Goal: Increase acreage of FHB resistant varieties

Performance measures: acres planted to FHB resistant varieties in affected areas

Needs: Cooperative evaluation of advanced lines for all important traits under best management practices (such as tillage, chemical control, biological control, forecasting models…) and accurate assessment of economic return.

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.

Anticipated Impacts: Widespread adoption of FHB resistant varieties with competitive agronomic and end-use performance.
Stabilize supply of high quality wheat and barley for end-users

Goal: Increase of efficiency of individual programs to develop FHB resistant varieties

Performance measures: See breeding program metrics below.

Needs: Maintain existing capacity for field testing of FHB, DON etc…
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 haplotype data for known QTL
Increased capcity for MAS backcrossing
Increased access to doubled haploid technology

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

Anticipated Impacts: Lower DON levels in wheat and barley.

Goal: Efficiently introgress effective resistance genes into breeding germplasm.

Performance measures: number of breeding lines with new sources of resistance in their pedigrees.

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

- Use breeding program resources to rapidly phenotype mapping populations in multiple environments for genetics studies

Outputs: Improved germplasm with diverse resistance

Anticipated Impacts: Breeding germplasm with higher levels of resistance to FHB and lower DON concentrations.

Breeding Program Metrics – Draft 12-7-06

I. Performance Metrics

1) Variety/advanced line performance relative to appropriate check varieties (DON, FHB severity, VSK, yield, quality).

2) Average performance of breeding lines (advanced, preliminary yield trial entries etc…) compared to appropriate check varieties for FHB and agronomics.

II. Program Metrics

1) Percentage of crosses made involving FHB resistant parent (native or exotic resistance)

2) Number of crosses (or lines) evaluated in early generation for FHB (Type II resistance, other disease measures, DON concentration, FHB marker haplotypes).

3) number of variety candidates entered into Uniform or Regional Yield Nurseries or industry quality evaluations with enhanced FHB resistance.

III. Release Metrics

1) Information on current variety performance in terms of FHB, DON, Yield.

2) Number of new releases with “native” FHB resistance.

3) Number of new releases with “exotic” FHB resistance.

4) Number of new releases carrying resistance alleles at mapped FHB QTL.

IV. Impact Metrics

1) Acreage in affected areas planted to varieties with enhanced FHB resistance.

2) Contribution to the parentage of releases (culivars/germplasm) and parents used in crosses by other research programs (germplasm sharing).

<u>Goal #1:</u> Validate integrated management strategies for FHB and DON

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, cultivar, residue management).
- Optimize fungicide application timing and methodology
- Deploy improved FHB/DON forecasting systems and validate the use of the disease forecasting systems in combination with resistant cultivars and chemical control.
- Utilize isolines (developed by breeders) with known response as standards across regions or grain classes.

Outputs:

- Uniform research design to facilitate regional and national interpretations of results.
- 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.

<u>Anticipated Impact</u>: Producers will make decisions based on regionally validated science-based information.

<u>Goal #2:</u> 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.

Performance Measures: Implement FHB/DON management methods validated through science-based research

Research Need: 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 FHB/DON behavior.
    - 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).
    - 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 Need: 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.

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.

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

Research Need:

- Enhancing forecasting capabilities:
    - Examining the ability to utilize other sources of weather data and 'ensemble' approaches to forecasting.
    - Develop forecasting tool for DON.
    - Validate forecasting tool for barley.
- Develop control methods that include biological control agents
    - Support discovery and development of biological control agents
    - Develop a better understanding of the ecological relationships associated with biological controls
- Continuous assessment of new control methods for FHB/DON.
- Develop platform for the exchange of information that facilitates more team-building.
- Screen new fungicide compounds across multiple environments as candidates are identified by industry.
- Determine factors influencing DON accumulation in wheat and barley grain
    - Evaluate the potential impact of environment during grain filling growth stages on finial 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: Evaluate and quantify factors influencing DON accumulation in asymptomatic wheat

Performance Measures: Provide information regarding specific factors influencing infection and toxin accumulation that can be used to develop the next generation of scab and DON risk assessment models.

