NC213: Marketing and Delivery of Quality Grains and BioProcess Coproducts

Approved

(Multistate Research Project)

Duration:	October 2013 to September 30, 2018
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Statement of Issues and Justification

The multi-state research project NC-213, Marketing and Delivery of Quality Grains and BioProcess Coproducts will end its five-year cycle on September 30, 2013. At the March 2012 Annual Technical Meeting, the NC-213 Research Committee developed its plan to rewrite the project for the next 5-year cycle.

NC-213 engineers, entomologists, plant pathologists, grain/food scientists and economists continue to solve important ongoing grain quality issues. Progress has been made in several areas:

- breakage of corn during handling and transport, - stress cracking of corn during drying, - development of instruments to measure grain quality attributes, - development of sensors to monitor grain quality, - alternative technologies and practices to protect grain from insect and fungal pests, - quality management and assurance systems for identity preservation and traceability, - attributes affecting processing of grain into various end products.

Advances in biotechnology and heightened awareness of food safety have presented new and larger challenges only addressable by collaborative efforts among researchers and extension providers. New challenges come over the backdrop of steadily increasing total grain volume with the related pressure on grain management infrastructure. Some examples are: - Development of high throughput assays for low concentration quality attributes (e.g., amino acids) and food safety concerns (e.g., mycotoxins). - Preparation of the grain market chain and supporting regulatory bodies for the food safety practices that will be instituted following the Food Safety Modernization Act (FSMA) of 2011. - Application of technologies to more precisely monitor or prevent product loss, driven by the rapid escalation of grain and grain product value in the last 5 years. - Reconfiguration of grain processing operations to better optimize the mix of feed, food and fuel outputs, with reduced inputs to operations. - Rapid development of new food, energy, and bioproducts (e.g., bioplastics.).

NC-213 provides an opportunity for its multi-disciplinary team members and industry stakeholders to interact and collaborate on addressing specific engineering, scientific, and economic issues associated with the overall project objectives. The annual technical meeting provides a unique experience for participants to learn about and interact on all issues related to grain quality in a multi-disciplinary environment. The participants also find more practical ideas and relevant information on their interests in research, development, practice, and policy through the panel discussions, presentations, and informal conversations. This can lead to enhance the quality of their research experience and provide the development of new

innovative research programs and partnerships with greater opportunity for extramural funding.

NC-213 has always had a very strong industry influence and the meetings are regularly attended by numerous industry representatives from grain handling, marketing and processing companies, allied service suppliers, and equipment manufacturers. Since 2000 there has been an Industry Advisory Board consisting of five elected representatives with its chair serving on NC-213├ s executive committee. During the 2012 Annual Technical Meeting, a roundtable with industry representatives discussed trends currently influencing the U.S. and global grain industries, and outlined research needs that NC-213 should address in its next 5-year project cycle. The recognition of the overall research needs blends independent NC-213 participants into a more unified, market-centered research team.

A new factor is the emergence of food safety as a trade and market driver. While the FSMA was a regulatory milestone, market concerns have been increasing steadily over 10 years or more. Several incidents demonstrate the need: StarLinkTM corn in 2000, aflatoxin in pet food in 2005 and 2012, and melamine in wheat gluten in 2007. Bulk markets are inadequately prepared for procedures that document and assure food safety ‼ activities such as cleanout and isolation, traceback and recall, lot documentation, and trace contaminant measurement are now critical. The NC-213 technical group is uniquely suited to address these issues, coming from an already established background in bulk grain and grain product marketing.

The biofuels industry has had the expected impact on grain production and storage. Due to the domestic demand for corn, approximately 40% more grain is being stored on U.S. farms and in commercial facilities to provide year-round feedstock. Recently added storage capacity has already increased U.S. on-farm and commercial grain storage capacity well beyond 20 billion bushels. The consensus in 2007 was that a principal challenge will be maintaining grain quality into the following summer months. The reality of this view was shown in 2009 when US corn was very wet, immature, and overran the drying capacity of most facilities. In Summer 2010, large amounts of damaged grain occurred, to the point where many buyers could not find standard grade #2 corn.

The production of co-products from the ethanol process, especially distillers dried grains with solubles (DDGS), has created new handling, storage, transportation, marketing and utilization challenges. DDGS volume now exceeds that of soybean meal, as a protein concentrate source, with 25-40% of DDGS now being exported. Export chains require much more quality control and stability in prodcuts than the previous local markets to livestock feed.

