VARIETY DEVELOPMENT AND HOST RESISTANCE (VDHR)

Goal #1: Increase acreage planted with varieties exhibiting improved FHB resistance.

Milestones/Performance Expectations:
Drafts developed by SC:

- One new variety with scab resistance released per year in each of the wheat types/regions.
- Three lines with scab resistance being increased every year in each of the wheat types/regions.
- Database(s) developed and maintained on website with detailed information on all the wheat varieties with some resistance. Place on the website for grower ratings of varieties.
- Establish mechanism for the annual identification of a) acreage by variety and b) variety by FHB resistance - this info will be used to document the anticipated increase of commercial acreage planted to wheat and barley with improved FHB resistance.
- Evaluate the economic impact of lines with improved FHB resistance with respect to the predominant cultivars in a region.
- A survey should be made to determine the wheat varieties currently in production to determine a baseline for the use of FHB varieties.
- Identify X (this will vary with marker class) with good FHB resistance to be prioritized for introduction.

Suggestion: All public breeders should pledge to not release any FHB susceptible varieties.

Performance Measures:

- Change in percent area planted to FHB resistant varieties in affected areas.

Research needs:

- Comprehensive evaluation of advanced lines for all important traits under best management practices (such as tillage, chemical control, biological control, forecasting models…)
- Accurate assessment of economic return to producers and end-users for planting/using FHB resistant varieties.

Outputs:

- Enhanced FHB resistance in varieties with complete package of other important traits (yield, quality, resistance to other diseases etc…).
- Variety performance information for education of producers and end-users.

Resources:

- Multi-location regional nurseries.
- Mechanism for funding large regional projects for multiple years.

Anticipated Impacts:

- Increase the options for farmers to adopt FHB resistant varieties which are competitive for agronomic and end-use performance.
- Release wheat and barley varieties which are genetically predisposed to reduced FHB expression and lower levels of DON production.
- More stable supply of high quality wheat and barley for end-users.

VARIETY DEVELOPMENT AND HOST RESISTANCE (VDHR)
(cont.)

Goal #2: Increase efficiency of individual breeding programs to develop FHB resistant varieties.

Milestones/Performance Expectations:
Drafts developed by SC:

- One new variety with scab resistance released per year in each of the wheat types/regions.
- Three lines with scab resistance being increased every year in each of the wheat types/regions.
- Database(s) developed and maintained on website with detailed information on all the wheat varieties with some resistance. Place on the website for grower ratings of varieties.
- Expand the number and increase the level of FHB resistance of entries in regional uniform FHB screening nurseries. Reporting of the performance of all entries shall be required for all breeding programs participating in the USWBSI.
- Establish a database to share information on the FHB resistance (or susceptibility) of all cultivars, advances lines and germplasm sources utilized by breeding programs.
- Annually, breeders in each market class contribute data called out in the performance measures to a table that is made available on the USWBSI web site.

Performance Measures:

NOTE: *Breeding programs should document progress with some of the following metrics when appropriate.*

- Total number as well as percentage of crosses made involving FHB resistant parent (native or exotic resistance).
- Number of crosses (or lines) evaluated in advanced as well as early generation for FHB (Type I or II resistance, other disease measures, DON concentration, FHB marker haplotypes).
- Average performance of breeding lines (advanced, preliminary yield trial entries etc…) compared to appropriate check varieties for FHB and agronomics.
- Number of variety candidates entered into Uniform or Regional Yield Nurseries or industry quality evaluations with enhanced FHB resistance.
- Number of new releases with "native" FHB resistance.
- Number of new releases with "exotic" FHB resistance.
- Number of new releases carrying resistance alleles at mapped FHB QTL.

Research Needs:

- Maintain existing capacity for field testing in mist-irrigated inoculated nurseries.
- Increased capacity for DON testing at breeder and analytical lab level.
- Increased capacity for MAS.
- Database to facilitate sharing of information on population development to facilitate germplasm exchange.
- In uniform nurseries collect additional data for:
  - other important traits.
  - marker haplotypes for known FHB and DON QTL.
- Increased capacity for MAS backcrossing of resistance alleles at specific QTL.
- Increased access to doubled haploid technology.