Research needs: Identify host-, weather-, and pathogen-related factors and interactions involving these factors that are associated with DON 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:

- Late/secondary infections and post-flowering weather conditions
  - Post-flowering inoculum density and the associations among inoculum density, weather, FHB, and DON accumulation.
  - Influence of weather (and variety) on infection efficiency (IE) at various growth stages between heading and grain maturity.
    - IE measured in terms of fungal biomass and visual symptoms at time *t* after inoculation (with a fixed inoculum dose).
    - Inoculate at flowering under a range of temperature and RH conditions to establish optima.
    - Hold weather fix (at *optima*) and vary inoculation time.
    - Evaluate different inoculum dose at optimum inoculation time and under optimum conditions.
    - Evaluate whether inoculum dose compensate for sub-optimal weather conditions and timing.
  - Influence of weather on temporal variation in fungal biomass of grain following inoculation at different growth stages between heading and grain maturation.

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.
- 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.

Resources:

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

Genetics – Biotech Action Plan Discussion

In general, a much greater degree of collaboration and division of labor is anticipated for future Genetics/Biotech research projects

Create new website resources to disseminate information useful to research community, so that redundant research is minimized.

FHB Resistance Mapping

Goal: Expeditious identification and characterization of novel loci for FHB resistance loci.

Research Need:
Research community needs to utilize current, best molecular markers to demonstrate novelty of new FHB resistance loci. This could include haplotype, pedigree, relatedness and preliminary map data.

Develop genome-wide marker fingerprints of FHB resistant material to facilitate rapid incorporation of new FHB resistance loci into breeding programs.

Current capacity to evaluate multiple segregating populations is insufficient.

Performance Measures
Initiative will only fund proposals to map new FHB resistance loci that provide preliminary data demonstrating the novelty of the resistance.

Unique FHB resistance loci from germplasm unrelated to previously identified resistance (3BS wheat) (Chr 2 barley).

Increase the capacity of field evaluation of FHB resistant germplasm.

Outputs:
Identification novel FHB resistance loci and accompanying markers for deployment

Impact: Increase of US wheat and barley market classes with additional genes that confer resistance to FHB

Gene Discovery

Goal: Efficient identification of candidate genes for resistance against FHB and DON.

Research Needs:
Rapid identification of genes essential for resistance to FHB and DON.
Transgenes and QTLs

Rapid high capacity assays for discovery and validation of genes with function in FHB and DON resistance.

Performance Measures:
Validation of gene functionality for FHB/DON resistance through development of high throughput assay systems.

Plant Transformation

Goal: Develop effective transgenic strategies to FHB resistance that can be used to complement natural genetic resistance or as a standalone solution.

Needs:
1. Establish and support centralized transformation facility(s) for more efficient generation of transgenic plants and seed stocks for Initiative funded research projects.

2. Preliminary data for efficacy transgenes must be provided for Initiative support.

3. The initiative should support centralized facilities for field testing of transgenics.

4. Development of tools for optimized gene expression in wheat and barley.

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

Incorporate validated transgenics into VDUN program.

PGG Action plan

Goal 1. Characterize genetic variation in FHB pathogen population in regard to fungal virulence and mycotoxin potential.
Performance measure. Increase information useable to make decisions on performance of plant varieties toward specific genetic variants of the pathogen.

Research needs. Characterize current FHB populations in the US and their interactions with plant varieties developed by USWBSI.

Outputs. 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 explaining significance of genetic variation to disease resistance and mycotoxin potential in wheat and barley.

Goal 2. Develop new strategies for reducing impact of FHB disease and mycotoxin contamination in barley and wheat.
Performance measure. Strategies for disease and mycotoxin management based on knowledge of pathogen biology, genome and genetics are developed.

Research need. Discovery of genes for pathogenesis, trichothecene reduction, novel antifungal compounds, etc. Development of RNAi approaches to modulate pathogen genes for disease control and mycotoxin reduction.

Outputs. Identify genes potentially useful to reduce disease or mycotoxin contamination when introduced into transgenic plants. Develop web-based resources for access to information on mutants created and their phenotypes. Determine patterns of pathogen gene expression and protein accumulation vital to disease and trichothecene accumulation. Develop new strategies for pathogen gene silencing.

Goal 3. Develop new strategies for minimizing survival and fitness of the FHB pathogen.
Performance measure. Strategies for reducing fitness of FHB pathogen are developed.