Crop and processing (efficiency) yields are primary concerns for the emerging biofuels industry. For example, increased corn production led to a higher percentage of corn-on-corn rotations that in turn increased the occurrence of mycotoxin producing fungi (e.g., Fusarium, Aspergillus spp). In 2009, the wet corn crop created vomitoxin problems and in 2012 the drought -stressed crop has a high incidence of aflatoxin. Development of new technologies to detect and reduce mycotoxin levels will be important. Economic models that take into account the additional resources required to maintain crop quality over longer periods of time will be critical to the cereal and oilseed industry. Co-products such as DDGS must now be considered. The biofuels industry demands a high-quality corn feedstock with low grain damage and very low mycotoxin levels. Identification of grain types and agronomic practices that result in high biomass to fuel conversions during processing will be necessary to help ensure the industry├ s economic viability.

New generation processing technologies may be able to increase outputs significantly. For example, pre-fermentation dry fractionation can remove valuable non-starch components before ethanol production, resulting in more feed/food availability at much reduced energy input to the plant. Matching grain properties to new process technologies and new products can further increase plant efficiency and total output quality and quantity.

Delivering low-cost, safe, and high-quality cereals and oilseeds for food, fuel, feed and other products require even more of a systems approach than before. The new challenges are completely multidisciplinary, multi-agency, inter-institutional, and interregional. The timeline for realization of impact is growing shorter with the increasing speed of information and technology transfer. The NC-213 objectives for the next 5-year cycle are revised as shown in the Objectives section. To better meet these objectives, the NC-213 committee has made increased documentable coordination among individual station groups, and more rapid translation of outcomes into demonstrated impacts as its two organizational priorities for the 2013 to 2018 cycle.

This cycle will also mark a significant transition in scientists as many of the original participants will be retiring. Synergy among stations, which created significant sharing of expertise across disciplines in the early growth of NC-213, will be required to retain the current knowledge as a background for the totally new science that is becoming the norm.

Since 1977, NC-213 has improved the efficiency of the U.S. grain industry and captured value along the cereals, oilseeds and coproducts supply chains. The evolution of the bioproduct industries has added commodity coproducts to the focus of study.

Related, Current and Previous Work

Related Work

NC213 focuses on the farm-to-user supply chain for raw grains and their processed products. World emphasis on food safety, environmental management, biosecurity, and overall quality continue to increase the need for NC-213 particularly when no other multistate project efforts are being directed in this area. A CRIS search of work conducted in other multistate projects that could potentially intersect with NC-213 objectives yielded projects that are inactive or terminating and projects that do not relate. Those projects are:

Inactive or terminating: NC129, Mycotoxins in cereal grains ; NC224, Competitiveness and value-added in the U.S. grain and oilseed industry; NC227, Ergot: a new disease of U.S. Grain Sorghum; NC1016, Economic Assessment of Changes in Trade Arrangements, Bio-terrorism Threats and Renewable Fuels Requirements on the U.S. Grain and Oilseed Sector (formerly NCT195 and NC224); NCDC215, Cover crops to improve environmental quality in grain and biofuel crop production systems in the Great Lakes and Upper Mississippi basins.

Projects that do not relate: NCERA184, Management of small grain diseases; Improving plant food (fruit, vegetable, and whole grain) availability and intake in older adults; SERA011, Review and Coordination of Oilseed Rape Research Programs in the Southern Region .

On the industry side, considerable activity occurs with two industry focused organizations, the Grain Quality Workshop and the Grain Elevator and Processing Society. Beginning in 2006 NC-213 collaborated with both of these groups by holding joint meetings on alternating years. In addition, there is considerable overlap in membership between these organizations

that presents multiple opportunities to share information and impact the U.S. grain and oilseed industries.

Current, Previous Work and Impacts

NC-213 scientists developed a single NIRS instrument calibration for the various forms of soymeal products being received by mills. This advancement will create uniformity and reduce analytical support costs at the same time. A multi-location milling company is now monitoring all inbound soybean meal based on the new calibration.

NC-213 scientists designed and built a low cost sorting device for wheat using a standard personal computer and color camera. At a wheat throughput of 3.5 kg per hour, the sorter separates the wheat with an accuracy 15 to 20% higher than what can be achieved with traditional sorters. Four wheat breeders in the United States have already adopted this system as their tool of choice for separating red and white wheat.

