Title - Marketing and Delivery of Quality Grains and BioProcess Coproducts

Project Duration - October 1, 2008 to September 30, 2012

Statement of Issues and Justification

The multi-state research project NC-213, Management of Grain Quality and Security in World Markets, will end its five-year cycle on September 30, 2008. At the February 2007 annual technical meeting, the NC-213 Research Committee developed its plan to rewrite the project for the next 5-year cycle.

NC-213's engineers, entomologists, plant pathologists, grain/food scientists and economists continue to investigate and address grain quality issues such as breakage of corn during handling and transport, stress cracking of corn during drying, development of instruments to measure grain quality attributes, and development of sensors to monitor grain quality. Other topics involve alternative technologies and practices to protect grain from insect and fungal pests and processing practices to insure the quality and safety of various end products. In addition, the group has expanded to look at quality management and assurance systems for identity preservation/traceability. This multi-state project provides an opportunity for team members and industry stakeholders to interact and collaborate on addressing specific engineering, scientific, and economic issues associated with project objectives.

Because of the industry endowment (provided by The Andersons, Inc.) that led to its formation, NC-213 has always had a very strong industry influence. 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 2007 Annual Technical Meeting, a roundtable with five 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 emerging biofuels industry was the primary focus of the roundtable. The industry panel shared that the ethanol and biodiesel industry will have a significant impact on the future of the grain industry. Due to the domestic demand for corn, at least 30% more grain will be stored on U.S. farms and commercial facilities to provide feedstock to the biofuels industry. U.S. on-farm and commercial grain storage capacity is already well beyond 20 billion bushels. The consensus of the panel was that a principal challenge will be maintaining grain quality into the following summer months, which has not happened on a large scale in the U.S. since the 1980s. Additionally, the production of co-products from the ethanol process, specifically distillers dried grains with solubles (DDGS), will result in new handling, storage, transportation, marketing and utilization challenges. Together this will require new practices and technologies for monitoring and maintaining quality, new measurement systems to quantify quality attributes, and development of alternative economic models. After development of alternative systems, evaluating the efficacy of these new practices, technologies and models to support this growing industry while simultaneously maintaining high quality grain stocks for other food, feed and industrial uses needs to be performed.

In addition to quality, both crop yields and processing efficiency are primary concerns for the emerging biofuels industry. For example, increased corn production will lead to a higher percentage of corn-on-corn rotations that in turn will increase the occurrence of several pest species including mycotoxin producing fungi (e.g., *Fusarium, Aspergillus spp*). These fungi are known to affect quality, quantity, and ultimately the ability to produce sufficient quantities of grain for feed, fuel, and food. Developing new technologies to detect mycotoxins and reduce mycotoxin levels will be important. Economic models accounting for 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 due to the importance of producing a high-value DDGS co-product along with ethanol and biodiesel. In addition, identification of grain types and agronomic practices that result in high raw material to fuel conversions during processing will be necessary to help ensure the industry's economic viability.

This project focuses on raw grain supply to and coproducts manufactured by the grain and biorefinery processing industries. Delivering low-cost, food-safe, bio-secure, and high quality cereals and oilseeds for food, feed, fuel, and industrial uses requires a systems approach. Therefore, the NC-213 objectives for the next 5-year cycle are revised to focus on three interrelated goals:

1. To characterize quality attributes and develop systems to measure quality of cereals, oilseeds, and bioprocess coproducts,
2. To develop methods to maintain quality, capture value, and preserve food safety at key points in the harvest to end product value chain,
3. To quantify and disseminate the impact of market-chain technologies on providing high value, food-safe, and bio-secure grains for global markets and bioprocess industries.

NC-213 will continue to have a significant impact on improving the efficiency of the U.S. grain industry and capturing value along the cereals, oilseeds and coproducts supply chains. Although NC-213 is not specifically focused on biofuels, the influence of biofuels on the U.S. grain industry cannot be overlooked. Therefore, NC-213 will address quality issues for food, feed, fuels, coproducts, and the emerging bioproducts industries. NC-213 will continue to have strong ties with industry. This multi-state project will use industry input and collaboration to ensure relevance and to aid in developing initiatives that can obtain extramural funding.

Related, Current and Previous Work (20,000 characters)

During the previous 5-year cycle the following activities, accomplishments, and impacts were achieved.

Activities and Accomplishments

Objective 1 - Develop practices and technologies to support quality management systems for production, distribution, processing, utilization of quality grains and oilseeds

A major effort by NC-213 researchers has involved quality surveys of corn, soybeans, wheat, sorghum, and numerous other crops targeted at end-use related factors. These have included:

- Evaluation of sorghum and corn for improved food uses and ethanol production. This enabled development of classification rules to predict the suitability of samples for a particular end-use.
- Wheat varieties were screened for novel gene expression that led to improved post-harvest resistance.
- Practices that affect the carotenoid pigment and lipid oxidation in durum wheat were documented and their influence on product quality determined.
- Comparison of maize quality measurements by laboratories' to provide the variance structure of within and between laboratories as well as hybrids.
- Soft white wheat varieties were evaluated for milling properties, dough characteristics, protein functionality, and baking properties. Biochemical studies on flour proteins were conducted and the use of transglutaminase (TG) to improve dough strength of weak gluten protein flour samples was investigated.
- Microbiological contamination and mycotoxin content of wheat from the northern plains was quantified.
- Physical and chemical properties of shelled corn during conditioning and processing were measured. Quantification of kernel properties and their variations have been documented to assess their impact on processing. This may help identify hybrids with specific traits that are by end-users.
- A mycotoxin surveillance network is being developed that includes a database consisting of mycotoxin incidence, GIS coordinates, cropping data including rotation, hybrid, planting date, fertility, and weather data.
- As a result of a grant from The Andersons, Inc., Kansas State and Purdue developed a common survey tool to gather data from 150 country elevators in seven states. Simulation and statistical tools proved to be an effective method for evaluating the efficiency and performance of grain elevators to determine practically achievable purity levels.
- Lactobacillus fermentum was evaluated as a method to improve food quality for material resource poor communities throughout the world. We have determined that individuals who survive on cereal-based diets, low in certain essential amino acids, cowpeas and L. fermentum provided useful, year-round dietary supplements.