VARIETY DEVELOPMENT AND HOST RESISTANCE (VDHR)
(cont.)

Outputs: More frequent release of FHB resistant varieties with high yield and other desirable attributes that insure widespread adoption by producers and end-users.

Resources:
- Genotyping labs
- Mist-irrigated inoculated nurseries
- DON testing labs
- Backcrossing Center – centralized facility to rapidly backcross resistance alleles from well-validated QTL into elite lines from breeding programs.
- Mechanism for funding large regional projects for multiple years.
- Doubled haploid facility

Anticipated Impacts: More varieties with enhanced FHB resistance and complete agronomic/quality/disease resistance package available to producers.

Goal #3: Efficiently introgress effective resistance genes into breeding germplasm.

Milestones/Performance Expectations:
Drafts developed by SC:
- Identify research programs to be charged (with specific funding) with introgressing resistance genes into wheat lines.
- Establish a database documenting the progress of the introgression of resistance from all sources of resistance (e.g. a table providing information on the sources of resistance utilized and giving the FHB evaluations from early generation materials utilizing those sources).
- Provide public documentation of the novelty of all known sources of genetic resistance.
- Demonstrate that the USWBSI has developed a plan to undertake the strategic testing of putative sources of resistance (e.g. define a small group of researchers who can cooperate to test new sources of resistance and establish their value quickly so that they may either be discarded or disseminated rapidly to other breeding programs).
- Annually, breeders in each market class contribute data called out in the performance measures to a table that is made available on the USWBSI web site.
- Create website listing all FHB resistance sources and describing any associated markers; keep this site updated.

Performance Measures:
- Number of breeding lines with new sources of resistance in their pedigree.

Research Needs:
- Information to determine whether "new" sources of resistance are truly "novel" sources of resistance – marker haplotyping, allelism testing etc…
- Coordination to strategically distribute new sources to different breeding programs for crossing and first generation "pre-breeding".
- Sharing of pre-breeding populations.
- Enhanced phenotyping of mapping populations (more environments in fewer years).

VARIETY DEVELOPMENT AND HOST RESISTANCE (VDHR)
(cont.)

- Screen various potential sources of wheat and barley for FHB / DON resistance to identify best sources for crossing.
- Verify new and novel sources of FHB /DON resistance.
- Use of molecular markers to pyramid resistance genes in suitable germplasm.

Outputs: Improved germplasm with diverse resistance.

Resources:
- Basic screening nursery for screening potential sources of FHB/DON resistance.
- Web accessible database to share information on resistant sources, breeding population development, marker haplotypes, etc… data.
- Regional coordination meetings / regional grants to facilitate collaboration.
- Mechanism for funding large regional projects for multiple years.

Anticipated Impacts:
- Breeding germplasm with higher levels of resistance to FHB and lower DON concentrations.
- Enhanced germplasm exchange among breeding programs to more quickly exploit diverse sources of resistance.

Goal #4: Develop and map diagnostic markers for effective sources of FHB resistance.

Milestones/Performance Expectations:
Drafts developed by SC:
- Identify X genes that increase FHB resistance.

Performance Measures:
- The Initiative should only fund proposals to map new FHB resistance loci that provide preliminary data demonstrating the novelty of the resistance.
- Identification of FHB resistance loci from germplasm unrelated to previously identified resistance (3BS wheat) (Chromosome 2H barley).
- Demonstrably increased capacity for field evaluation of populations segregating for FHB resistance.
- Increase the incorporation of different types of FHB resistance into germplasm lines and varieties.

Research Needs:
- Investigate and elucidate the genetic basis of different types of FHB gene resistance expression.
- Identify pathways and mechanisms of FHB resistance/susceptibility.
- Demonstration that potential new sources of FHB resistance are unique should include haplotyping will markers for ALL known and validated FHB QTL, not only those for 3BS in wheat and Chr2 in barley. Develop genome-wide marker fingerprints of FHB resistant material to facilitate rapid incorporation of new FHB resistance loci into breeding programs.
- Increase the capacity to evaluate segregating populations.

VARIETY DEVELOPMENT AND HOST RESISTANCE (VDHR)
(cont.)