NC-213 scientists modified a common laboratory roller mill system to effectively detect hidden insect infestations in wheat kernels at low cost based on the kernel electrical properties. This technology should help grain handlers and millers detect grain that is infested and take action before the insect population increase and damage more grain and is currently being transferred to a major food processor in the United States.

NC-213 scientists showed that a quality management system (QMS) facilitates tracing bulk products through handling and distribution channels to a much greater degree of accuracy than previously anticipated, with tracking precision increasing by 50% over the last two years of study. The three largest grain companies in Iowa have implementing quality management systems to identify solutions to grain inventory and operations problems corroborating that QMS is a cost saving practice.

NC-213 scientists demonstrated the effectiveness and profitability of alternative insect control strategies in grain storage and processing firms. Presentation of initial results to elevator managers and employees at extension workshops led the workers to decide to: work at sealing bins, adopt more cleanliness practices, research closed-loop fumigation for their facility, pay more attention to IPM, and consider more carefully the economics of IPM.

NC-213 scientists found that swine diets can utilize more biofuels coproducts than are normally included in rations, in tradeoff with corn grain. More inclusion of biofuel coproducts will alleviate some of the competition for corn between processing and feeding, and will reduce the transportation needs for hard-to-handle coproducts. Less conflict between feed and fuel needs will allow both to grow at rates needed to supply world food needs and domestic fuel demands.

NC-213 scientists established a professional development program in partnership with the Grain Elevator & Processing Society (GEAPS) providing a curriculum for the design and operation of grain handling and processing facilities. This successful University-industry partnership had over 400 participants from 14 countries (including five Latin American countries. Participants have significantly increased knowledge of the design and operations issues covered in the courses.

NC-213 scientists found that NIRS is a rapid nondestructive technique that is able to measure organic substances in minutes. Standard deviation of ethanol yield across typical corn samples was 0.1 gal/bu, which represents $5-7m variation in revenue to a 100m gal per year dry grind ethanol plant. Changes in agronomic practices, such as delayed planting, or increase N

fertility can have $2-4m per yr impacts at the ethanol plant, based on compositional changes that drive ethanol yield changes.

Researchers developed lines of corn for organic systems with increased levels of methionine, lysine, and cysteine, deliberately manipulated to break the correlation with total protein. This program was created as NIRS measurement of amino acids in corn has been hampered by the high correlation between the total protein content and the typical amino acid level. When average corn is used to calibrate NIRS analyzers, the calibration estimates the amounts of amino acids for protein level.

NC-213 researchers found that sorghum is an excellent source of a wide variety of bioactive compounds that can be produced in large quantities because sorghum can be easily grown, stored and processed to concentrate its unique components effectively. In addition, they discovered that tortillas containing tannin sorghum brans have good dark color and good acceptability with significantly high levels of antioxidants and dietary fiber.

NC-213 researchers discovered that with the adoption of color image sorting technology, a low cost sorting device for wheat, could be built using a standard personal computer and color camera. Special programming techniques can be used for a high throughput while keeping the sorter cost low. Accuracy is 15 to 20% higher than traditional sorters.

NC-213 researchers created a system that measures insect infestation of wheat kernels using the electrical conductance. The apparatus is low cost (-/+$1500 for parts) and can inspect a one kg sample in less than one minute. A partnership was formed with private industry to produce and market commercial versions of the system. The technology is currently being adopted by a major food manufacturing company.

NC-213 scientists conducted research on automated detection of fusarium head blight or scab damaged wheat kernels. FHB causes yield reductions of up to 50% and crop losses in the US have exceeded $1 billion. In addition, FHB can produce the toxins that must be below FDA guidelines. This technology will help the grain industry detect FHB and improve the safety of the US food supply. The technology can also be used to rapidly screen new wheat lines for FHB resistance.

NC-213 researchers presented at GEAPS 2010, held in Wichita, Kansas in February 2010. This presentation helped bring together GEAPS participants and NC-213 researchers to see how both parties can work together in problem solving grain, cereals, and oilseeds issues. This was a tremendous opportunity for NC-212 as over 1,800 attended the annual international technical conference and exposition. Survey results for this presentation were outstanding.