Objective 2: Develop basic knowledge, science-based performance standards, and technologies that promote crop quality, food security and food safety in grain markets.

NC-213 researchers have successfully developed numerous new analytical tools. This allows for the accurate measurement of grain quality traits for evaluation of suitability for various end uses, such as:

- Soybean fatty acids and amino acids were measured using FT-NIR spectroscopy.
- Rapid measurement and monitoring using FT-NIR of fermentation processes and variability in DDGS quality have been developed.
- Expanding the capability of NIR instruments by eliminating the requirement of only one instrument model utilized in a given trading system that reduced testing costs and provided incentives for new technology development.
- NIR models were extended to include amino acid, fatty acid, extractable starch and other parameters.
- CO2 sensors can effectively monitor spoilage prior to the time that spoilage would be detected by traditional methods. In-lab and pilot bin experiments as well as tests in large commercial storage structures have been successfully conducted.

Improvements in grain quality, storage management and processing have been accomplished that increased food safety and reduced costs. Some of these include:

- Evaluation of ozone for reducing off-odors, control of insect pests, microbial loads, and mycotoxin content has been conducted. Ozone and hydrogen peroxide were evaluated for treating Fusarium head blight infected malting barley.
- A portable propane heat systems for low-risk disinfestations of empty bins was developed.
- A computer model was developed to simulate the temperature of headspace air and grain in the upper portion of a bin. This allowed for the investigation of the effect of low temperatures on mortality of Indianmeal Moth (Plodia interpunctella).
- A small prototype continuous-flow dryeration system was set-up and data collected for a range of operating conditions. Single kernel moisture content and stress crack analysis tests were performed while corn was steeped in the tempering bin.
- Biological evaluation of the reduction of Fumonisin B1 toxicity in corn grits by extrusion processing has been performed. This research produced evidence of reduction in toxicity of fumonisins in corn after extrusion processing with 10% added glucose and a lowered toxicity in rats.
- Quality management system (QMS) applications for agriculture have not traditionally been employed. Researchers have worked with three facilities to obtain ISO certification and six have private certification in preparation for ISO implementation. Site and food security needs have been easily added to the ISO system.
- A conceptual and flowchart analysis of grain isolation/traceability was initiated, along with an inventory of current providers of QMS/traceability services.
- Currently available precision farming, communication and other technologies were investigated that could be used to aid in the segregation and tracing of differentiated grains from the seed bag to the planter, through post-harvest handling and delivery.

- Trapping and interpreting the data of stored product insects within buildings is difficult. However, the use of contour analysis in mapping red flour beetle trap catch to locate foci of infestation in buildings has proven effective. Contour maps of trap catch are powerful tools for communicating insect problems to management.
- Flaxseed as an alternative antifungal agent has been frequently discussed. The antifungal activity of different varieties was documented and it was determined that the stability was influenced by heat. The data reported suggested that flaxseed could be useful as an antifungal agent in food with minimal heat application.

Objective 3: Create and disseminate scientific knowledge that will enhance public confidence in market-driven quality management systems for grain.

NC-213 scientists have been involved with implementing new quality management systems, such as:

- Assessing the susceptibility of shelled corn to invasion by storage fungi using NIR, FT-NIR, electrolyte leakage, and damage index. This would allow grain industry personnel to evaluate the allowable storage time of corn.
- Production of wheat-free foods from sorghum was demonstrated that would provide persons with celiac disease new food choices. The quality of wheat-free sorghum bread and sorghum waffles was improved.
- Objective grading and end-use property assessment of single kernels and bulk grain samples would decrease the time and cost of seed breeding programs. This project helped speed the development of new grain varieties by seed breeders.
- One of the major challenges in tortilla quality is the deterioration of texture with time. Tortilla quality was measured using both objective and subjective methods and was shown to be dependent upon flour properties as well as ingredient formulation.
- Researchers evaluated the shelf-life extension of 100% whole wheat tortillas by adding enzymes. These included bacterial alpha-amylase, glucose oxidase, transglutaminase, phytase, pentasonase, and a blend of cellulose and amylase.
- Kernel characteristics, milling properties, and dough and bread-, tortilla- and asian alkaline noodle-making properties of hard winter wheat progenies were evaluated. The influence of compositional characteristics on product quality was defined.
- Outreach programs to develop supply-chains in agriculture have been conducted. New Iowa State Extension efforts in grain storage training and in supply chain evaluation were started.
- A distance education program, involving several NC-213 members, focusing on grain and biorefinery operations was developed in collaboration with the U.S. grain industry. Three courses were offered through Purdue University five times between summer 2005 and 2007. Currently, ten more courses are in various stages of development and planning.
- NC-213 organized the 2004 International Quality Grains Conference, which addressed the emergence of a global market place for differentiated products that requires the traditional commodity-based production, handling and processing

industry to adopt new practices that will assure the purity, quality and biosecurity of cereals and oilseeds from seed to consumer.