Research needs. Discovery of targetable metabolic or biological vulnerabilities that lead to reduced fitness.

Outputs. Potential biological or cultural control strategies based on knowledge of pathogen biology, genetics or genomics. Identify host sources with reduced ability to produce inoculum. Identify when and in what plant tissue trichothecenes are produced during the life cycle of the pathogen.

Action Plan for Scab Initiative
Food Safety Toxicology and Utilization- Diagnostic

Goal 1.1: Provide analytical support for DON/trichothecene quantitation for initiative stakeholders.

Performance measure: 1.1.1 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: 1.1.2: 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.
- 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: 1.1.3: Diagnostic labs will include measurement of ADONs, other trichothecenes and glycosidic forms in 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: Multiyear 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.

Action Plan for Scab Initiative
Food Safety Toxicology and Utilization- Safety Research

Goal 1.2: Provide requisite information on DON/trichothecene safety issues to producers, millers, researchers, risk assessors, and regulators.

Performance Measure 1.2.1: 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:
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 1.2.2*:* 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:
Anticipated Impact: Improved understanding/communication of the importance of the problem among the producers, millers, researchers and government.

Performance plan measure 1.2.3*:* Conduct research on inhalation risks of DON and related trichothecenes, exposure and 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 inflammation/asthma.
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

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

Nuts and Bolts of Scab Screening:

From flip charts:

What are we doing now that absolutely must be continued?

- Emphasize DON evaluation
- Continue field evaluations
- Evaluate over multiple locations and years
- Absolutely essential that resources be available for breeding programs to continue field evaluations in misted, inoculated nurseries in order to keep selecting for FHB resistant breeding lines.
- Get rid of susceptible lines faster (to save resources)
- Characterize low DON lines in Uniform Nurseries
- Reduce greenhouse evaluations

What do we need to do that we're not doing now?

- Need more understanding of the relationship between the plant, the fungus and DON (What causes the fungus to produce DON in wheat?)
- Determine genetic control of DON level in the plant
- What's happening between rating and harvest (the fungus may be a saprophyte on senescencing wheat heads). Also what's happening between harvest and processing?

What factors are most important in determining the accuracy of DON measurements?

- Don't run DON on VS lines
- How does particle size and sampling error affect DON
- Grain sampling – lots of error can occur
- FDK and DON – should both be measured?
- Should tombstones be removed first and then DON evaluated? (combines blow out tombstones)

- Should more DON samples from yield trials be sent for analysis (ND does this)?

- Greater capacity for DON evaluations may be needed (an issue at ND)

NUTS AND BOLTS OF SCAB SCREENING (notes from a note-taker)

I. Breeding, evaluation in research nurseries

a. Which indices to prioritize? Some felt visual estimation of one number (IND) per plot is fine. Some felt we could reduce greenhouse Type II testing, but still need incidence, severity, and FDK from field. There was general agreement with putting more emphasis on %FDK and DON.

b. Ascospores vs. conidia as inoculum. It was noted that colonized grain spawn, which generates ascospores, is less labor-intensive, but can lead to multiple infections. Spraying conidia generates basically a single infection event, and this has some effect on Type I vs. Type II.

c. What relationship does DON have to resistance types? DON has only been shown to be a pathogenicity factor in wheat, not in barley, corn, or potato. DON is not required for infection of wheat, but it is an important aggressiveness factor (higher DON-producing isolates are more aggressive). It is controversial whether DON is translocated in heads in advance of the pathogen's mycelial growth (in other words, whether Type II resistance is essentially resistance to the spread of DON in the head). There is evidence that plants can degrade DON, which would be related to "resistance to DON."

d. What is Type I resistance? Lower incidence of infected heads appears in the field, and is repeatable. Heads can be sprayed in the greenhouse and rated after 5-7 days, but it is tricky.

e. Methods and accuracy of DON measurement: ELISA has been traditional. ELISA kits have specific ranges within which they're accurate, e.g. 1-5 ppm or 1-25 ppm, and in these ranges they are as accurate as GC-MS. At higher DON levels, ELISA can lead to sampling-error and repeatability kinds of mistakes because one must dilute the sample (and one should be sure to dilute in the matrix, rather than in water). Elevators that test for DON use ELISA. The USWBSI service labs are moving to GC-MS.