As a result of work conducted by NC-213 scientists, information from research on DDGS will have an impact on U.S. dry grind ethanol producers. Understanding the distribution of mycotoxins in wet grains and thin stillage and during corn fractionation will help develop strategies to reduce final mycotoxin concentrations in DDGS and other dry grind coproducts.

NC-213 researchers found that drying wet distillers grains and condensed distillers soluble to DDGS is an energy intensive process which consumes the second largest energy budget in corn to ethanol production. The results from this research will help in optimizing the drying process of DDGS in order to decrease energy consumption, while maintaining product quality.

Through extensive research, NC-213 scientists found that single seed determination of viability and biotech status could preserve germplasm collections, improve seed quality monitoring, and open significant markets

for non-GM grains that were previously inaccessible due to lack of practical testing methods.

NC-213 scientists developed a method that simplifies and reduces cost of development calibrations to automatically measure grain and soybean composition. This method is being used at the University of Kentucky to measure soybean breeder samples oil and protein content and this method is being used at Iowa State University for single seed measurement.

NC-213 research resulted in the commercialization of sorting technology and adoption by seed breeders/producers. A low cost color image based sorting device for grains was refined, commercialized, and transferred to a manufacturing company through a Cooperative Research and Development Agreement with National Mfg. who has sold over ten of these machines to various seed breeders and seed foundations in the US and internationally. The new sorting system has unprecedented accuracy, throughput, and low cost for inspection/sorting systems.

NC-213 researchers at North Dakota State University, through a Cooperative Research and Development Agreement, are working with Jolly Time Popcorn to adapt a sorting machine for popcorn. The system is also being used by US and international scientists. The camera design has been transferred to an electronics manufacturer (Short Dog Electronics). NDSU seed foundation states that the machines shortened production time for yellow flax by one year, increased production by 20%, and reduced contaminates by 90% over past practices.

A commercially viable CO2 monitoring sensor and system for grain storage structures was created and in late 2010, the system was introduced commercially on a limited scale through a licensing agreement between the developer (BinTech, Boulder, Colorado) and The GSI Group (Assumption, Illinois) as the exclusive distributor.

Research conducted in this program showed that a less expensive, user-friendly calibration and validation process will increase the feasibility of using NIRS analysis in many operating situations. If multiple models and makes of instruments can be approved for trade use, the total cost of testing will be competitively reduced and further enhance industry support services for analytical applications in bioindustries.

The results obtained from assessment of Raman spectroscopy combined with chemometrics showed that this technique is an excellent alternative (rapid and low-cost) to detect aflatoxins in grains over conventional spectroscopic and standard wet chemical methods. Raman spectroscopic methods may allow fast qualitative and quantitative evaluation of mycotoxin substances to provide real-time monitoring for mycotoxins in grains and oilseeds at receiving points.

NC-213 scientists and engineers successfully built and demonstrated a new type of electronic sorting machine that can detect and separate many types of weed seeds, discolored seeds, and fungal infected seeds. This new capability has been demonstrated to and adopted by breeders and producers of grass seed, flax seed, alfalfa seed, pulses, corn seed, soybean seed, and wheat seed. Additionally, a popcorn producer is evaluating the technology for removing fungal damaged popcorn kernels.

Research conducted by NC-213 investigators resulted in an automated single kernel near-infrared (SKNIR) spectroscopic method to identify wheat kernels damaged by Fusarium fungi and to estimate the toxin deoxynivalenol (DON) levels. Breeders throughout the US are using this technology to study scab infections, objectively score breeding lines, and to select resistant seed.

Objectives

1. To characterize quality and safety attributes of cereals, oilseeds, and their processed products, and to develop related measurement systems.
2. To develop efficient operating and management systems that maintain quality, capture value, and preserve food safety in the farm-to-user supply chain.
3. To be a multi-institutional framework for the creation of measureable impacts generated by improvements in the supply chain that maintain quality, increase value, and protect food safety/security.

Methods

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Methods

This project focuses on the farm-to-user supply chain for raw grains and their processed products. World emphasis on food safety, environmental management, biosecurity, and overall quality continues to increase the need for systems approaches to operational problems across the chain. In addition to traditional sources of funds, competitive grants, both individual and collaborative across states, will be pursued in order to facilitate the objectives and activities of the stations.