Impacts

1. NC-213 scientists have developed and evaluated practices and technologies that provide critical information to grain producers and processors that allows them to improve the overall quality, food safety and bio-security of grain.
2. NC-213 scientists developed grain quality management systems that led to the formation of international quality standards affecting global grain markets.
3. Over 95% of all hard winter wheat cultivars were evaluated by NC-213 scientists for end-use quality. This information allows the U.S. wheat industry to focus on high value cultivars and capture increased value.
4. NC-213 scientists successfully leveraged funding from numerous other sources. These funds led to implementation of several programs focused on enhancing quality, food safety and bio-security for the U.S. grain supply. Impacts include increased sales as well as increased quality and safety.
5. Demonstrated several new applications for NIR that demonstrated the capabilities of high-speed diode array technology.
6. A team from Texas A&M University and USDA/GMPRC conducted research and testing on food products from sorghum. Some of this work was conducted and presented in workshops in Central America, Mali, South Africa, and the United States. New sorghums, as a result of the research, are especially important as a new grain for use in gluten free and ethnic foods.
7. NC-213 scientists have developed systems that allow grain processors to institute component pricing systems resulting in increased sales of U.S. grains.
8. NC-213 scientists conducted research that shows that adding transglutaminase increases flour quality and reduces the need for costly testing.
9. NC-213 scientists discovered that by reducing humidity and moisture wheat kernel quality is increased and a greater economic return realized.
10. NC-213 scientists have developed systems that track the origin and shipping history of bulk grains and that allowed producers to realize higher prices.
11. By using techniques developed by NC-213 scientists corn starch levels can rapidly be determined and producers can realize increased profits of 4-6 cents/bu. Other research increased the ethanol yield from sorghum.
12. Adoption of ozone and heat treatment will benefit producers and handlers of food and feed grains by providing additional pest management tools to producers.
13. Iowa State has assisted a large elevator in the creation of a certified quality management and product tracking system, based on the American Institute of Baking Quality Systems Evaluation System (QSE). The grain tracking system demonstrated significant income potential due to more precise inventory management.
14. A team of NC-213 scientists developed a distance education program focusing on grain and biorefinery operations in collaboration with the U.S. grain industry. These courses transfer knowledge to grain industry professionals around the world.

15. NC-213 organized the 2004 International Quality Grains Conference. The conference was attended by over 200 experts from academia, government and industry from more than 10 countries.

Related Multi-State Projects

The revised NC-213 project Marketing and Delivery of Quality Grains and BioProcess Coproducts connects and complements the following existing multi-state projects, which were identified, based on a NIMSS website search (http://www.lgu.umd.edu/lgu_v2/search_form.cfm?type=1):

- NC-129 Mycotoxins in Cereal Grains: This project specifically focuses on understanding the overall problem of toxigenic fungi and mycotoxins in pre-harvest cereal grains. In comparison, the NC-213 project considers fungi and mycotoxins as one of several pest and pathogen problems in grains and their products that affect the food, feed, fuel and fiber supply chains. NC-213 has a broader focus and several researchers and industry stakeholders participate in both projects. Interaction between both project groups takes advantage of synergies.
- NC-1016 Economic Assessment of Changes in Trade Arrangements, Bio-terrorism Threats and Renewable Fuels Requirements on the U.S. Grain and Oilseed Sector: This project focuses on the economic assessment of trade arrangements, bio-terrorism threats, and renewable fuels requirements that currently impact the U.S. grain sector. These forces are external to the firms in the grain industry, producers and consumers, and largely outside of their control. In comparison, the NC-213 project is less concerned about trade and market policies and more interested in the assessment of market-based technologies and practices that affect the quality of grains and their products. Therefore, little if any overlap exists between these two NC projects.
- NC506 Sustainable Biorefining Systems for Corn in the North Central Region: This committee is currently conducting research related to corn-to-ethanol processing. This project potentially overlaps with parts of the NC-213 objectives. NC-213 has a history of evaluating quality attributes of all cereal grains as well as their processed products such as wheat flour, corn flour, meal and flake quality, etc. The primary co-product of the dry grind corn-to-ethanol process is distillers dried grains with solubles (DDGS). NC-213 researchers have been working on measuring the physical properties, storability, handling, processing/pelleting and transporting of DDGS, and therefore consider DDGS as one of the many "grain-based products" they have addressed as a multi-disciplinary research team. NC-213 expects to coordinate research with NC 506 in order to take advantage of synergies and avoid overlap.

Objectives (4,000 characters)

The goal objective of the project is to enable and facilitate the marketing and delivery of quality grains and their products for the global food, feed, fuel, and fiber supply chains. This will be accomplished using the following three objectives:

1. To characterize quality attributes and develop systems to measure quality of cereals, oilseeds, and bioprocess coproducts,
2. To develop methods to maintain quality, capture value, and preserve food safety at key points in the harvest to end product value chain,
3. To quantify and disseminate the impact of market-chain technologies on providing high value, food-safe, and bio-secure grains for global markets and bioprocess industries.

Methods (20,000 characters)

As in previous years several inter-institutional projects will be accomplished taking advantage of the expertise demonstrated at each individual institution.

