

**U.S. Wheat and Barley Scab Initiative:
An Unprecedented University, Government, And Industry Collaboration
Focused On Accelerated Research Of A Serious Cereal Disease Problem
By Dr. Rick Ward¹ · Tracy Saylor²**

Prepared for the International Wheat Scab Symposium
(International Symposium on Wheat Improvement for Scab Resistance)
May 5-10, 2000, Suzhou and Nanjing, China

It is indeed a privilege and honor for me to participate in this International Wheat Scab Symposium. There are three objectives I intend to accomplish during this Symposium, and during my visit to this fascinating country: 1) To present an overview and update of the U.S. Wheat and Barley Scab Initiative; 2) To learn more about scab research taking place here in China, a key resource and longtime leader in the research of *Fusarium* head blight; and 3) To help foster more international communication and collaboration of scab research.

Overview of FHB in the U.S.

Scab infections have been reported worldwide from wherever cereal crops are grown. In the United States, reports of scab can be traced back to at least the early part of the last century. In 1917, for example, scab was found in 31 of 40 states surveyed, with losses estimated at 288,000 metric tons (10.6 million bushels), primarily in Ohio, Indiana, and Illinois³.

The disease was particularly problematic in the 1990s, inflicting yield and quality losses on farms in at least 18 states. Scab is responsible for over 500 million bushels of wheat lost in the U.S. since 1991, conservatively valued at over \$2 billion in farm-gate losses alone, according to industry and university estimates.

Scab was particularly epidemic in the spring wheat and durum wheat-producing region of the United States in 1993, and in the soft red and white wheat growing region in 1996. So bad, in fact, that some farmers burned their standing wheat and barley fields instead of harvesting them. And some highly infected grain didn't even qualify for market bids, ending up in landfills⁴.

Scab can be a serious food safety issue. The toxin that may be produced from scab called deoxynivalenol (DON or vomitoxin) can make barley unacceptable for malting and brewing, and wheat unacceptable for milling. Food industries throughout the U.S. can incur losses from the cost of dealing with grain infected by scab and DON. The disease can also hurt U.S. wheat and barley export sales. To this day, scab and DON continue to cripple the U.S. six-row malting barley production region, and farmers are still trying to recover financially from the string of poor crops in the last decade.

Why was scab such a problem in the U.S. in the 1990s? Weather patterns conducive to scab development were a key factor. Government programs in the early 1990s that discouraged crop rotations in wheat-intensive areas were a factor. Reduced tillage is another factor. Increased field residue that on one hand prevents topsoil erosion and conserves soil moisture can also harbor *Fusarium* inoculum.

But the fact remains that we cannot control the weather, we cannot expect a large shift in tillage trends, and we will always grow large amounts of wheat and corn in the United States. Thus, we must search for other solutions for managing scab⁵. As one U.S. wheat producer who

lost five wheat crops to scab in the 1990s put it, “*scab is like a thief that robs during the night, and it’s about time we put it away.*”⁶

Organization of the USWBSI

Thus, in 1997, recognizing the threat of scab to the viability of the U.S. wheat and barley industries, leaders representing producers, agribusiness, millers, brewers, food processors, and state and federal crop scientists, began to organize a national, multi-disciplinary, and multi-institutional research system, designed to win the war on scab in the most time and resource efficient manner possible.

The result of these efforts is the U.S. Wheat and Barley Scab Initiative, which has four objectives:

- Coordinating scab-related research efforts for maximum synergy and results.
- Supporting the deployment of methods to minimize the threat of scab in the United States.
- Educating producers, processors, and consumers about wheat and barley scab.
- The Initiative also recommends a budget for the funding of scab research proposals to the Agricultural Research Service of the U.S. Department of Agriculture.

The existing private, state, and federal research system of the U.S. manages research of most of newly emergent pests and diseases. But some problems, like scab of wheat and barley, present unusual challenges that warrant new approaches to research. There are several reasons why scab falls into this category:

- Scab has already caused billions of dollars in economic losses, and vulnerable to the whims of weather, continues to be an economic threat to growers, processors and consumers of wheat and barley throughout much of the U.S.
- Focused research is needed in a wide array of disciplines, studying many possible management solutions and approaches.
- Recent experience clearly signals that no single institution can bring to bear the critical mass of research this problem demands.
- Scab solutions are likely to be both site and system specific, which dictates involvement of local experts in all of the directly affected states.
- Opportunities for acquiring competitive funds for scab research from traditional federal sources are extremely scarce.

As a result of these special circumstances, scab of wheat and barley is one of several plant disease complexes accorded special status as “Emerging Diseases” in recent Federal budgets.

Initiative Funding

Congress appropriated \$500,000 to boost scab research efforts in fiscal year 1998. This funding allowed initial phases of the U.S. Wheat and Barley Scab Initiative to begin. An additional \$3 million appropriated in FY99 enabled more facets of the Initiative's scab research plan to be activated.