Outputs: Identification of novel FHB resistance loci transferred to VDUN along with accompanying markers to facilitate deployment.

Resources:
- USWBSI funding for characterization of new sources and types of FHB resistance.
- High throughput genotyping facilities.

Anticipated Impact:
US wheat and barley market classes enriched with additional genes having diverse functionality that confer resistance to FHB.

FHB MANAGEMENT (MGMT)

Goal #1: Validate integrated management strategies for FHB and DON**.**

Milestones/Performance Expectations:
Drafts developed by SC; refined with input from former EEDF RAC (6/26/07):

- Short-term (1-2 yr) goal: Assemble all available data on DON accumulation in relation to management practices (by region or wheat type).
- Year 1 - establish regional teams of researchers to develop a regional nursery to examine a limited number (e.g. 5) of lines from the uniform regional FHB nurseries (with different genes/gene combinations) to test the interaction of best management practices on the resistance of lines to be released with improved FHB resistance.
- Teams are set up to carry out an integrated factorial experiment in each state or sub-region with varieties appropriate to that location that represent a range of resistance levels. Other factors are planting date and fungicide treatments.
- The projects are planted by spring 2008 (spring wheat) or fall 2008 (winter wheat).
- Make available to industry data from the multi-state trials determining best management practices for FHB management.
- Validate current models using data from the multi-state trials.
- Validate models using 3 year economic data.

Performance Measures: Building a database of disease and mycotoxin responses to specific management strategies alone and in combination.

Research Needs: Identify the best management methods for FHB/DON or Good Farming Practices (GFP) for FHB/DON management - through integrated management studies. Studies to measure integrated effects will include but are not limited to:

- Evaluate the potential disease reductions through combinations of host resistance and fungicides.
- Research documenting the impact of tillage, cropping sequence on disease risk and potential role as part of the integrated management for FHB/DON.
- Develop disease forecasting models that help producers and their advisors evaluate the risk of disease based on environment, cultivar resistance and crop residues.
- Develop economic analyses of responses to integrated management strategies alone and in combination (i.e. fungicide, biological control, cultivar, residue management).
- Optimize fungicide and biological control application timing and methodology.
- Deploy improved FHB/DON forecasting systems and validate the use of the disease.

Outputs:

- Improved or enhanced forecasting systems.
- Document good farming practices (GFP) for FHB/DON management on regional and national basis.

Resources: Multiple collaborative locations distributed across US. A team approach will be used to reflect overlap across traditional research areas and regional/national scope. Teams will be composed of breeders, pathologists, economists and other scientists from other disciplines as needed.

FHB MANAGEMENT (MGMT) *(cont.)*

Anticipated Impact: Producers will make decisions based on regionally validated science-based information.

Goal #2: Enhance communication and end user education/outreach. We recognize that our audience includes, but is not limited to producers, agricultural advisors, research community, and grain processors.

Milestones/Performance Expectations:
Drafts developed by SC; refined with input from former EEDF RAC (6/26/07:

- Conduct a survey of the industry to determine current FHB management practices, where is information about best practices being obtained, and how growers are making decisions regarding FHB.
    - Year 1 - put together the survey implementation team, develop the survey instrument and outreach plan, and identify the population to be surveyed.
    - Year 2 - gather, tabulate, and analyze the survey data
- Document negative data for why management was ineffective in reducing FHB.
- A database with the results from Goal 1 is available on the USWBSI web site.
- An interdisciplinary team is formed to design and oversee the survey regarding adoption of FHB/DON management practices.
- An interdisciplinary team is formed to design the “ScabSmart” outreach materials and platform.

Performance Measures: Implement FHB/DON management methods validated through science-based research – Need to revise; MM: duplicate of PM for Goal #1.

Research Needs:

- Implement best management methods - Good Farming Practices (GFP) for FHB/DON management - through integrated management studies. Studies to measure integrated effects will include but are not limited to:
    - Identify sociological and economic influences on factors that affect adoption of practices that would reduce FHB/DON Develop survey tool for multiple audiences - customer need, customer knowledge and source of that knowledge.
    - Survey stakeholder groups to determine current status of FHB management adoption.
    - Conduct limited focus groups in regions/grain class production areas.
    - Assess survey and focus group responses.
    - Conduct a follow-up survey to assess changes in management behavior (3-5 yrs).
- Develop "ScabSmart" outreach materials and platform for exchange of information.
    - Develop Industry-University alliance to interpret Good Farming Practices.
    - Conduct "Train-the-Trainers" workshops to ensure a common message and understanding of what is different in certain circumstances.
    - Conduct region-wide training events for influencers (growers, consultants, and influencers).