The annual technical meeting, as managed by NC-213, has always had substantial impact on informal collaborations. The encouragement of preliminary data presentations in a collegial setting has historically created interactions and exchanges that were not always reflected in formalized ways, but which spread technologies much farther than would otherwise have been possible. The highlighting of specific projects in the bi-ennial joint technical meeting with Grain Elevator and Processing Society has also increased breadth of researchers and industry alike.

Each of the objectives below has been categorized into specific areas of common focus to illustrate both the collaborations that already exist among the states, and the collaborative potential that will be formalized in this cycle of NC-213. Those topics that have formal collaborative projects already established are so noted. The NC-213 administered Andersons Research Grant Program projects will be targeted at listed collaborations needing development incentive. Reporting and development of general efforts to bolster funding in target areas will be part of the annual technical meeting in this cycle.

Objective 1. To characterize quality and safety attributes of cereals, oilseeds, and their processed products, and to develop related measurement systems.

1a) Develop Methods to Identify, Measure, and Analyze Quality Attributes. (Participants IA, IL, IN, KS, MO, and USDA-CGAHR.)

1) Develop non-invasive imaging techniques (NIR, soft X-rays, X-ray microtomography) to determine the quality and processing characteristics of grains, oil seeds, and food products. IA/IL/KS/IN/KY/USDA.

2) Develop and validate calibration for rheological properties of cereal grains and their products based on their physical and chemical properties. Develop in-line NIR calibrations for measuring ash, protein, and moisture content of products from wheat, corn, and soybean for industrial process control. Develop new methods to characterize sorghum proteins, starch, and phenolic compounds and apply these methods to characterizing physical and chemical characteristics of grain sorghum related to end-use quality. KS/USDA-CGAHR.

3) Assess and report economically viable attribute values for corn, soybean, and wheat. These economic values can be used to conduct cost-benefit analyses and market impacts from the measurement of novel attributes. MO.

4) Investigate methods for quantitative evaluation of odors in grain and grain processing co-products and investigate the use of a commercially available CO2 test kit for measuring the susceptibility of shelled corn to growth of storage fungi. IN.

5) Establish models to predict rancidity risk for canola stored in southern climates as affected by temperature and length of time in storage. Methods to detect rancidity will be developed and improved. OK/KS.

6) Establish the end-use quality profiles of soft and hard wheat for the specific food use, and develop the efficient and effective test methodologies. WA.

1b) Develop Methods to Preserve and Improve Quality Attributes. (Participants IA, IN, KS, ND, OK, and USDA-CGAHR.)

1) Development of systems and methods to preserve quality and improve processing characteristics of identity-preserved wheat. KS/ND.

2) Determine the effect of oil removal from coproducts on quality, nutritional value, and handling characteristics. Determine if secondary fermentation can create nutritionally-enhanced premium feed products. KS/ND/USDA-CGAHR.

3) Investigate physical and chemical processes to remove common mycotoxins (aflatoxins, DON, fumonisins, zearalenone and T-2 toxins) in dried distillers grains with solubles. Approaches include pre-cleaning and sorting and application of physical and chemical treatments. IN/ND.

4) Develop methods for determining caking potential of dried distillers grains with solubles. IN.

5) Develop systems that reduce the cost of storing grain in large storage structures (i.e., large diameter steel bins, bunkers and circular ground piles) and improve the post-storage quality of grains stored in these structures. IN.

6) Investigate gaseous treatment technologies to mitigate insect, microbial, and mycotoxin contamination and odors. USDA-CGAHR/KY/KS.

7) Develop new stored-grain packing factors for the commonly traded grains and validate over a wide range of field conditions. USDA-CGAHR/KY/KS. USDA contract awarded.

Objective 2. To develop efficient operating and management systems that maintain quality, capture value, and preserve food safety in the farm-to-user supply chain.

2a) Improve Food Safety and Handling and Traceability of Grain and Oilseeds. (Participants IA, IL, IN, KS, MN, ND, NE, OK, and USDA-CGAHR.)

1) Develop a pilot framework for a food safety risk analysis for corn and soybean supply chains from production to processing. IA/KS ‼ part of an awarded FDA contract.

2) Create and validate a survey instrument to measure quality climate (perceptions employees have about the relative importance of grain quality as compared with other business goals) within grain handling environments. Relate employee perceptions to their quality decision-making patterns in terms of food safety and security with bulk commodity crops. IA/IN.

