith noted. That leads to a dramatic reduction in the length of the breeding cycle (down to as little as one year) and in increasing gain per unit of time.

"The key to success of GS is training accurate models using marker and phenotype data sets to predict breeding values," the Minnesota barley breeder stated. He has implemented genomic selection in a barley breeding population that was developed by crossing elite parents from three different Midwest barley programs to enhance FHB resistance. The first cycle of GS was conducted in the fall of 2010 with 384 markers on about 1,400 F3 breeding lines. The correlation beween the GS prediction and the observed FHB in field trials was 0.54, indicating that GS should be useful in increasing the rate of improvement of FHB resistance in barley. ❖

— 2011 FHB Forum —

University of Nebraska wheat breeder **Stephen Baenziger** *(right)* provided both sides of the score card in his talk, titled "Breeding for Scab Resistant Hard Winter Wheat: The Thrill of Victory and the Agony of Defeat."

"Of all the traits we breed for in the Great Plains, breeding for Fusarium Head Blight is certainly among the most difficult," Baenziger affirmed. A primary reason why, he explained, is the highly variable climate of Great Plains states, where east-to-west gradients range from relatively high rainfall to very low annual rainfall. Even the more-arid parts of the Great Plains can incur serious FHB outbreaks in years of higher rainfall — partly because rains often occur around the time of wheat flowering. Also, there's more corn being grown in these areas and, as well, more minimum tillage.

Add to all that a breeding nursery complication: "Much of the Great Plains has winds during the night and early morning, which dry the wheat tissue before infection can occur, even under mist irrigation," the Nebraskan pointed out. That makes selecting for FHB-tolerant lines even more challenging.

Nonetheless, "excellent progress has been made with identifying and deploying native resistance," Baenziger reported. Cultivars such as Everest (a Kansas State University release), Overland (Nebraska), Lyman (South Dakota), Art

(Syngenta) and Hitch (Westbred) have higher tolerance to FHB than others and are proving commercially successful throughout the region. Overland, for instance, was planted on 11% of Nebraska wheat acreage in 2011 and is also grown in adjacent states. Such developments constitute the "thrill of victory," Baenziger affirmed.

On the flip side, however, native resistance can be overwhelmed in bad FHB years. So gene pyramiding and/or an integrated management approach that incorporates fungicides becomes necessary to hold the disease in check. "Though we have worked for 10 or more years with parent lines containing *Fhb1*, there is currently no released line — and few advanced experimental lines — with *Fhb1* or other major known QTLs," Baenziger noted. That is an example of "the agony of defeat."

The lack of success with incorporating *Fhb1* into elite germplasm led the Nebraska breeder and his colleagues to wonder whether *Fhb1* or closely linked genes had a detrimental effect on agronomic performance. Study findings led to a change in strategy: ensuring that FHB QTLs are first placed into adapted backgrounds through backcrossing — "and then forward breeding can occur."

"By pyramiding two or more QTLs into a background with native resistance, and with the use of a fungicide, we hope to reduce the chance for high levels of DON to a minimum in the Great Plains," Baenziger told the Forum audience. "We now have sufficient elite germplasm to really make progress in creating lines with excellent FHB tolerance." The use of molecular markers is central to this effort, he added, for the speed and efficiency they provide, compared to phenotypic assays.

The bar has been set high. "By 2016, we want 90% of the wheat grown in affected areas to be FHB-tolerant," Baenziger stated. ❖

Left: Several focused group discussion sessions during the 2011 FHB Forum provided opportunities for those directly involved in the various USWBSI research areas and coordinated projects to come together, discuss their progress and challenges, and to chart action plans for future work. Pictured here is the Variety Development and Host Resistance / Northern Soft Winter Wheat group, whose discussion was led by Clay Sneller (left) of Ohio State University.

Talks on USWBSI Website

Below are invited speaker presentations from the 2011 Fusarium Head Blight Forum that can be accessed on the U.S. Wheat & Barley Scab Initiative website (www.scabusa.org). The entire proceedings of the 2011 FHB Forum also can be downloaded from this site.