FHB MANAGEMENT (MGMT) *(cont.)*

    - Partner with CCA organization to deliver on-line training for crop advisors via the Crop Advisors Institute and ICCA magazine. Pre- and Post-testing (learning assessments) would "certify" a crop advisor as a "Certified FHB Manager - 2007". Only the year of testing would be certified.
- Develop economic assessment tools based on discounts/premiums assessed by millers and maltsters, market prices at terminals, and other factors (a model for this tool is available at NDSU in the form of a crop value calculator).

Outputs:
- Survey tools to identify trends in management and adoption of technology.
- Science-based educational materials/training tools with a unified message.
- GFP document for FHB/DON management on regional and national basis.

Resources: Multiple collaborative locations distributed across US. A team approach will be used to reflect overlap across traditional research areas and regional/national scope. Teams will be composed of industry seedsmen, breeders, pathologists, economists and scientists from other disciplines as needed.

Research Needs: Improve communication within the scientific community:
- Establish a separate section for FHB reports in Plant Disease Management Reports.
- Arrange for a Plant Disease feature article series on progress in each RAC (Terry Niblack, University of Illinois is the incoming feature editor).
- Feature speaker at the next Forum to provide a synthesis of progress in managing FHB/DON since the inception of the USWBSI.

Outputs:
- Research reports in refereed journals.
- Communicate a clear message to the scientific community about progress of USWBSI.
- Communicate to researchers the need for realistic interpretations and timely and definitive results.

Resources: Individual and collaborative reporting of data. A dedicated site established for reporting FHB/DON data.

Anticipated Impact: Increased adoption of practices by producers and decision makers will result in FHB/DON reduction and leading to substantially reduced frequency of unacceptable DON levels in grain loads.

Goal #3: Develop the next generation of management tools for FHB/DON control.

Milestones/Performance Expectations:
Drafts developed by SC; refined with input from former EEDF RAC (6/26/07:
- Document that there is an actual reduction in DON when “novel” management tools are used.
- New understanding is attained of factors influencing final DON levels in grain.
- DON risk forecasting tool is available to growers.

FHB MANAGEMENT (MGMT) *(cont.)*

- Add additional crop management (previous crop, tillage) to FHB forecasting system.
- Develop content for website describing what does not work.

Performance Measures: Evaluate the potential of new technologies for the management of FHB/DON.

Research Needs:

- Enhance forecasting capabilities:
  - Examine the ability to utilize other sources of weather data and 'ensemble' approaches to forecasting.
  - Develop forecasting tool for DON.
  - Develop and validate forecasting tool for barley.
- Develop control methods that include consistent and effective biological control agent.
  - Support discovery and development of biological control agents showing consistent and effective FHB/DON control.
  - Develop a better understanding of the ecological relationships associated with consistent and effective biological controls.
  - Identify practices or methods that lead to consistent expression of BCA activity.
- Continuous assessment of new control methods for FHB/DON.
- Screen new fungicide compounds across multiple environments as candidates are identified by industry.
- Confirm FHB/DON control levels at recommended label rates for new fungicides.
- Determine factors influencing DON accumulation in wheat and barley grain
  - Evaluate the potential impact of environment during grain filling growth stages on final DON levels
  - Determine the role of environment, pathogen population, and cultivar on the accumulation of mycotoxins.
- Develop a repository for negative data with potential explanations for why control was not attained.

Outputs:

- Uniform research designs
- Data interpretations regionally and nationally
- Enhanced and improved forecasting systems
- GFP document for FHB/DON management on regional and national basis.

Resources:
Multiple collaborative locations distributed across US. A team approach will be used to reflect overlap across traditional research areas and regional/national scope. Teams will be composed of breeders, pathologists, economists and other scientists from other disciplines as needed.

