CHEMICAL, BIOLOGICAL AND CULTURAL CONTROL (CBCC)

FY07 Research Priorities

The Chemical, Biological and Cultural Control research area of the U.S. Wheat & Barley Scab Initiative supports research efforts addressing one or more of the following priorities:

- **Uniform Tests:**
  - Collaborative efforts to evaluate **advanced fungicide treatments** in solo and as tank mixes of efficacious active ingredients for effective and consistent performance against FHB of wheat (all classes) and barley across multiple environments.
  - Collaborative efforts to evaluate **advanced biological control agent (BCA) treatments** for effective and consistent performance against FHB of wheat (all classes) and barley across multiple environments and relative to chemical standards with the most efficacious agents advanced to the chemical trial.

- **Biocontrol:**
  - Discovery, Development and Evaluation: Discovery, development, optimization and greenhouse/field evaluations of BCAs and BCA formulations in preliminary tests to provide promising agents for advanced screening.
  - Biocontrol Advancement: Formulation and evaluation of formulated BCAs that were proven to be **comparable in efficacy** to currently available commercial fungicides in collaborative, uniform field evaluations.

- **Application Technology:** Development and evaluation of ground or aerial application technologies that enhance the efficacy of fungicides against FHB compared with standard commercial application practices. Priority will be given to collaborative, interdisciplinary proposals using field-scale equipment. Ascertain an understanding of the deposition of products relative to efficacy including the distribution of the product on the head, mobility of products in the plant and interaction of droplets with head morphology, and developed explanations for the mechanisms for the increased activity associated with specific application technologies.

- **Integrated Disease Management:** Evaluation of methods and strategies for disease management including determination of the influence of modern crop management practices on disease development and selection of the best disease control systems that can be used in concert. These methodologies may include, but not be limited to variety selection, tillage practices, crop rotations, and chemical/biological control inputs.

- **Deliverables:** Developing multi-state deliverables that describe effects of control practices and technologies are encouraged. These deliverables may include traditional print media and electronic media.

ETIOLOGY, EPIDEMIOLOGY AND DISEASE FORECASTING (EEDF)

FY07 Research Priorities:

The Etiology, Epidemiology and Disease Forecasting research area of the U.S. Wheat & Barley Scab Initiative (USWBSI) supports research efforts addressing one or more of the following priorities:

- **Pathogen Biology and Epidemiology**: Determination of the environmental conditions that favor pathogen survival, inoculum production, dispersal, infection, colonization, and mycotoxin production. The investigation and quantification of factors that increase the risk of severe epidemics; factors affecting temporal and spatial development of disease epidemics; and the development and delivery of disease forecasting/risk assessment systems.

- **Host-Parasite Interactions**: Investigations of the infection and colonization process including interactions between the fungus and susceptible/resistant wheat or barley varieties; and mycotoxin production and impact on pathogen colonization. Research addressing factors associated with high levels of mycotoxin in asymptomatic grain. Research should address cellular, tissue, whole organism (plant or fungus) and/or population levels.

FOOD SAFETY, TOXICOLOGY AND UTILIZATION OF MYCOTOXIN-CONTAMINATED GRAIN (FSTU)

FY07 Research Priorities:

The Food Safety, Toxicology and Utilization of Mycotoxin-contaminated Grain research area of the U.S. Wheat & Barley Scab Initiative (USWBSI) supports research efforts addressing one or more of the following priorities:

Toxicology

- Characterization of dose response and 'No Adverse Effect' levels for acute and chronic trichothecene oral and inhalation exposure in experimental animal models.

- Identification of biomarkers for trichothecene exposure in animal models that are predictive of adverse effects.

- Correlation of animal model trichothecene toxicity studies to human cell cultures.

Analytical Methods

- New instrumental methods that significantly improve efficiency, selectivity and sensitivity in detection of trichothecene mycotoxins in grain, foods, and processed grain byproducts.

- Novel bioanalytical methods such as immunoassay or PCR that offer significant improvements in the quantitation or detection of *Fusarium graminearum* or its trichothecene mycotoxins.