Objective 1 - To characterize quality attributes and develop systems to measure quality of cereals, oilseeds, and bioprocess coproducts.

A major focus of NC-213 researchers is related to developing new measurement systems and techniques.

- IA/IL - Calibrations for measuring subunit (amino acid, fatty acid, carotenoids, etc.) factors in corn and soybeans using NIR will be extended. Image analysis technology will be applied to single seeds, low-concentration food safety/biotechnology factors, and biomass characterization. The chemometrics of transferring spectral data among brands of NIRS, from bulk sample applications to single seed applications, and from single beam spectrometers to individual pixels of image analysis will be developed.
- IN/USDA GMPRC - Instruments and systems are being developed to measure grain moisture content and carbon dioxide emissions to monitor grain quality more effectively than existing temperature-based systems.
- OK - Develop THz sensing methods to determine oilseed rancidity and internal insect infestation of stored grains and packaged food products.
- TX - Develop new detection methods for antibiotic residues and illegal substances in distiller's dried grains using mass spectrometers to increase the value of DDGS.
- TX - Explore the suitability of spectral technology including FTIR, RAMAN, and hyperspectral imaging on rapidly identifying hazards in grains and their co-products.

Numerous stations are collaborating on developing improved grain products and systems from wheat, soybeans, sorghum, and bioprocessing coproducts, such as:

- KY/IA/IN/SD – Measure the material properties (coefficient of internal friction, coefficient of friction on building materials, and other relevant properties) of bioprocessing coproducts as a function of moisture content and source. In addition, the storability of bioprocessing coproducts will be evaluated.
- MI/NDU/WA - Identify soft and hard wheat cultivars with enhanced quality for traditional and non-traditional processing for wheat products as well as processing into value-added products with increased levels of constituents with health benefits. Characterize microbial loads and mycotoxins in wheat and evaluate their impact on

quality, safety and utilization. This includes their effects on the sensory characteristics of final products.

- KS/NDU/SD - Isolate and characterize components from bioprocessing coproducts for use as livestock, human and pet food ingredients.
- NE/TX - Develop improved wheat, sorghum and corn cultivars and hybrids with enhanced quality for processing into value added products with increased levels of healthy nutrients. Document sorghums varieties with unique phenolic compounds and high levels of antioxidants, natural pigments that are stable to pH and other healthy components at relatively high levels compared to other competing sources. Collaborate with wheat breeders to develop wheat cultivars with improved properties for use in flour tortillas. Define the key attributes that affect tortilla flour quality. Continue to analyze maize hybrids for physical and chemical traits (Stenvert hardness, breakage susceptibility, floaters, etc.) associated with end-use processing performance for ethanol production, alkaline cooking, dry and wet milling.
- OK/TX - Develop prototype food products with outstanding levels of healthy components and nutraceuticals from grains and non-traditional food crops.
- USDA-GMPRC/TX - Develop tracing caplets that can be readily incorporated in grains during storage, handling, and end-use processing without affecting the functional properties of grains.

Objective 2 - To develop methods to maintain quality, capture value, and preserve food safety at key points in the harvest to end product value chain.

Systems to maintain quality and preserve food safety are being jointly developed by numerous stations.

- IN/USDA-GMPRC - Scale up and commercialize carbon dioxide detectors as biomonitors for the early detection of spoilage and insect activity in stored grains prior to detection by traditional methods.
- KS/IN/MN/OK/USDA-GMPRC - Investigate alternative, stored product protection technologies for conventional and organic grains and their products. Investigations will include refinement of heat treatment, low oxygen environments, and closed loop fumigation systems to kill microorganisms and insects. This includes development of improved pest detection and management systems to protect processed grain products at food processor through to, and including, retail.
- IA - Implement the American Institute of Baking Quality Systems Evaluation System (QSE). The QSE system has been converted to the more management-based ISO 9000 at local elevators and will now be applied to agronomy and feed locations. A procedure and template for converting alternative or industry-specific quality management system formats to ISO 9000-2000 certifiable formats will be created.
- IA/KS/TX – Traceability systems based on ISO 22005 and HACCP for high value (pharmaceutical, industrial) and feed grains will be developed and compared. A universal lot identification and aggregation system will be tested. The systems and accompanying cost-benefit analysis procedure will be compared with work being done in the EU through the TRACE project. Tracing caplets will be evaluated as a method for tracing grain lots. Caplets will be manufactured using non-contact ink jet

technology with edible ink and laser coding methods, to print bar codes on tracing caplets, and evaluate the feasibility of protective coating materials

- IN - Incorporate CO2 movement into a 3D computer simulation model to predict the generation and diffusion of CO2 due to biological activity (fungi and insects) in a grain mass.
- IN - Scale up the continuous-flow dryeration process to increase the capacity of existing grain dryers and improve the quality of dried corn while reducing energy consumption. Validate an existing computer simulation process model by collecting data using a pilot system installed at a farm near Reynolds, Indiana.
- USDA GMPRC - A mechanistic model of grain commingling in bucket elevators is being developed and will be validated with a small number of lab-scale and full-scale experiments. The model will be used to predict grain commingling in bucket elevators to widen the applicability of an existing decision support system (DSS).