Anticipated Impact: Novel methods to integrate in FHB/DON management plans will be identified.

Goal #4: Develop a full understanding of specific factors influencing infection and toxin accumulation that can be used to develop the next generation of scab and DON risk assessment measures.

FHB MANAGEMENT (MGMT) *(cont.)*

Milestones/Performance Expectations:
Drafts developed by SC; refined with input from former EEDF RAC (6/26/07:

- Year 1 - determine if DON can be detected in asymptomatic grain; establish a relationship between grain symptoms and DON (+/- not quantification).
- Understanding is improved of the roles of host genetics, pathogen genetics, and environmental variables on DON accumulation.
- Years 3-4 - apply the above information to the FHB prediction model.
- Publications are submitted on:
    - role of post-flowering weather and late/secondary infections;
    - conditions leading to high DON with low/no visual symptoms; and
    - relative contributions of in-field vs. external inoculum sources.
- Practical recommendations are developed based on the publications.
- The FHB risk forecaster is updated using the results described in the publications.

Performance Measures: Provide information regarding specific factors influencing infection and toxin accumulation, particularly the role of post-flowering weather and late/secondary infections, the conditions leading to high DON with low/no visual symptoms, and relative contributions of in-field vs. external inoculum sources, that are essential for the next generation of scab and DON risk assessment models.

Research Needs: Identify host-, weather-, environment-, and pathogen-related factors and interactions involving these factors that are associated with DON accumulation, including accumulation in the absence of visual symptoms or when severity symptoms are low. Specific studies will be conducted to evaluate the effects of the following factors on DON accumulation:

- the role of post-flowering weather in disease and DON accumulation generally;
- late/secondary infections and the influence of post-flowering weather conditions
    - Determine the importance of post-flowering inoculum density and the associations among inoculum density, weather, FHB, and DON accumulation.
    - Determine the influence of weather (and variety) on infection efficiency (IE) at various growth stages between heading and grain maturity.
    - Determine the influence of weather on temporal variation in fungal biomass of grain following inoculation at different growth stages between heading and grain maturation.
- the relative contributions of inoculum from in-field debris vs. airborne spores from nearby and distant sources. These studies should determine regional variability, and translate the findings into regionally appropriate and specific recommendations for debris management.

Outputs:

- Uniform experiments conducted using locally-adapted varieties.
- Models describing associations among inoculum density/dose, inoculation timing, temperature, RH, and variety on infection, fungal biomass and DON accumulation in the absence of visual symptoms.

FHB MANAGEMENT (MGMT) *(cont.)*

- Improved accuracy of FHB risk assessment models and development DON forecasting models.
- Generate data suitable for the development of process-based FHB and DON risk assessment models.
- Regionally appropriate, specific recommendations for corn and small-grain debris management based on full understanding of relative contributions of inoculum from in-field debris vs. nearby and distant sources.

Resources: A multi-state collaborative effort involving researchers from all major US wheat and barley-growing regions.

Anticipated Impact: Risk forecasting and management recommendations available to growers are more useful because they reflect enhanced understanding of conditions throughout wheat development that affect FHB and DON levels.

GENE DISCOVERY AND ENGINEERING RESISTANCE (GDER)

Goal #1 – Gene Discovery: Increased efficiency of identification of candidate genes for resistance against FHB and reduced DON accumulation.

Milestones/Performance Expectations:
Drafts developed by SC:

- Identify X new candidate genes that confer increased *Fusarium* resistance.

Performance Measures: Identification of genes and transgenes that improve FHB resistance and/or reduce DON accumulation.

Research Needs:

- Rapid identification of wheat and barley genes essential for resistance to FHB and DON.
- Rapid identification of genes that confer susceptibility to FHB. If such genes are identified, incorporation of non-expressing alleles or silencing via transgenic approaches may provide a novel path to FHB resistance.
- Rapid identification of transgenes that can be utilized to increase resistance to FHB and/or reduce DON accumulation.
- Rapid high capacity assays for discovery and validation of genes with function in FHB and DON resistance.

Outputs: Genes and transgenes that can be incorporated in new wheat and barley lines with improved FHB resistance or reduced DON accumulation.