In fiscal year 2000, funding for the Initiative was boosted by the U.S. Congress to \$4.3 million. The current research grant period for the Initiative extends from May, 2000 to April, 2001. Current research supported by the Initiative involves 104 projects in six research areas

carried out in 23 states by over 70 scientists from 22 land grant universities and the USDA's Agriculture Research Service (ARS).

Initiative Research Plan, Structure

The Initiative research plan is leveraged by existing sources of investments in personnel, facilities, and supplies. The Initiative is comprehensive, with six major research emphasis areas:

- Variety development and coordinated screening nurseries
- Epidemiology (how scab develops, spreads) and disease management
- Food safety, toxicology, and utilization
- Biotechnology
- Germplasm introduction and enhancement
- Chemical and biological control

Research projects conducted under these emphasis areas of the Initiative are first identified by researchers in both the private and academic sectors. They are then reviewed under a prioritization process so that the most urgent projects are addressed immediately. Much of the research work is being carried out at land-grant universities in scab-threatened areas, and augmented by the ARS research sites that are involved. Accountability and relevance to practical solutions are fundamental principals for projects conducted.

Guiding the Initiative research is a broad-based Steering Committee with representatives from various sectors of the wheat and barley industries, wheat and barley production areas, and state and federal crop researchers. Relevance of targeted research is assured by the central role that industry (growers and processors) has in the focus and direction of the Initiative's research work.

Eight members of the Steering Committee also serve on an Executive Committee. The Steering and Executive Committees are advised by committees representing the six research areas of the Initiative, composed of recruited volunteers from the scientific leaders of the U.S. wheat and barley research communities. The composition of all committees is designed to ensure balanced input from all commodities, regions, disciplines, and institutions engaged in the battle against scab.

The Initiative's Networking and Facilitation Office, based at Michigan State University, facilitates the work of these committees. That office also promotes communication among the varied parties interested in scab, and represents the Initiative's only 'fixed' asset.

Each year, the Steering Committee submits to the USDA-ARS a comprehensive and optimized research plan designed to achieve the Initiative's goals. That plan is the Initiative's recommendation for how the USDA-ARS can most effectively employ the funds appropriated by the U.S. Congress for collaborative scab research. The relevance of the research plan is assured by the central role that industry (growers and processors) plays in the Initiative's work.

The USDA-ARS oversees the Initiative's funding disbursement, project proposals and progress reports. However, the Initiative maintains autonomy of its research objectives. The unprecedented nature, magnitude, and scope of this collaboration required constant innovation by the administrative staffs of the Initiative, ARS, and the participating Land Grant Universities. We are happy to report that the ARS has been supremely cooperative and has exhibited degrees of flexibility and sensibility not commonly attributed to Federal agencies.

National FHB Forum

For the past seven years, the scab research community and wheat and barley industry leaders have gathered in a national forum to discuss scab research results and progress, and to plan projects for the coming year.

We were pleased to have Dr. Dajun Liu of Nanjing Agricultural University as a guest speaker at the 1999 National FHB Forum. Dr. Liu's address on wheat breeding for scab resistance in China and in relation to other research efforts may be found along with other proceedings of the 1999 Forum, on the Initiative's website, www.scabusa.org. Information about the 2000 National FHB Forum will soon be posted at this web site as well. The Forum this year will be held December 10-12, 2000, in Cincinnati, Ohio. We welcome your submission of posters and manuscripts, and encourage your attendance.

Initiative Progress

The speed and magnitude of the success our industries have had in generating funds and associated research plans is an arguably unprecedented happening in U.S. plant agriculture. However, all we've really done is enabled ourselves to fully engage in the real challenge, which is the elimination of scab as a destructive force in the U.S. food system. We now have a substantial solution-discovery engine up and running. Still, in the three years that the Initiative has been underway, structural and programmatic progress has been made.

The Initiative has helped raise awareness of the community-wide impacts of agricultural disasters. National awareness of the serious nature and economic implications of scab has improved, and is indeed a welcomed development. Communication and collaboration among crop scientists has improved across disciplines and institutions, with greater regional and national linkages. Moreover, the Initiative has resulted in a working coalition and strengthened communications among U.S. wheat and barley research, production, processing, and end-use sectors. The Initiative also serves as a model for other public/private, state/national, multi-disciplined research partnerships to follow.

Substantial research efforts were already underway in several states before anyone had notions of a national effort. Still, the Initiative has played a part in a number of programmatic accomplishments already across the nation.

Promising new sources of host plant resistance genes are reported, along with substantial progress in molecular tagging of previously discovered genes. Conventional plant breeders are eliminating highly susceptible varieties and improving the resistance in new releases. Likewise, investments in biotech solutions have enabled progress in the arena of genetic engineering. Some early events in a *F. graminearum* infection and the molecular response in wheat have been characterized. Transgenic wheat and barley plants carrying antifungal protein genes have been developed and are now being tested.