3) Reduce biohazard risk, quality and quantity losses, cost of distribution, and cost of regulatory compliance using new information technologies that facilitate supply chain integration and communication. Cost/benefit templates will identify economically sustainable traceability practices. OK/IA/ND.

4) Develop efficient handling methods for cereal grain products and their coproducts, including: simulation models to predict flowability of grains and coproducts; simulation models to optimize size reduction, mixing, and other food and feed unit operations. KS/USDA-CGAHR/IN/NE.

5) Develop novel methods for drying, disinfesting, and disinfecting cereal grains and processed products including controlling phosphine-resistant insects. KS/USDA-CGAHR.

6) Develop harvesting and storage methods suited for developing countries that reduce postharvest corn and soybean loss during on-farm and village-level storage. IL.

2b) Identify, Measure, and Evaluate Aflatoxin, Insects, and Other Grain Contaminants. (Participants IA, IL, IN, KS, KY, ND, NE, OK, USDA-CGAHR, and WA.)

1) Investigate efficacy and economic viability of insect control technologies for food processing facilities that can be used as alternatives to current technologies such as methyl bromide fumigation and improve stored grain insect control with a 3D stored grain ecosystem and fumigant distribution model. KS/IN/MN/OK/USDA- CGAHR.

2) Develop models that relate inbound corn quality at ethanol plants to ethanol production yield and DDGS quality/quantity. IL/IA.

3) Establish the end-use quality profiles of soft and hard wheat for the specific food use, and develop efficient and effective test methodologies. WA.

4) Develop application and cost benefit templates for ISO22000/GFSI compliant food safety management systems at grain and grain processing industries. Match these systems against the requirements of the Food Safety Modernization Act. IA.

5) Evaluate the role of wheat seed quality/seed source in disease development, disease prevention and mycotoxin risk. NE.

Objective 3. To be a multi-institutional framework for the creation of measureable impacts generated by improvements in the supply chain that maintain quality, increase value, and protect food safety/security.

Multi-State Collaboration Efforts.

1) NC-213 collaborators conduct outreach activities for general training and for research transfer.

2) NC-213 collaborators will organize the 2015/2016 International Grain Quality and Technology Conference to be held in Manhattan KS. KS/USDA-CGAHR station representatives will be the conference co-chairs. The conference will be a forum for exchange of technical and practical information, including challenges and economic opportunities involved in creating and capturing value in the grain-based food, feed, fiber and fuel supply chains. The last International Conference was held in 2008.

3) NC-213 collaborators, using NIRS analysis will develop/adopt common set of calibrations, calibration update protocols, user practices and databases to be made available first to NC213 members, then other public users, then to private sector users.

4) NC-213 collaborators will develop a grain production and handling food safety- quality management system (FSQMS) template built around ISO 9000 and 22000 certification, with regionally adapted supporting/training/documentation materials.

5) NC-213 collaborators will develop a national strategy for preservation, food safety and biosecurity of the US grain production and market chain, with regionally or end use adapted methodologies.

6) NC-213 collaborators will train FDA and FDA-contract personnel for food safety inspections of bulk grain and grain processing facilities under the Food Safety Modernization Act. Extend training to distance education based programs for industry professionals. Assist firms with FSMA compliance in cost effective ways.

7) NC-213 collaborators will develop the International Grain Operations and Processing Center into a major industry-funded organization for distributing grain operations training and for organizing applied problem solving in emerging issues.

Measurement of Progress and Results

Outputs:

- Objective 1-Output 1-Further development of spectroscopic measurement technologies will improve quantification of quality/food safety attributes in grains and grain products.
- Output 2-Multi-institution tests or transfers of NIRS calibrations and their supporting databases will be done. Distribution of protocols and databases will be through the professional societies American Association of Cereal Chemistry and American Oil Chemists Society, both of whom have Guideline Methods for NIRS calibration.
- Output 3-The risk analysis for key food safety issues in corn and soybeans from production to processing will be presented.
- Output 4-Indicators of in-storage deterioration will be identified and measured.
- Output 5-Advanced storage management techniques that protect inventory, quality and food safety will be developed. Supporting technologies (CO2, detoxification, others) will be applied.
- Output 6-Quality factors of several grains and grain products potentially related to end use economics will measured in new and more detailed ways.
- Output 7-Standardized processing methods for producing wholesome, shelf-stable and food safe whole wheat flour from identity-preserved varieties.
- Output 8-Development of effective handling strategies and nutritional profiling of feed products from advanced and alternative grain processing methods.