Resources:

- USWBSI funding of gene discovery.
- New high throughput assays for genes functioning in FHB resistance and susceptibility: for example, virus-induced gene silencing and Physcometrella.

Anticipated Impact:

- Additional genes available for breeding FHB and DON resistant barley and wheat
- Proof of gene efficacy will speed up breeding with native resistance genes and provide options for incorporating resistance transgenes into commercial wheat and barley.

Goal #2 – Plant Transformation: Develop effective FHB resistance through transgenic strategies.

Milestones/Performance Expectations:
Drafts developed by SC:

- Assess the activity of the candidate genes when expressed in wheat.

Performance Measure: Establishment of a central laboratory for the generation of transgenic plants and T1 seed stocks for Initiative funded research projects.

GENE DISCOVERY AND ENGINEERING RESISTANCE (GDER) *(cont.)*

Research Needs:

- Establish and support centralized transformation facility(s) for more efficient generation of transgenic plants and seed stocks for Initiative funded research projects. Establishment and optimization of wheat and barley transformation is expensive and requires much time and specialized skills. Support of one or a few transformation facilities would provide a great benefit to research into transgenic solutions for FHB.
- Preliminary data for efficacious transgenes must be provided for Initiative support.
- The Initiative should support centralized facilities for field testing transgenic wheat and barley.
- Development of tools for optimized gene expression in wheat and barley.
- Incorporation of validated transgenics into VDUN programs.

Outputs: T.B.D.

Resources:

- USWBSI funding for research identifying and developing effective transgenic solutions for FHB resistance and reduced DON accumulation.
- New website with latest information (positive and negative) from USWBSI-funded research about the efficacy of transgenes for FHB resistance or DON reduction.
- This website would also give up-to-date information about the latest tools for effective expression of transgenes in wheat and barley in FHB resistance strategies (organ/tissue specific promoters, introns, 5' and 3'UTRs etc.)

Anticipated Impact:

- Development of transgenic wheat and barley plants with FHB resistance and DON reduction that can be used to complement natural genetic resistance or as a standalone solution.
- More efficient use of individual lab time and resources.

PATHOGEN BIOLOGY AND GENETICS (PBG)

Goal #1: Characterize genetic variation in FHB pathogen population with regard to aggressiveness toward plants and mycotoxin potential.

Milestones/Performance Expectations:
Drafts developed by SC:

- Determine genotype of strains being used for GH and field screening.
- Put together isolate collection of characterized strains to distribute as required.
- Compile information about the aggressiveness of different Fusarium strains and make a range of these strains available to researchers.
- Characterize the interaction of these strains of various cultivars.

Performance Measure: Information useable for making decisions on performance of plant varieties toward specific genetic variants of the pathogen.

Research Needs. Maintain knowledge of FHB pathogen populations in the U.S., strains that are likely to travel here, and characterize their threat to plant varieties being developed by USWBSI.

Outputs:
Short-term: Identify and characterize regional variation in genotypes and chemotypes of fungal strains used as inoculum by breeders developing resistant and DON-reduced plant varieties. Make available culture collections reflecting regional differences in pathogen genotypes and chemotypes. Create publications and websites for stakeholders explaining significance of genetic variation to disease resistance and mycotoxin potential in wheat and barley. Develop and continuously update recommendations for breeders on the use of appropriate strains for screening.

Resources:

- Website devoted to information on strains in use and those available for use in testing.
- USWBSI funding for research to characterize the effects of individual strains on varieties.

Anticipated Impact: Genetically characterize strains used for screening new varieties will provide a better prediction of the resilience of varieties response to natural populations in the field.

Goal #2: Characterize plant-fungal interactions in plant lines being developed by USWBSI.

Milestones/Performance Expectations:
Drafts developed by SC:

- Characterization of cultivar/strain interactions with respect to colonization, infection, mycotoxin production.
- Determine where and when DON is produced in different cultivars.

Performance Measure: Information of how plant infection occurs and DON accumulates in plants over time and how these processes vary between resistant and susceptible varieties, with consideration of the problem of high-DON, asymptomatic grain.