Other important areas of emphasis are related to the more efficient utilization of grains and coproducts:

- IA/KS - Improve value of corn fermentation co-products by removing oil to increase feed quality of DDGS and to generate an alternative oil source for biofuels. This includes seed preparation and additional treatments may maximize oil distribution into the liquid fraction (stillage), and how the oil in the stillage can be effectively recovered.
- KS/NE/TX – Evaluate environmental practices and pre-processing techniques to improve the efficiency of ethanol production, wet milling, and alkaline cooking from grain based products. Quantify the feed processing characteristics of co-products from ethanol and biodiesel production facilities and develop value-added products. In addition, develop feed processing equipment and techniques to reduce or eliminate microbiological contamination in animal feeds.
- NE/NDU – Improve the Determine the antifungal and antimycotoxigenic activity of foodborne bacteria (Lactobacillus, Propionibacterium, Streptococcus, Bacillus and others) alone, and in combination with antifungal chemicals such as propionates, sorbates, acetates and naturally occurring plant products (flaxseed) to develop novel, new preservative methods to maintain quality and safety of grain. Finally the stability of bioactive compounds in common foodprocessing environments will be assessed.
- NDU - Developing an efficient means of separating oilseed (e.g. flaxseed) and cereals (e.g. wheat) based on color by using an electronic color sorter.
- NDU - Determine the effect of environment during grain fill and preharvest production practices on end-use quality of durum and hard red winter spring wheat. This includes determining the relationship between oxidative stress level and carotenoid pigment content during grain filling and the relationship between oxidative stress level in seed at harvest and loss of pigment during processing.
- NDU/WA - Development of new processes and products using peas, chickpeas, flaxseed and lentils to expand their use.

Objective 3 - To quantify and disseminate the impact of market-chain technologies on providing high value, food-safe, and bio-secure grains for global markets and bioprocess industries.

NC-213 scientists perform a number of outreach activities to aid in the implementation of successful research programs.

- NC213 members will organize the 2008 Grain Quality and Technology Congress to be held in Chicago (http://www.grainqualitytechnology.org/chicago08/) led by IL/IN station reps. The overall goal of the conference is to provide a global symposium on the technical, scientific and economic opportunities and challenges involved in creating and capturing value in the grain-based food, feed, fiber and fuel supply chains.
- IN – Expand the Grain and Biorefinery Operations Distance Education Program by developing additional course offerings and involving more NC-213 members as content experts and lecturers.
- IA/KS/OK/TX - Provide training in storage and biosecurity issues related to traceability principles, and their application to the recent FDA regulations requiring forward and backward tracking of all food products. The bio-security website training program will be expanded, and also delivered on site as needed. Grain storage/management related materials are being organized into a multi-level training program. These materials will be delivered onsite by Extension specialists, and will become podcasts and web module(s). Asses the cost of traceability on competitiveness of US grains in global markets.
- IA - Operate quality analysis testing/instrument calibration services to support research and marketing activities. Achieve ISO 17025 certification with related statistical control of data management.
- IA/OK - Develop a raw-material quality/quantity based assessment of the potential of grains and non-food/feed crops to meet grain supply needs for both food and fuel production. The resulting impact on grain markets, food processing firms, and their customers of using those feedstock sources will be measured.
- MN/OK - Stimulate adoption of protection practices at food processor through to retailer via “Green Program” techniques of pest management. This includes the evaluation of traditional Integrated Pest Management technologies. Evaluation of both cost and effort measures in “Green Program” and IPM will be considered.
- TX - Assess the impact of regulatory policies including defining acceptable methanol content in crude glycerin and sulfur in DDGS and other grain based feed ingredients on the competitiveness and supply of biofuel co-products.

Further Multi-State Collaboration Efforts

Participants of NC-213 are focused on trying to foster multi-state collaborative efforts. As such, a number of secondary goals have been developed to try to increase the level of multi-state research, instruction, and extension efforts.

- NC213 participants using NIRS analysis develop/adopt common set of calibrations, and calibration update protocols, to be made available first to NC213 members, then other public users, then to private sector users.
- NC213 participants develop a grain production and handling quality management system template built around ISO 9000 and 22000 certification, with regionally adapted supporting/training/documentation materials.
- NC213 participants 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.
- At least three proposals per year that involve two or more NC213 participating entities will be submitted to national or other peer reviewed funding sources.

Measurement of Progress and Results

Outputs (4,000 characters)

- Further development of measurement technologies (NIR, FT-NIR, HPLC, etc.) will allow for the accurate quantification of grain quality attributes (fermentable starch, protein, oil, mycotoxins, etc.).
- Quality factors of several grains will be related directly to end use economics.
- 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.
- An international conference related to the project objectives will be held in 2008.
- Non-chemical and other alternative methods of insect control will be refined and the cost reduced.
- Operating details, certification systems, and risk analysis templates will be developed for production of products requiring isolation or specialized marketing.
- Further development of alternative crops (such as sorghum, flaxseed, and spelt) for high value food products.
- Determination of quality traits that are advantageous to processors that can be incorporated into new varieties and hybrids.
- Development of new processing techniques to reduce the toxicity and quantity of fumonisin in corn grits.
- Development of 3-day CO2 test kit that would accurately determine the risk of spoilage during continued storage or shipment to tropical climates where conditions are more conducive to fungal growth.

Outcomes or Projected Impacts (4,000 characters)

- Identity preserved grains with higher quality and purity will be delivered to users that meet their specifications in an economically viable manner.

- 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.
- Audited certification and product tracing systems will be in use by specialty and commodity marketer.
- Participate with the grain and bioprocess industries in producing economical products while ensuring the safety and value of food and coproducts.
- Develop quality assurance protocols for DDGS co-products that will guide ethanol plant managers on what to monitor and how to improve the quality of their DDGS during production.
- More industry professionals trained in grain and biorefinery operations through distance education and earning Continuing Education Units (CEU) for successful completion of courses.