f. What types of samples should we be DON-testing? Some varieties display a wide range of Fusarium damage, while others separate into either plump kernels or FDK. Should we do DON tests on what's not blown out the back of the combine, or on the entire grain crop? General feeling that that the former would reflect what growers produce, but not the innate genetic resistance of the genotypes in a breeding nursery.

g. Sampling methodology. In commercial settings, regulations cover how many probes should be taken relative to container size. Where samples are drawn from and how

h. many are drawn have a huge influence on the results. Five g. of seed is the current standard for breeders. Particle size makes a big difference. We need standard protocols for grinding, cleaning grinders between samples, particle size, etc. We also need more capacity for DON testing.

i. High-symptom, low-DON cases: Nivalenol producing strains in the South can lead to this situation, also F. avenacearum in the North.

Comments from two feedback forms received:

- Screen for DON at earlier generations
- Use ELISA instead of GC mass spect.
- Need better understanding of the genetic control of low DON and the DON-plant interaction
- Use FDK and severity at the earliest generations
- Wwe should be focusing on DON but screen for FDK and severity at earlier generations.
- Develop better techniques for evaluating type I
- Restrict greenhouse screening to material following field screening
- Need less point inoculation testing; limit to material tested in filed evaluations
- Increase capacity for DON evaluation for each region

Reinventing the Initiative

1. Multiple year grants – ARS – prepared to find ways to give funding for multiple years – conditionally based on strong performance. Funding commitment, but not actual allocation of funds past one year. Must have flexibility. Stagger grants; some one year, some are multiple years.
2. Move towards cooperative projects rather than competitive.
3. State, Regional and National: Submit a regional breeding project for Hard Red Winter Wheat (NE, SD, IA, KS, MO) – i.e. regional uniform nurseries.
4. Top-down directed: Pre-breeding and variety development
5. Cap projects – regional or cropped-based.
6. Must address education and public relations – how do you get the grower/producer to change his practices.
    a. Market signal - $$ (premium/discount)
    b. Get the Millers and Breeders to collaborate (Millers' obstacle – breeders customer is the producer, not the Millers).
7. Mennel – pretty happy with forecasting models.

Website Enhancements:

- Database that listed all sources of resistance (markers, QTLs)
- Standardization of techniques i.e. screening, sampling, testing – charge a group o f people to determine what is a priority.
- FSTU – Assays

Grants/Funding:

- One review committee for regional or mini caps. Obtain ad-hoc reviewers, and then come to the Executive Committee (EC) with recommendation. Small grants, seed money projects/pilot projects – organize a separate committee or get ad-hoc reviewers
- Maintain basic component – understanding the mechanism. Focus on accomplishments.

Formally meet with aphlotoxin Initiative.

Revise policies and procedures – simplify processes.

Bushnell – foster international collaboration.

Stakeholders want results now.

Communicating With the Real World Session

Monday, Dec. 11, 2006
USWBSI 2006 Forum, Dec. 9-12, Raleigh, NC

Moderators: Jim Bloomberg, Bayer CropScience, and Marcia McMullen, North Dakota State University

Outline of Discussion Points:

1) Current practices – North Dakota State University Example
2) How professionals do their communication – Scott Kurfman, AdFarm Ad Agency
3) Defining our audiences
4) Clarifying our message
5) New ideas
6) Deliverables

1) Current practices example: Marcia McMullen, North Dakota State (handout):

a) Growing season: 5 field days, AgDakota listserve, Crop and Pest Report (15 weekly issues), County AgAlerts, Training and Weekly updates on Disease Forecasting website and toll free number; field demonstrations
b) Fall & Winter season: District and State Crop Improvement meetings, 4 major Crop Trade shows; Pesticide Certification training, ND Durum Forum, International HRSW Show, Barley annual Meeting, many county meetings
c) 2006 Scab Summit: VP of Ag invited legislators and policy makers to discussion of FHB – where we were, progress made, and future outlook
d) 12 various publications related to FHB management strategies, risks of DON, and variety response, available as hard copy and on NDSU web site
e) Regional Variety response and yield and quality information – available as hard copy, NDSU website + websites of 10 research/extension centers in ND