PATHOGEN BIOLOGY AND GENETICS (PBG) *(cont.)*

Research Needs: Studies on pathogen infection, movement, and DON accumulation during grain maturation and when resistance is expressed.

Outputs:

Short-Term: Detailed histology of infection and accumulation of DON over time in different cultivars. Development of standardized techniques for screening, sampling and testing varieties based on knowledge of pathogen biology.

Long-term: Understanding of the biology of DON accumulation of asymptomatic wheat and the role of DON as a pathogenicity factor in barley.

Resources: USWBSI funding for understanding the infection process and mycotoxin accumulation over time.

Anticipated Impact:

- Understanding of how asymptomatic grain with high DON develops.
- Understanding of how infection and grain colonization occurs.

Both of these will have impacts on breeding for resistance- both the focus and the mechanism. In addition, the information may have impacts on more effective fungicide applications.

Goal #3: Develop new strategies for reducing impact of FHB disease and mycotoxin contamination in barley and wheat.

Milestones/Performance Expectations:

Drafts developed by SC; refined with in put from PBG RC:

- Test genes identified from Goal #2, and apply to reducing DON for their ability to reduce DON and disease.
- Implement knowledge of genes identified as essential to pathogenicity and collaborate with GDER for evaluation.

Performance Measure: Strategies for disease and mycotoxin management based on knowledge of pathogen fitness, biology, genome and genetics are developed.

Research Needs:

- Discovery of genes for pathogenesis, trichothecene reduction, novel antifungal compounds, etc.
- Development of molecular approaches to modulate pathogen genes for disease control and mycotoxin reduction (e.g. blocking DON biosynthesis).
- Develop new strategies to reduce sporulation on potential inoculum sources of the pathogen (e.g., residues of corn).

Outputs:

Short-term:

- Develop web-based resources for access to information on mutants created and their phenotypes.

PATHOGEN BIOLOGY AND GENETICS (PBG) *(cont.)*

- Determine patterns of pathogen gene expression and protein accumulation vital to disease and trichothecene accumulation.

Long-term:

- Identify genes potentially useful to reduce disease or mycotoxin contamination when introduced into transgenic plants.
- Develop new strategies for pathogen gene silencing.

Resources:

- Funding from USWBSI for gene discovery.
- Continued use of data obtained from USWBSI funds to procure other federal funding.

Anticipated Impact:

- Identification of genes to be used in the development of resistant, transgenic plants.
- Identification of novel means for controlling the scab pathogen based on gene discovery or other biochemical strategies.

Food Safety, Toxicology and Utilization of Mycotoxin-contaminated Grain (FSTU)

Goal #1: Provide analytical support for DON/trichothecene quantitation for Initiative's stakeholders.

Milestones/Performance Expectations:
Drafts developed by SC:

- Standardized sampling protocols adopted for regional (commercial field) and research testing for DON and posted on the USWBSI's website.
- Accurate information and analysis regarding ADONs and DON is publicly available in a form accessible to the FHB research community and the interested public.
- Provide DON data is a timely manner.

Performance Measure 1.1: Increase awareness about optimal sampling, grinding and test protocols for mycotoxin analysis.

Research Needs: Lack of awareness about optimal sampling and grinding protocols for grain industry, milling industry and initiative researchers. This may result in incorrect data and inhibit effort to reduce DON

Outputs:

- Short term
  - Session/meeting devoted to sampling /analytical methods. Present at next initiative meeting.
  - Protocols will be included in USWBI web page within the year.
  - Links to protocols will be provided to initiative users.
- Long term- Recommended methods will be updated/modified taking into account FGIS- and EU-recommended protocols.

Resources: Diagnostic lab directors

Anticipated Impact: Clarify stakeholder concerns over test accuracy and repeatability of data. Implementation of standardized sampling and grinding protocols can improve comparability/quality of data.

Performance Measure 1.2: Increase capacity for the analysis of DON and other tricothecenes

Research Needs: Initiative members need increased test capacity and turnaround time to make progress since the future focus will be less DON. The extent of need is unknown.

Outputs:

- Diagnostic labs
  - Survey of initiative users for anticipated needs, and continued evaluation of new technology.
  - Request to EC for expanded capacity (existing labs or new lab, if needed), and increased capabilities on- line within 12- 16 months.