Milestones *(4,000 characters)*

- The 2008 International Grain Quality and Technology Congress will be held in July 2008 in Chicago, IL.
- The GEAPS-Purdue Grain and Biorefinery Operations Distance Education Program will offer five courses during January through July 2008 including two new ones (GEAPS 590 Fundamentals of Ethanol Processing; GEAPS 540 Grain Operations Safety Management), and six courses during January through July 2009 including four new courses (GEAPS 542 Electrical safety, GEAPS 541 Grain Entrapment Rescue, GEAPS 591 Ethanol II, GEAPS 521 Aeration System Design and Operation).
- Material properties for DDGS will be determined by 2009.
- Extrusion reduction in fumonisins will be quantified and the data available to the food industry and regulatory agencies by 2010
- Decision making spreadsheets will be developed for forward and backward tracing of grains by 2009.
- Implement a universal lot identification and aggregation system to manage traceability of less-than-fully approved GM events by 2010.
- A national database of grain quality-yield information will be published in 2009.
- A database of corn to ethanol traits will be developed by 2010 and storability recommendations for DDGS and coproducts of cellulosic ethanol by 2012.
- Specific grain quality traits that optimize production efficiencies for key end uses, including ethanol production, will disseminated to processors by 2010.

Outreach Plan (2,000 characters)

International Conference

NC-213 is organizing in conjunction with Purdue University and the University of Illinois the International Grain Quality and Technology Congress the International

Quality Grains to be held July 15-18, 2008 in Chicago, Illinois. The objectives are to present current knowledge on:

1. Characterization of quality attributes and measurement technologies to quantify agronomic, quality and end use traits of cereals, oilseeds and co-products within the food, feed, fiber and bioenergy complex.
2. Best management practices, systems and technologies to maintain and assure the identity, purity, integrity, consistency, quality, biosecurity and marketability of cereals, oilseeds and co-products through the supply chains from production through harvest, handling, post-harvest, and processing operations, to final end use.
3. Economic assessment of measurement technologies and management practices for creating and capturing value within the food, feed, fiber and bioenergy complex.

Distance Education

Purdue University is working with GEAPS (Grain Elevator and Processing Society) to expand the development and offering of distance education courses for grain and biorefinery industry professionals and make these courses accessible to undergraduate and graduate students at NC-213 member institutions. Texas A&M in collaboration with national grain and feed associations will expand distance learning courses to ensure safe feed is manufactured using grains and bioprocess coproducts.

Organization and Governance (4,000 characters)

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/oardc.ohio-state.edu/nc213).

- 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 Coordinator's Office.
- There will be four officers (chair, vice-chair, past chair, and secretary), 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. It sets the agenda for the annual business meeting, plans special meetings and conferences, overseas production of 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 book of project reports will be reformatted to match the revised project outline. It will primarily be posted on the NC-213 website, and only a limited number of hard copies will be printed and distributed.

- A special topic-oriented summer workshop will be held annually. In 2008, NC-213 will have as its major outreach effort the International Grain Quality and Technology Congress to be held July 15-18, 2008 in Chicago, IL (see above).
- The function and responsibilities of the NC-213 industry advisory committee will continue to grow.

HOMEPAGE
OUTLINE
APPENDIX E : PARTICIPATION
HISTORY
SAES-422 (REPORT & MINUTES)
MEETING INFO
PARTICIPANTS DIRECTORY
TECH COMMITTEE OFFICERS
PUBLICATIONS
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ADDITIONAL DOCUMENTS
CSREES APPROVAL LETTER
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ALL PROJECTS

NC213: Marketing and Delivery of Quality Grains and BioProcess Coproducts

Appendix E: Format for Reporting Projected Participantion

Part 1: Participant List

Station / Institution and Department	Participant	Objective No.	Research						Extension	
			KA	SOI	FOS	SY	PY	TY	FTE	Program
Illinois - University of Illinois	Marvin Paulsen	1,2,3,4	402 503 511	1510 1510 1510	2020 2020 2020	0.40	0.90	0.10	0.00	• not specified
Indiana - Purdue University	Richard Stroshine	2	511 503 502	1510 1599 1510	2020 2020 2020	0.10	0.00	0.00	0.00	• not specified
Iowa - Iowa State University	Thomas Brumm	1	0	0	0	0.10	0.25	0.00	0.00	• not specified
Iowa - Iowa State University	Chad E Hart	1,4	604 604	1510 1820	3010 3010	0.10	0.00	0.00	0.00	
Iowa - Iowa State University	Charles Hurburgh Jr.	1,2,3	404 502 711 604	1510 1820 1510 6230	2090 2000 3010 2020	0.50	3.00	0.00	0.30	• Agricultural competitiveness and profitability
Iowa - Iowa State University	Tong Wang	1	501	1820	2000	0.10	0.50	0.00	0.00	• not specified
Kansas - Kansas State university	Subramanyam Bhadriraju	2,3	503 401	5399 3910	2020 1010	0.20	0.20	0.10	0.20	• Agricultural competitiveness and profitability
Kansas - Kansas State university	Ronaldo Maghirang	1	512	1549	1060	0.10	0.10	0.00	0.10	• Agricultural competitiveness and profitability
Kansas - Kansas State university	Dirk Maier	2,3	503 401	5399 3910	2020 1010	0.10	0.10	0.10	0.10	
Kansas - Kansas State university	Leland McKinney	3	512	1549	1060	0.10	0.10	0.00	0.10	• Agricultural competitiveness and profitability
Kansas - Kansas State university	Tom Phillips	1	512	1549	1060	0.20	0.10	0.10	0.20	• Agricultural competitiveness and profitability
Kentucky - University of Kentucky	Michael Montross	2	402 402	1899 5199	2020 2020	0.10	0.10	0.10	0.00	• not specified
Kentucky Cooperative Extension	Samuel McNeill	2	0	0	0	0.00	0.00	0.00	0.10	• Agricultural competitiveness and profitability • Community resource and economic development