Problems: Many sources of information, no central source, difficult to find
Advantages: Local information, more responsive to immediate needs

USWBSI web site: Multiple links to extensive information about FHB
Advantages: good source of general information or research specific information and many links to other resources;
Disadvantages: Not responsive to local needs or immediate information needs;
Difficult to find or search for specific research information

2) Professional Communicator: Scott Kurfman, AdFarm (advertising agency)

"Understanding our Audience"

Communicators need to **balance *Relevance with Impact***
If farmers don't see relevance, they move on; but also have to get their attention

Relevance: What the audience wants to hear and what we want to say are not always the same. Our producer audience: They want to learn how to make more money so they can pay off new truck or put daughter through college

"% of people understanding the disease is a lot smaller than the % of people who live the problem"

Impact: Garner their attention (facilitates message delivery)
Simple messages, tied to economics

Engagement: If successful with *relevance* and *impact*, then get *engagement*
Engagement types:
Emotional: FHB is bad and it hurts my pocketbook, but I can beat it
Cognitive: Application – analysis – seek for more info
Ex: hot line, toll free number
I don't know as much as I thought, but I need to learn more, learn what I can to manage FHB
Physical: Act – share the message – recruit others
I'm going to start doing something about FHB in my crop
I need to spread the word on the issue
AdFarm example: Virtual Grower Roundtable in HRSW region, called "Halt to Scab"

Scott Kurfman's Keys to Success:
a) know your audience (demographically and personal)
b) get on their level – respect them, their time, interests, needs, speak to them at appropriate level
c) Don't assume – what they think or care about your message
d) Maintain your honor – yours is an honorable task

3) Who is the audience?
a) Initiative
b) General public – includes consumers of our grain products
c) Stakeholders – Producers, commodity groups, ag professionals, dealers, distributors, elevators, millers
d) Government, policy makers

4) Clarifying our message
a) Keep talks simple, bullet points (Dumb it down, keep it simple; what's in it for them, but some tech still needed, as the message is complicated but hard to distill in to one bite) Don't talk so much like scientist
b) Add important economic message
c) Expand or clarify audience: distributors of products now giving a lot of the information so find better ways to target them, too
d) Can we "bundle" our FHB message?

5) **New ideas (or at least new to a region)**
a) Add extension specialist commentary to forecast map info (as in soybean rust and as done in a pilot project for FHB in soft red winter wheat area)

b) Add Toll-free # for status of disease risk (currently in LA, KY for other diseases and in ND for wheat disease forecast site) Works best with volatile, important, hot topics
c) Use web cam to show wheat/barley development and tie in recommendations to this web cam site (like corn development site which is very popular)
d) Verification program, like Mississippi Smart (field verification of practices in farmer fields)
e) Develop a Scab Smart program Web site: FHB "shell" for management information , made available to everyone, then make it useful for individual regions
f) Round table discussion for area influencers; Stakeholder focus groups to determine where the knowledge gaps are, what information they need and how they would like to receive it
g) Focus on real time vs long term
h) Sort available data on Initiative web site; consolidate to understandable message; web site as more of an educational tool for general public and then "educator password protected site"
i) Stress progress made; Focus on marketing ourselves
j) Initiative put together impact or success stories – could have multiple customers; Use testimonials
k) Communicate to audience for stable funding source about progress (stakeholders), communicate progress

6) Deliverables

Time Frame	Deliverable
1 – 2 yrs	Searchable Initiative website for public and perhaps another for researchers
1 yr	Scab Smart: general recommendations featured (Shell), then region specific recommendations, add economics if possible
Now	Success stories from Initiative, including impacts
1 yr	Focus groups, to determine stakeholder's information needs and information gaps
1 -2 yr	Educate the educator on methods to better communicate with our stakeholders (use experts in communication, marketing the message)

The session was started out by people in the room talking about what research they were FHB doing. One thing that was evident was there was good collaboration between the public barley improvement programs (breeder, pathologist, and cereal chemist), the Busch Agricultural Resources, Inc. (BARI) program, and the malting and brewing industries. This part of the session was particularly helpful for those who don't work on barley full time.