- Output 9-Fundamental information will be developed on structural characteristics and its relation to quality of grain and products.
- Objective 2-Output 1 Improved management systems for controlling rancidity, insect growth, and overall grain handing losses will be developed. Non-chemical and other alternative methods will be emphasized.
- Output 2-Food safety systems for bulk grain will be created, with their related traceability requirements, regulatory compliance impacts, and connection with occupational safety programs.
- Output 3-A survey instrument for measuring the quality climate of grain handling facilities will be validated and applied to corn and soybean handling facilities.
- Output 4-The knowledge of quality attributes as they affect end user value or functionality will be expanded in corn, wheat and other small grains. Implicit and explicit premium and discount schedules for grain and oilseed quality attributes will be determined.
- Output 5-Unit operations in feed and food processing will be modeled to identify potential efficiencies.
- Output 6-A national program concept for long term storage, food safety and market efficiency will be completed.
- Output 7-The potential of externally introduced atoxigenic fungi to control mycotoxin development in wheat will be determined.
- Objective 3-Output 1-Distance learning courses, hands on workshops, web-based information services and analytical support will be created to transfer research developments to stakeholders. Joint educational opportunities between universities and industry groups will be expanded.
- Output 2-An international conference related to the project objectives will be held in 2016. The three overall activities will be the focus of the conference.
- Output 3-Industry and regulatory personnel will be trained in the application of the Food Safety Modernization Act in their respective areas of work.
- Output 4-Feasibility studies, marketing studies, business plans and pro -forma financial analysis will be blended into new methods for assessing business opportunities for identity-preserved commodities on a global scale.
- Output 5-The ICGOP Center will receive tax exempt status, and will become the coordinating organization for industry training and applied problem solving programs.
- Multi-Objective Output 1-At least three proposals per year that involve two or more NC-213 participating entities will be submitted to national or other peer reviewed funding sources other than those managed by NC-213.

Outcomes or projected Impacts:

- Outcome/Impact 1Grains with higher quality and purity will be delivered to users that meet their specifications in an economically viable manner.
- Outcome/Impact 2-Genetic selection and food product development for specialized traits will faster and less expensive.
- Outcome/Impact 3-A greater understanding of quality attribute premiums and discounts will assist purchasers and sellers in assessment of the cost-benefit for optimal levels of quality attributes.
- Outcome/Impact 4-Advanced analytical techniques will become more routine in the quality and food safety analysis of grains. Trade will become more efficient and more able to remove suspect products from the food chain.

- Outcome/Impact 5-Grain storage losses will be reduced with a reduced reliance on chemical intervention at a lower cost than conventional chemical methods. The potential to reduce energy consumed during grain cooling is estimated at 25-50 percent.
- Outcome/Impact 6-Auditable certification and product tracing systems will be in use by specialty and commodity marketers; users will be documenting significant economic efficiencies from more accurate inventory management and simplified cross-compliance with process-driven regulations
- Outcome/Impact 7-Quality assurance protocols for corn DDGS co-products will improve the quality of DDGS and measurably increase the trade of DDGS in domestic and international markets.
- Outcome/Impact 8-Grain handling operation managers will be able to use risk analysis to optimize food safety management and compliance. Regulatory agencies will prioritize risk and interventions in bulk grain supply chains.
- Outcome/Impact 9-Regulatory personnel will be conducting efficient and targeted food safety inspections that identify issues of consensus importance to industry and the consuming public.
- Outcome/Impact 10-A long term vision will be guiding public and private investment in post harvest grain handling and processing operations.
- Outcome/Impact 11-The consuming public will have increased confidence in their basic food sources because industry professionals will become credentialed in scientific aspects of grain handling, processing and food safety.
- Outcome/Impact 12-If atoxigenic strains are as protective in wheat as for Aspergillus/corn/aflatoxin in corn, wheat producers will have a new and powerful defense against climate driven toxic pathogen outbreaks.
- Outcome/Impact 13-Workers and supervisors in grain handling and processing facilities will be trained on grain dust hazards and methods of mitigation.

Milestones:

(2016): The International Grain Quality and Technology Congress will be held in 2016, at a venue to be determined.

(2014): Hands on courses for FDA regulatory personnel, covering feed manufacture, grain handling, flour milling, corn and soybean processing will be offered at least twice, with on-demand distance education modules created from each course.