Michigan - Michigan State University	Perry Ng	1	502	1549	1000	0.10	0.25	0.00	0.00	• not specified
Minnesota - University of Minnesota	Stephen A Kells	2,3	503 503 503	3110 1599 1510	1130 1130 1130	0.10	0.00	0.00	0.00	• not specified
Minnesota - University of Minnesota	Bill Wilcke	3	402 503 503	1510 1541 1820	2020 2020 2020	0.25	0.00	0.00	0.00	• not specified
Montana - Montana State University	David K. Weaver	3	211 503 215	1541 1599 1540	1130 1130 1130	0.10	0.00	0.00	0.00	
Nebraska - University of Nebraska	P. Stephen Baenziger	1	204	1544	1080	0.10	0.00	0.00	0.00	• not specified
Nebraska - University of Nebraska	Lloyd Bullerman	2	712 712 712 712 503 503	1540 1540 1510 1510 1510 1510	1150 1102 1150 1102 1150 1102	0.20	0.20	0.10	0.10	• Agricultural competitiveness and profitability
Nebraska - University of Nebraska	Heather E Hallen-Adams	2	712 712 712	1540 1540 1540	1080 1102 1040	0.40	0.10	0.25	0.10	
Nebraska - University of Nebraska	David S Jackson	1,2,3	502 501 511 502 512 501	1510 1520 1510 1520 1520 1510	1000 1000 1000 1000 1000 1000	0.15	0.00	0.15	0.15	• Agricultural competitiveness and profitability
Nebraska - University of Nebraska	Devin Rose	1	502	1540	2000	0.15	0.40	0.00	0.00	
North Dakota - North Dakota State University	Anuradha Boddeda	1,2	712	1599	1102	0.00	0.10	0.00	0.00	• not specified
North Dakota - North Dakota State University	Clifford Hall	1,2	502	1599	2000	0.15	0.00	0.25	0.00	• not specified
North Dakota - North Dakota State University	Kenneth Hellevang	1,2	0	0	0	0.00	0.00	0.00	0.05	• Agricultural competitiveness and profitability
North Dakota - North Dakota State University	Frank Manthey	1,2	502	1545	2000	0.20	0.00	0.15	0.00	• not specified
North Dakota - North Dakota State University	Senay Simsek	1,2	502 502	1541 1544	2000 2000	0.10	0.00	0.10	0.00	• not specified
North Dakota - North Dakota State University	Charlene Wolf-Hall	1,2	712	1599	1102	0.10	0.00	0.00	0.00	• not specified
Ohio - Ohio State University	Matthew C. Roberts	1,2,3	604	6230	2020	0.10	0.00	0.00	0.10	• Agricultural competitiveness and profitability

Oklahoma - Oklahoma State University	Brian D Adam	3,4	604 604 503 603 603 503 503 604	1599 1550 1511 1540 1530 1520 1510 1541	3010 3010 3010 3010 3010 3010 3010 3010	0.20	0.00	0.00	0.00	
Oklahoma - Oklahoma State University	Carol Jones	1,2,3	503 503 503 503 503 503 503 404 4040 404 404	5330 5399 2410 2235 2030 1848 1820 1629 1599 1540 1499 1510	2020 2020 2020 2020 2020 2020 2020 2020 2020 2020 2020 2020	0.10	0.00	0.00	0.00	
Texas AgriLife Research	Joseph M Awika	1,2	501 502 502	1510 1520 1540	2000 2000 2000	0.10	0.00	0.00	0.00	
Texas AgriLife Research	Tim J Herrman	unknown	604 604 604 503 503 503	1520 1540 1510 1540 1510 1520	3030 3030 3030 2020 2020 2020	0.10	0.00	0.00	0.00	• not specified
Texas AgriLife Research	Kyung M Lee	3	503 503 503 503 503 503	1510 1510 1540 1520 1540 1520	2000 2020 2020 2020 2000 2000	0.00	0.20	0.00	0.00	• not specified
Texas AgriLife Research	Christian Nansen	1,2	215 215	1510 1520	1130 1130	0.10	0.00	0.10	0.00	• not specified
Texas AgriLife Research	Lloyd Rooney	1	502 501 502	1510 1520 1540	1030 1030 1030	0.50	1.00	0.00	0.00	• not specified
USDA, ARS	Paul Armstrong	2,3,4	404 503	1540 1510	0 2020	0.50	0.00	0.00	0.00	
USDA, ARS	Frank Arthur	2	503	1540	1130	0.10	0.00	0.10	0.00	• not specified
USDA, ARS	Floyd Dowell	2,3,4	404	1510	2020	0.50	0.50	0.00	0.00	
USDA, ARS	Thomas Pearson	2,3,4	0 404	1540 1510	0 2020	0.50	0.00	0.50	0.00	
USDA/ARS	Kurt A Rosentrater	1	511	5340	2020	0.20	0.00	0.00	0.00	• not specified
USDA/ARS Grain			0	1820	0					