Items noted as needs by the group included:

Collaborative testing of FHB-tolerant breeding lines in a trial with Prosaro and other fungicides if warranted. Les Wright of BARI indicated that he would try to obtain monies from his company to help support this project.

Corby Kistler offered to provide different chemotypes of the pathogen to researchers wanting to test if barley lines respond differently to the different chemotypes.

The group was very supportive of preparing a mini-CAP type grant that would include barley improvement, chemical and cultural control of FHB, DON testing, etc.

A statement was made by industry about the need to demonstrate the value of the forecasting system for barley. I interpret that this was not a negative comment, but rather people want to know if it works so they can use it and if it doesnt then research in that area can cease. I sensed some frustration with the time it is taking to resolve this issue, so it should be a priority.

It was acknowledged that most mid-west breeding programs had some lines with good resistance which were due to be commercial-scale tested in the near future, but with the lack of resistance available in barley, comments were made that there needs to be as many lines as possible in the pipeline. I interpreted that to mean that both gene discovery, pre-breeding and breeding should be a priority.

An industry representative suggested the need for research on the effect on the brewing process of fungicides being used in the field, in particular the effect on yeast. Similarly it was also suggested that transgenic barley with antifungal genes should also be tested for its impact on the brewing process. An integrated approach was suggested with agronomy, pathology, residue chemistry and brewing chemistry being involved.

HRS wheat & Durum - regional breakout group

1. Regional cooperative effort to provide growers with ranking of cultivars for FHB resistance. (This might require additional/broader uniform testing but might only need researchers in a region to communicate/agree on the relative rankings)

2. Develop a searchable catalog of germplasm screened for FHB (including resistant AND susceptible) - including phenotyping, markers identified, haplotype data and other relevant info.

3. Mine uniform nursery data from breeding programs for "high DON/low FHB severities" data points to document and explore higher than anticipated DON in HRSW.

4. Examine best management practices with respect to Fungicide x Genotype combinations - using germplasm prior to release.

5. Coordination within the region
    a) researchers within the region (e.g. regional workshops vs discipline based workshops)
    b) researchers and stakeholders (might join with wheat quality council tour)

6. Coordination across regions (e.g. discipline, cross regional workshops)

Scab Initiative: Hard Winter Wheat (HWW) Region

The HWW region is unique for the following reasons:

1. The HWW group is smaller than those for other market classes.
2. The breeding programs in the HWW region participate in excellent nurseries to obtain information on other important traits (such as RGON, SRPN, NRPN).
3. There is excellent collaboration between breeders and pathologists in all states.
4. There are indigenous sources of resistance to FHB already in adapted cultivars.

The following are interdisciplinary, collaborative arrangements within the HWW region that should enhance progress on management of Fusarium head blight:

1. Although the breeding program in South Dakota is the leading breeding effort in the region for resistance to FHB, the programs in Nebraska and Kansas are also heavily committed to the effort. There is excellent cooperation among these programs.
2. The "Tri-state FHB Phenotyping Nursery" for the region was begun in the 2005-06 season to help generate more accurate data and to quantify GxE interactions within the HWW region.
3. There is a genotyping facility in the region that provides marker and backcrossing support for all of the breeding efforts.
4. A regional program was initiated in the 2006-07 season to test fungicides on adapted cultivars within the tri-state area. In the future, this program may be expanded to incorporate other management practices as crop rotations and tillage. Additionally, treatments from the HWW biocontrol research program can feed into this effort for testing across the region.
5. Recent changes in personnel have brought needed expertise in FHB forecasting to the region.
6. Along with the ongoing, normal research efforts, the above collaborations will allow the following needed areas of research for the HWW region:

Combining cultivar development with response to fungicides.
Epidemiological parameters unique to the region.
Quantifying DON production during "saprophytic growth" of the fungus.
More efficient communication within the region.
Historical risk of FHB in HWW states.
Educational programs for the region.
Regional vulnerability assessment.

There is interest among HWW researchers to potentially develop a regional proposal to the USWBSI to even better coordinate efforts for the HWW area. Such a proposal would likely include:

1. Breeding to build adaptability and FHB resistance into HWW cultivars.
2. Support to the breeding efforts from the regional Genotyping and MAS Center to help incorporate important traits (FHB resistance) into adapted lines.
3. Quantifying the historical and predicted FHB hot spots within the HWW region.
4. Collection of regional information on FHB phenotypes, performance of fungicides, effects of tillage and crop rotation, and performance of biocontrol agents.
5. Enhancing educational programs within the region on best-management practices.