GENETIC ENGINEERING AND TRANSFORMATION (GET)

FY07 Research Priorities:

The Genetic Engineering and Transformation research area of the U.S. Wheat & Barley Scab Initiative (USWBSI) supports research efforts addressing one or more of the following priorities:

- Transform wheat, barley, and durum to demonstrate the effectiveness of anti-*Fusarium* transgenes to limit Fusarium infection and early stages of growth and spread. Early testing may be done in vitro, in growth chambers, and in greenhouses. Definitive field testing must be conducted as early as possible. Priority will be given to strong anti-*Fusarium* gene candidates identified in other projects (e.g., protein screening, QTLs, microarrays).
  - Where possible, use modern wheat, barley and durum commercial cultivars for more realistic field evaluations and better germplasm for use by plant breeders.
  - Proposals should include realistic methods to detect and measure levels of antifungal protein encoded by transgenes. (This may not be possible for low-abundance proteins, such as transcription factors.)
  - Develop new transformation technologies or strategies with specific application to *Fusarium* resistance.
  - Transform with antisense or RNAi constructs designed to eliminate expression of host genes that facilitate infection or Fusarium genes necessary for infection.
  - Transform with genes that enhance signaling networks identified in the resistance response.

- Develop methods/systems for rapid screening (e.g., transient expression) of potentially useful antifungal genes in wheat, barley or Durum.

- Identify targeting sequences (promoters and signal sequences) to express transgenes in specific spike tissues and/or subcellular compartments where hyphae grow during earlier stages of infection.
  - Develop *Fusarium*-inducible tissue-specific promoters.

- Develop strategies to enhance acceptance of *Fusarium* resistant transformants. Where possible, develop "like into like" (e.g., barley genes re-expressed in barley) strategies, cereal into cereal, crop plant into crop plant, etc. Reduce integrated vector sequences. Eliminate possibilities for spreading transgene to non-target plants.

- Wide species testing is still encouraged in order to rapidly discover strategies for developing resistance.

HOST GENETIC RESOURCES (HGR)

FY07 Research Priorities:

The Host Genetic Resources research area of the U.S. Wheat & Barley Scab Initiative (USWBSI) supports research efforts addressing one or more of the following priorities:

- Discovery and/or introgression of novel sources of FHB resistance effective against U.S. populations of *Fusarium* in barley and durum wheat through systematic search, assessment and transfer of FHB resistance from cultivars, breeding lines, land-races, and wild species into adapted genotypes. Emphasis in common wheat is on discovery of unique and complementary sources of FHB resistance to facilitate enhancement and pyramiding of FHB resistance genes. Complementary sources should have FHB resistance conferred via mechanisms differing from those of known Type I and II sources or be governed by loci that are non-allelic or conferring significantly higher levels of resistance either alone or when combined with other known FHB resistance genes. Discovery and characterization of resistance sources within the primary gene pool of all three crops is of the highest priority, particularly in adapted native sources of common wheat. For those working in secondary and tertiary gene pools, a clear indication as to how usable germplasm will be developed and its effectiveness validated in adapted genotypes, and when it will be made available to plant breeders is critical.

- Determining the novelty of new resistance genes via phenotypic differentiation on the basis of effectiveness, mode of action and mechanism of resistance, allelism tests with known FHB resistance genes, and studies of molecular marker diversity in comparison to known and validated FHB QTLs. Uniqueness of all putative new FHB resistance loci should be validated and confirmed via marker haplotype analysis in comparison to all known and validated FHB QTLs. Studies should be directed to understanding the inheritance and mechanisms of resistance and allelic relationships to known FHB loci. Note that traditional molecular mapping research proposals focusing on marker identification and QTL characterization of newly identified resistance sources should be submitted to Host Genetics and Genomics RA.

- Generation of unique and adapted parental germplasm (pre-breeding). As the number and diversity of FHB resistance genes increases within barley, durum wheat, and common wheat, resources will shift from the two previous priorities to introgression of unique and effective FHB resistance genes and pyramiding of unique and/or known genes into adapted lines suitable for direct use as parents in cultivar development programs. Studies should be directed towards introgression of validated unique FHB resistance genes not previously deployed in adapted parental lines using classical (phenotypic selection) and/or molecular breeding (where markers are available) methods, and pyramiding of complementary FHB resistance genes into adapted parental lines via marker assisted selection (MAS). Projects focusing on MAS introgression and selection of single known and previously deployed FHB QTL in breeding populations should be submitted or included in proposals submitted to Variety Development and Uniform Nurseries RA.