• *New Sources of Resistance to FHB and Indicators of their Action* / George Fedak, Agriculture & Agri-Food Canada

• *FHB Resistance in Durum Wheat - Progress and Challenge* / Xiwen Cai, North Dakota State University

• *Breeding for Scab Resistant Hard Winter Wheat: The Thrill of Victory and the Agony of Defeat* / P. Stephen Baenziger, University of Nebraska

• *Using Maker-Assisted Selection to Improve FHB Resistance in Hard Winter Wheat* / Guihua Bai, USDA-ARS, Kansas State University

• *Genomic Selection for Fusarium Head Blight Resistance in Barley* / Kevin Smith, University of Minnesota

• *Microbial Detoxifications of Deoxynivalenol (DON) and their* Potential *Applications in Mitigating Mycotoxin Contaminations* / Ting Zhou, Agriculture & Agri-Food Canada

• *Tracking Released Clones of Vegetative Compatibility: A Native Fungal Mechanism for Inducing Death in* G. zeae / John Leslie, Kansas State University

• *Can Brachypodium Provide Insight into FHB?* / Paul Nicholson, John Innes Center, United Kingdom

• *Identification of Candidate Genes for Head Blight and Deoxynivalenol Resistance* / Fiona Doohan, University College Dublin, Ireland

• *An Overview of Wheat Transformation at Kansas State University* / Harold Trick, Kansas State University

• *Trichothecene mycotoxins inhibit mitochondrial translation: Implications for the mechanism of toxicity* / Anwar Bin-Umer, Rutgers University

• *Subcellular targeting of plant defensin MtDef4 determines the outcome of plant-pathogen interactions in transgenic Arabidopsis* / Jagdeep Kaur, Danforth Plant Science Center

• *The Economics of Mycotoxin Contamination to the Milling Industry and Consumers* / Don Sullins, ADM Milling Company

• *A New Understanding of DON's Mechanisms of Action* / Jim Pestka, Michigan State University

• *A Time Course of Scab in Developing Field-Grown Wheat Spikes* / Christina Cowger, USDA-ARS, North Carolina State University

• *Barley Scab: Forecasting to Management* / Pravin Gautam, South Dakota State University

• *Assessing the Best Fungicide Application Timing for Fusarium Head Blight and Mycotoxin Management* / Carl Bradley, University of Illinois

• *Efficacy and Stability of Integrating Fungicide and Cultivar Resistance to Manage FHB and Don* / Pierce Paul, Ohio State University ❖

Fusarium Focus

Fusarium Focus is an online newsletter published periodically by the U.S. Wheat & Barley Scab Initiative. The USWBSI is a national, multi-disciplinary and multi-institutional research system whose goal is to develop as quickly as possible effective control measures that minimize the threat of Fusarium Head Blight (scab), including the production of mycotoxins, for the producers, processors and consumers of wheat and barley. Contact information is as follows:

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Upcoming Events

• Registration for the **4th International Symposium on Fusarium Head Blight** is now open. The event will be held in Nanjing, China, on August 23-26. The Symposium website link is: http://4thisf.njau.edu.cn:8058/Defaulten.aspx

• **MycoRed North America 2012** will take place on June 24-28 at Carleton University in Ottawa, Ont., Canada. David Miller (Carleton) and Art Schaafsma (University of Guelph) are the event's chair and vice chair. The conference will include keynote lectures by international experts, along with oral presentations, poster sessions and discussion groups.

For more information on MycoRed North America 2012, go to the conference website: http://mycored.ca/

Recent Scab-Related Peer-Reviewed Publications

• Horevaj, P., Brown-Guedira, G., and Milus, E.A. 2012. Resistance in winter wheat lines to deoxynivalenol applied ino florets at flowering stage and tolerance to phytotoxic effects on yield. *Plant Pathology*. DOI: 10.1111/j.1365-3059.2011.02568x.

• Bin-Umer, M.A., McLaughlin, J.E., Basu, D., McCormick, S., and Tumer, N.E. Trichothecene mycotoxins inhibit mitochondrial translation - Implication for the mechanism of toxicity. *Toxins*, 2011. DOI: 10.3390/toxins30 x000x.

• Makandar, R., Nalam, V.J., Lee, H., Trick, H.N., Dong, Y., and Shah, J. Salicylic Acid Regulates Basal Resistance to Fusarium Head Blight in Wheat. *Molecular Plant-Microbe Interactions*, 2012, Vol. 25, No. 3, pp. 431-439.

Listings of recent FHB-related publications by USWBSI-associated principal investigators are invited. All PIs are encouraged to submit listings. If publications are currently accessible through the Web, please include the URL address. Listings for the next edition of Fusarium Focus should be sent to Don Lilleboe at dlilleboe@forumprinting.com