Several projects confirm the efficacy of foliar fungicides in suppressing scab, and promising bio-control agents are being studied. Good progress in unraveling the mysteries of the pathogen's life is evident. Some highly innovative methods are being employed in that effort, including employment of *Fusarium* that has a fluorescent gene from jellyfish, and radio controlled aircraft to document aerial spore movement. There is new knowledge regarding the fate and effect of DON in food products, as is new work on the toxicological properties of that mycotoxin.

Over the longer term, benefits to the U.S. wheat industry stemming from the Initiative will go beyond scab, providing a model to address specific research challenges whatever they may be. Indeed, spillover effects from research methodologies and systems employed by the Initiative will benefit other wheat research areas.

Expectations and challenges

It is possible that emergence of other unforeseen, urgent crop research priorities could affect Initiative project funding. However, this is unlikely. There is every reason to expect re-appropriation of funding to the Initiative on par with the FY2000, \$4.3 million funding level, on an annual basis for at least several years. Increases specifically associated with scab have also been made in the base budgets of specific ARS facilities in the past three years (\$1.375 million). Combined, these funds represent an unprecedented commitment to wheat and barley research at the Federal level.

Other fundamental challenges remain as well. First, how do we increase the scientific productivity of the resources committed to scab research, and second, how do we minimize the time lag between discovery of a solution and its comprehensive employment in relevant at-risk systems? We believe that we've only begun to scratch the surface of the wealth of opportunities for synergistic collaboration on both of these issues.

One means of addressing the first challenge of scientific productivity is full employment of modern communication technologies, i.e., the Internet. The Internet has already played a significant role in the Initiative's history, both through email list servers, and through a central web site. However, little if any progress has been made in moving towards the kinds of 'virtual communities' of scientists made possible by the real-time, or near real-time communication systems available through the web.

The second challenge, the lab vs. real-world time lag, requires pro-active forward thinking by across-discipline alliances representing all aspects of the continuum from the lab to the field or factory. In both cases, these challenges require continued investment and belief in research system components that transcend the individual research scientist.

Controversy regarding biotechnology presents another challenge that must be discussed. As noted earlier, progress is being made in the area of transgenic approaches to greater tolerance of fusarium. It will likely be years before a genetically-engineered, scab-tolerant wheat variety will be available commercially. But will the fervor of biotech be settled by then? If not, how should this new variety be processed and marketed? We must work with the wheat and barley industries to establish protocol for these key questions.

International Collaboration

It is my hope too that the cooperation and collaboration of the U.S. Wheat and Barley Scab Initiative will serve as a platform for greater international cooperation and collaboration. This is occurring to some extent now, with germplasm exchanges and other examples, such as this international forum. However, there is room for improvement, particularly in the area of communications. To that end, I believe the Internet can and will play a key role. For example, linking or posting of the proceedings from this Forum on the web site of the U.S. Wheat and Barley Scab Initiative, and the dissemination of our Initiative's results and proceedings to you in

this room, and other crop scientists researching scab around the world. I believe we can work together more proficiently on conducting and communicating scab research, and I look forward to working with you to accomplish that goal.

Notations

- 1 Rick Ward, Co-chair of the U.S. Wheat and Barley Scab Initiative, Wheat Breeder/Associate Professor, 382 PSSB /Michigan State University East Lansing, MI 48824 Ph. 517/ 285-9725, Fax 517/ 353-3955, email: wardri@pilot.msu.edu
- 2 Tracy Saylor, agricultural writer and communications associate, U.S. Wheat and Barley Scab Initiative, 1960 55th Ave South, Fargo, ND, 58104, Ph. and fax 701/271-6875, email: tsaylor@corpcomm.net
- 3 McMullen, M, Jones, R, Gallenberg, D, “Scab of Wheat and Barley: A Re-Emerging Disease of Devastating Impact” 1340 Plant Disease / Vol. 81 No. 12 Publication no. D-1997-0902-04F The American Phytopathological Society
<http://www.scisoc.org/feature/FHB/0902-04F.pdf>
- 4 “Wheat Diseases Becoming a National Priority” November, 1996 Prairie Grains, p. 13
- 5 McMullen, Jones, Gallenberg, “Scab of Wheat and Barley: A Re-Emerging Disease of Devastating Impact”
- 6 “Wheat Diseases Becoming a National Priority” November, 1996 Prairie Grains

U.S. Wheat & Barley Scab Initiative Networking & Facilitation Office

Susan Canty, Michigan State University, 372 Plant & Soil Sciences Building, East Lansing, MI 48824
Phone: (517) 355-2236 Fax: (517) 353-3955 Email: scabusa@pilot.msu.edu Website:
<http://www.scabusa.org>