Marketing and Production Research Center	Mark Casada	2	0 503	1540 1510	0 2020	0.50	0.00	0.50	0.00	• not specified
Washington - Washington State University	Byung-Kee Baik	1	502 502 502	1543 1544 1550	2000 2000 2000	0.30	0.00	0.00	0.00	• not specified
Wisconsin - University of Wisconsin	Sundaram Gunasekaran	1	501	1599	2020	0.10	0.00	0.00	0.00	• not specified

Part 2: Research Summary

Combination of KA, SOI, and FOS	Total SY	Total PY	Total TY
0-0-0	0.100	0.250	0.000
0-1540-0	0.417	0.000	0.417
0-1820-0	0.167	0.000	0.167
204-1544-1080	0.100	0.000	0.000
211-1541-1130	0.033	0.000	0.000
215-1510-1130	0.050	0.000	0.050
215-1520-1130	0.050	0.000	0.050
215-1540-1130	0.033	0.000	0.000
401-3910-1010	0.150	0.150	0.100
402-1510-2020	0.217	0.300	0.033
402-1899-2020	0.050	0.050	0.050
402-5199-2020	0.050	0.050	0.050
404-1499-2020	0.008	0.000	0.000
404-1510-2020	0.758	0.500	0.250
404-1510-2090	0.125	0.750	0.000
404-1540-0	0.250	0.000	0.000
404-1599-2020	0.008	0.000	0.000
4040-1540-2020	0.008	0.000	0.000
501-1510-1000	0.025	0.000	0.025
501-1510-2000	0.033	0.000	0.000
501-1520-1000	0.025	0.000	0.025
501-1520-1030	0.167	0.333	0.000
501-1599-2020	0.100	0.000	0.000
501-1820-2000	0.100	0.500	0.000
502-1510-1000	0.025	0.000	0.025
502-1510-1030	0.167	0.333	0.000
502-1510-2020	0.033	0.000	0.000
502-1520-1000	0.025	0.000	0.025
502-1520-2000	0.033	0.000	0.000
502-1540-1030	0.167	0.333	0.000
502-1540-2000	0.183	0.400	0.000
502-1541-2000	0.050	0.000	0.050
502-1543-2000	0.100	0.000	0.000
502-1544-2000	0.150	0.000	0.050
502-1545-2000	0.200	0.000	0.150
502-1549-1000	0.100	0.250	0.000
502-1550-2000	0.100	0.000	0.000
502-1599-2000	0.150	0.000	0.250
502-1820-2000	0.125	0.750	0.000

503-1510-1102	0.033	0.033	0.017
503-1510-1130	0.033	0.000	0.000
503-1510-1150	0.033	0.033	0.017
503-1510-2000	0.000	0.033	0.000
503-1510-2020	0.567	0.333	0.200
503-1510-3010	0.025	0.000	0.000
503-1511-3010	0.025	0.000	0.000
503-1520-2000	0.000	0.033	0.000
503-1520-2020	0.017	0.033	0.000
503-1520-3010	0.025	0.000	0.000
503-1540-1130	0.100	0.000	0.100
503-1540-2000	0.000	0.033	0.000
503-1540-2020	0.017	0.033	0.000
503-1541-2020	0.083	0.000	0.000
503-1599-1130	0.067	0.000	0.000
503-1599-2020	0.033	0.000	0.000
503-1629-2020	0.008	0.000	0.000
503-1820-2020	0.092	0.000	0.000
503-1848-2020	0.008	0.000	0.000
503-2030-2020	0.008	0.000	0.000
503-2235-2020	0.008	0.000	0.000
503-2410-2020	0.008	0.000	0.000
503-3110-1130	0.033	0.000	0.000
503-5330-2020	0.008	0.000	0.000
503-5399-2020	0.158	0.150	0.100
511-1510-1000	0.025	0.000	0.025
511-1510-2020	0.167	0.300	0.033
511-5340-2020	0.200	0.000	0.000
512-1520-1000	0.025	0.000	0.025
512-1549-1060	0.400	0.300	0.100
603-1530-3010	0.025	0.000	0.000
603-1540-3010	0.025	0.000	0.000
604-1510-3010	0.050	0.000	0.000
604-1510-3030	0.017	0.000	0.000
604-1520-3030	0.017	0.000	0.000
604-1540-3030	0.017	0.000	0.000
604-1541-3010	0.025	0.000	0.000
604-1550-3010	0.025	0.000	0.000
604-1599-3010	0.025	0.000	0.000
604-1820-3010	0.050	0.000	0.000
604-6230-2020	0.225	0.750	0.000
711-1510-3010	0.125	0.750	0.000
712-1510-1102	0.033	0.033	0.017
712-1510-1150	0.033	0.033	0.017
712-1540-1040	0.133	0.033	0.083
712-1540-1080	0.133	0.033	0.083
712-1540-1102	0.167	0.067	0.100
712-1540-1150	0.033	0.033	0.017
712-1599-1102	0.100	0.100	0.000
Grand Total:	8.100	8.100	2.700

Part 3: Extension Summary

Program	Total FTE
Agricultural competitiveness and profitability	1.35
Community resource and economic development	0.05
Grand FTE Total:	1.60

Last Modified: 03-Sep-2010

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