(2014): Arrive at a premium/discount schedule for conventional soybean attribute levels of oil and protein and for the new soybean attribute level oleic acid. Two to three business opportunity assessments conducted annually and one case study annually.

(2014): Food safety risk analysis and quality climate measurement completed for bulk grain supply chain.

(2013): The scheduled expansion of the Kansas State distance education programs in Grain Handling, Feed Manufacturing, and Flour Milling will continue. The FDA inspector training courses will be integrated with these industry offerings.

2013-National Stored Product Pest Management Training Conference will be held once in every four years at Manhattan, KS. A workshop on use of aerosols for stored product management will be organized once every two years at Manhattan, KS

Projected Participation

Include a completed Appendix E

Outreach Plan

NC-213 has successfully engaged end-users to disseminate information throughout the grain industry. At the investigator level, most NC-213 participants have split appointments among research, teaching, and extension lines. Private industry will continue to be an integral part of NC-213 through the Industry Advisory Committee, the Industry Issues Panel (part of the annual meeting), and the expansion of distance education courses focused on the grain industry. There are two industry representatives as a part of the Andersons Research Grant Competition Review Panel to insure relevancy and to assess the potential for new technology to flow into the commercial sector.

The once-per cycle International Grain Quality and Technology Conference (2016) will continue to be summary venue for NC-213 scientific results. The objectives are to present current knowledge from each of the NC-213 objectives The three overall multi-state collaboration activities (one per objective) will form the basis for the material in their respective sections of the conference.

Distance Education is an increasing component of any extension and outreach program. NC-213 participants will contribute to the distance education program developed for the Grain Elevator and Processing Society (GEAPS) and led by Kansas State University. This program is being expanded:

-To offer credentials to industry professionals completing 6 or more courses.

-To offer a standalone minor in grain operations, attachable to degrees at any collaborating institution.

-To offer templates for two-year vocational degrees.

-To train regulatory and support personnel as well as industry professionals.

The International Center for Grain Operations and Processing, an industry-foundation supported coordinating body, will provide a marketing point for the above training (and others) to meet the demographic changes of the US workforce in the face of increased ag sector growth, and an organizing point for practical problem solving in issues of the day for the grain industry.

Business opportunity assessments will be publicaly available, when disclosure is allowed. Case studies will be used in academic and executive development training.

Traditional outlets of journal publications, conference proceedings, extension fact sheets, and relevant industry meetings will remain an important part of NC213 outreach. The annual reports for the last cycle document 50 or more refereed publications per year from NC213 related projects.

Organization/Governance

The organization and operation of NC-213 will be similar to that used in the last five year cycle. A detailed description of roles and responsibilities is available at (http://www.nc213.org).

The NC-213 Administrative Advisor serves as the Project Coordinator. This position will remain based at The Ohio State University. The quarterly

newsletter and the NC-213 website will continue to be managed out of the office of the NC-213 Coordinator.

There will be five officers (chair, vice-chair, past chair, secretary, and the Industry Advisory Committee Chair), and six co-chairpersons, two for each of the objective groups. Officers and objective co-chairs are elected from the membership of the NC-213 Technical Committee.

The Executive Committee is made up of the coordinator, chair, vice-chair, past chair, secretary and objective chairs, the Industry Advisory Chair, and the U.S.D.A. Representative. The Executive Committee sets the agenda for the annual business meeting, plans special meetings and conferences, overseas production of the annual report and oversees development and revisions of the 5-year work plan.

The NC-213 Technical Committee is made up of one designated representative from each of the participating organizations. It holds an annual business meeting, typically in conjunction with the annual NC-213 technical conference, to set future directions for the project.

The annual technical conference (typically held in February) will continue, with previously agreed upon improved requirements for presentations and publicity. The Annual Progress Reports from Participating Stations will be formatted to match the revised project outline. It will primarily be posted on the NC-213 website, and only a small number of hard copies will be printed and distributed.

Literature Cited

Attachments

none

Land Grant Participating States/Institutions

ID, IL, IN, IA, KS, KY, Kentucky Cooperative Extension, MI, MO, NE, ND, OK, TX, WI

Non Land Grant Participating States/Institutions

USDA ARS, USDA, ARS, USDA-ARS/KS, USDA/ARS Grain Marketing and Production Research Center

Signatures:

s:/F. William Ravlin