Food Safety, Toxicology and Utilization of Mycotoxin-contaminated Grain (FSTU) *(cont.)*

- Facilitate on-site rapid testing
  - Workshop(s)/continuing education devoted to sampling /analytical methods at initiative meeting(s) perhaps including kit manufacturers.
  - Suggested rapid assay protocols (e.g. FGIS) will be included in USWBI web page. Links to protocols will be provided to initiative users.
  - Solicit bulk discounts for initiative users.
  - Continued evaluation of new technologies.

Resources: Diagnostic lab directors.

Anticipated Impact: Increased testing will enable breeders to achieve goals of DON reduction sooner.

Performance Measure 1.3: Diagnostic labs will include measurement of ADONs, other trichothecenes and glycosidic forms in selected surveillance samples.

Research Needs: There is concern about change in *Fusarium* genotypes and masked (glycosidic) trichothecene forms but there are limited data on occurrence individual toxins other than DON. FDA survey data is very limited.

Outputs: Multi-year year survey data on occurrence of different trichothecenes and relative ratios of these analytes.

Resources: Diagnostic lab directors.

Anticipated Impact: This data will assist discussion of "shifts" in observed mycotoxin profiles.

Goal #2: Provide requisite information on DON/trichothecene safety issues to producers, millers, researchers, risk assessors and regulators.

Milestones/Performance Expectations:
Drafts developed by SC:

- Validate current FDA standard of DON ppm in flour.
- Improved safety protocols and strategies established for workers (researchers, growers, grain-elevator operators).
- One or more studies are in progress regarding DON and related tricothecenes that will allow extrapolation from animals to humans.
- A scientific publication is generated from this study or studies.
- The information is used to produce accessible outreach materials for the public.
- A list is compiled of commodity groups, food safety groups, and other interested parties that have received the access outreach material.

Food Safety, Toxicology and Utilization of Mycotoxin-contaminated Grain (FSTU) *(cont.)*

Performance Measure 2.1: Conduct research on adverse effects of consuming DON and related trichothecenes that allow extrapolation from animals to humans and inform regulators thus enabling science-based risk assessment. Key considerations are groups at high risk and biomarkers of exposure/toxicity.

Research Needs: EU has established DON regulatory standards that are much lower than U.S. and there is pressure on CODEX to follow suit. There is new concern about change in Fusarium genotypes and mycotoxin profiles.

Outputs:

- Publication of research/reviews in high impact journals that inform international risk assessors and regulation.
- Participation in national/international research meetings/ forums/committees that inform risk assessors.
- Develop preliminary data for NIH-funded human epidemiology studies.

Resources: Food safety researchers

Anticipated impact: Risk assessors and regulators will use data to make sound scientifically valid decisions that ensure public health but minimize economic effects to wheat and barley industries.

Performance Measure 2.2*:* Summarize known toxicology information on DON, /trichothecenes, their risks and rationale for regulations.

Research Needs: There is lack of easily comprehensible information on DON and its risks. This creates confusion among producers, millers and Initiative scientists.

Outputs:

-Web pages with questions and answers about DON safety.
-Initiative-originated reviews/position paper(s).

Resources: Scab Web support facility, food safety researchers.

Anticipated Impact: Improved understanding/communication of the importance of the problem among the producers, millers, researchers and government.

Performance Measure 2.3*:* Conduct research on inhalation risks of DON and related trichothecenes, exposure and risk management

Research needs: Inhalation of DON and other trichothecenes poses unknown hazard to farmers, grain handlers, millers and researchers. Inhalation is more effective than ingestion in delivering these toxins. Effects could involve increased infection, inflammation and asthma.

Food Safety, Toxicology and Utilization of Mycotoxin-contaminated Grain (FSTU) *(cont.)*

Outputs:

- New data/publications on effects of trichothecene/contaminated grain dust inhalation on toxicity markers.
- New data /publications on occupational exposure to DON in grain dust.
- Provide information about "at-risk" occupations and mitigation strategies.
- Develop preliminary data for NIH-funded human epidemiology studies.

Resources: Environmental and occupational safety workers

Anticipated Impact: Ensure safety of wheat and barley industry workers.