- Implementation of regional or market class collaborative research with the USDA-ARS Regional Cereal Genotyping Centers to identify and verify unique sources and QTL conferring FHB resistance via haplotyping studies and to rapidly introgress novel FHB resistance genes and pyramid previously mapped complementary FHB resistance genes into elite cultivars or parental lines via MAS. Studies in this area should emphasize high throughput genotyping, rapid generation advance, and strong field validation of FHB resistance as critical components of an aggressive, cutting edge scientific project with accelerated delivery of practical outcomes.

HOST GENETIC AND GENOMICS (HGG)

FY07 Research Priorities:

The Host Genetics and Genomics research area of the U.S. Wheat & Barley Scab Initiative (USWBSI) supports research efforts addressing one or more of the following priorities:

Mapping

- Genetic analysis and mapping (using molecular markers and/or physically map) of new and/or novel FHB resistance in wheat and barley germplasms, including unique types of resistance (i.e. in addition to type II).

- Develop user-friendly markers and other techniques which accelerate gene deployment via MAS.

- Validate FHB resistance QTL/markers.

- Determine the durability and level of enhanced resistance when different sources and mechanisms of FHB resistance are combined into the host genotype.

- Develop BAC contigs and saturation maps for important QTL regions to facilitate MAS and map-based cloning efforts.

Gene Discovery, Mechanisms of Resistance

- Identify genes encoding effective anti-*Fusarium* proteins.

- Select mutants for enhanced resistance and enhanced susceptibility to help identify genes involved in FHB resistance.

- Characterize molecular mechanisms of host–pathogen interactions as it relates to the host to identify potential resistance genes. Identify potential candidate genes involved in FHB resistance, and characterize the function of a specific candidate gene.

- Determine signaling pathways that could be used to enhance host resistance or that are affected by *Fusarium* during infection.

PATHOGEN GENETICS AND GENOMICS (PGG)

FY07 Research Priorities:

The Pathogen Genetics and Genomics research area of the U.S. Wheat & Barley Scab Initiative (USWBSI) supports research efforts addressing one or more of the following priorities.

- **Develop novel control methods based on pathogen genetic and genomic information.** Obtain data to test feasibility or demonstrate concept.

- **Characterize FHB pathogen diversity, phylogenetics, or taxonomy.** Identify aspects that may affect disease severity, mycotoxin contamination, pathogen ecology, pathogen evolutionary potential, stability of host resistance, or phytosanitary issues.

- **Characterize the genomes of FHB pathogens**. Identify unique or conserved adaptive features and important genes or gene families that correlate with the pathogenic lifestyle.

- **Identify and characterize genes that control important pathogen traits,** including pathogenicity, aggressiveness, mycotoxin production, sexual and asexual reproduction, environmental persistence, and dispersal.

- **Identify and characterize important pathogen gene and protein expression profiles, regulatory networks, and developmental or metabolic pathways.** Determine patterns of gene expression and protein accumulation vital to pathogenic adaptation as well as signaling, regulatory, and developmental programs essential for disease expression.

- **Characterize host-pathogen interactions at the molecular level**. Identify infection and colonization processes that are affected by host resistance. Identify pathogen molecular features that may serve as effectors of host defense responses, as targets of defense responses, or as countermeasures against host defense responses.

Investigators are encouraged to describe how the proposed research could lead to practical solutions to problems caused by FHB.

VARIETY DEVELOPMENT AND UNIFORM NURSERIES (VDUN)

FY07 Research Priorities:

The Variety Development and Uniform Nurseries research area of the U.S. Wheat & Barley Scab Initiative (USWBSI) supports research efforts addressing one or more of the following priorities:

- The breeding and release of FHB-resistant wheat and barley varieties and germplasm that are adapted to FHB-threatened states.
- Multi-location validation of FHB resistance through participation in the appropriate uniform FHB screening nurseries.
- Improvement and evaluation of selection methods designed to minimize the time to delivery of FHB resistant barley and wheat varieties.
- Enhancement of accuracy and consistency of FHB resistance phenotyping.
- Provide growers with accurate FHB ratings of current varieties.

The delivery of new FHB-resistant wheat and barley varieties, and germplasm, is the overarching objective of this research area, and ancillary research should clearly support that objective. Priority will be given to those proposals that clearly delineate research methods, timetables, and expectations for deliverables. Successful pre-proposals should incorporate FHB breeding research into an overall breeding context that gives appropriate weight to yield, end use quality and resistance to other pests and stresses.