Soft Red Winter Wheat Breakout (southern group)

Carl Griffey presented a summary of current facts, needs, and potential integrated projects (see attachment).

Opened up breakout for discussion

Major outcomes of session:

1. Identify best sources of resistance and evaluate lines more than one year in Uniform FHB Nurseries
2. Evaluate 'best lines' from Uniform FHB Nurseries for yield and quality traits
3. Collaborate across RAC
4. Increase communication within and across RAC to avoid duplication
5. Develop integrated protocols
6. Deploy varieties and production strategies that enhance grain quality (weathering, pre-harvest sprouting, and lower DON), e.g. plant multiple varieties having diverse maturities
7. Increase educational efforts to stakeholders (THIS NEED WAS VOICED IN CCBC/EEDF AND COMMUNICATION SESSIONS)
8. Need to get producers to plant FHB resistant varieties
9. Breed for resistance to DON within varieties with resistance to Fusarium
10. Develop website to facilitate information exchange among breeder and genomics groups
11. Develop quick selection tools/techniques for detecting DON
12. Minimize variation in DON within tests (improve experimental design and test locations)
13. Evaluate DON production in FHB resistant varieties after the varieties have reached physiological maturity through grain harvest
14. Increase funding period for grants beyond one year
15. Increase collaboration across RAC to communicate major accomplishments
16. Need to characterize resistance, develop genetic markers, and work more with the genotyping centers
17. Staggered flowering dates within uniform nurseries creates problem for timely harvest and could impact conclusions concerning DON production. (i.e. all varieties are not subjected to the same environmental / epidemiological scenario)
18. The CCBC committee has expressed a desire to screen fungicide treatments on FHB resistant and susceptible varieties
19. Identify new sources of Type I resistance
20. Improve varieties (i.e. Good genetic resistance, but poor yielding/agronomic characteristics)
21. Develop diagnostic markers to detect multiple QTLs
22. Increase research on DON production in wheat that is beyond physiological maturity.

Questions/Concerns

1. Are breeders screening for type II resistance in the greenhouse (knowing 3B and 5A QTL are present) losing 5A QTL after going to the field
2. Expressed concern that there is a major push to breed for yield and not genetic resistance to FHB
3. Experimental design in Uniform Nurseries may need to be changed to allow for more accurate screening.

Notes from the breakout session for scientists focused on soft wheat from the Northern region
Moderated by Larry Madden and Clay Sneller

Many ideas and issues from the previous breakout sessions were discussed in this session

Top priority: There is a need to develop an integrated control program, determines its costs and benefits, and connect this information to all extension programs in the region. Our group discussed and initiated a plan where the best genetics from the Northern Uniform Scab Nurseries would be entered into a regional trial using Best Management Practices. This would test whether a package of technologies exists to obtain low DON. This information is crucial scientists, growers and end-users. We proposed to form a group that would coordinate this project.

Other Ideas (not in any order)

1. Optimizing the information from the Uniform Scab Tests
   Haplotying the entries
   Test best entries over years
   Couple the genetic to best management practices (see below)

2. Coordinate phenotyping mapping populations in multiple environments
3. Breeders could use association mapping in conjunction with geneticists to uncover more genes
4. Establish a data base with information pertaining to pre-breeding (eg, what novel sources of resistance are being used, what marker-introgression efforts are on-going, etc)
5. The varieties that growers use are not always well screened for FHB (if at all), many are not derived from USWBSI participants, so insufficient information is available to guide growers. It was suggested to screen these lines in a uniform trail. Concerns were raised about the size of such a test, how to eliminate redundant (branded) entries, properly accessing seed of proprietary genotypes, and liabilities if the education material derived from the trials recommended NOT growing some genotypes.
6. Need research on histology of infection and accumulation of DON over time in different cultivars.
7. Pathologists offered to identify best strains for breeders to use in screening.
8. Communication of information from scientists to growers in not very good. Example, growers could use the scab forecasting information more.