



# NC213: Marketing and Delivery of Quality Grains and BioProcess Coproducts

(Multistate Research Project) Status: Active

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## NC213: Marketing and Delivery of Quality Grains and BioProcess Coproducts

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Duration: 10/01/2018 to 09/30/2023

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### Statement of Issues and Justification

The 5-year cycle for the multi-state research project NC-213, Marketing and Delivery of Quality Grains and BioProcess Coproducts ends on September 30, 2018. At the March 2017 Annual Meeting, the NC-213 Executive Committee and Membership created a committee to rewrite the project for the next 5-year cycle.

NC-213 researchers address critical, continuing issues in post-harvest grain quality. A major strength of the committee is its multi-disciplinary approach to research, facilitated by the diverse disciplinary background of researchers, including the fields of engineering, economics, grain and food science, plant pathology, entomology, and others. Advances have been made in several areas:

- Reducing breakage of corn and oilseeds during handling and transport
- Methodologies for instrumental and sensor measurement of grain quality attributes
- Innovative and alternative technologies and practices to prevent insect, microbial, and fungal damage to grain and grain by-products in storage
- Agronomic practices resulting in high biomass to fuel conversion during processing
- Use of quality management practices and assurance systems for grain characterization, identity preservation, traceability, food safety, and regulatory compliance
- Risk analysis modeling of toxins in grain and oilseeds
- Prevention of post-harvest losses through enhanced handling and storage technologies
- Optimizing processing systems to balance the needs of feed, food, and fuel outputs
- Development of various processes for scalable and sustainable production of new food, energy, and bioproducts

Continuing research examines strategies in processing and handling to improve safety and quality of wheat flour. Projects have identified tempering practices and milling conditions as potential factors in lowering the microbial load of wheat flour and improving the quality of the final product, noting better dough handling and higher loaf volume in wheat flour bread. The feasibility of alternative screening and separation analytic methods were developed and tested for use in toxin screening in maize and sorghum and breeding sorghum for enhanced nutritional quality. Many measurement and testing options exist, but changes in instruments and mycotoxin test kits require both speed and accuracy. The quality of grain and the speed and accuracy of measurement and testing methods has crucial implications for biotechnology concerns, food safety and usage of co-products from biofuel operations.

With increased production capacities and aging grain handling infrastructure, bulk markets are not adequately prepared to manage procedures intended to document and validate food safety activities in the grain and oilseed supply chain. The ability to implement, document, and verify activities such as [clear reporting](#), [traceback](#), [recall](#),

and isolation has never been more important. Providing guidance on the implementation of these procedures through ISO and other standards organization is expected to serve as the basis for a practical training program for food safety in the grain and oilseed handling and processing industries.

Post-harvest handling and storage practices remain a challenge to global food security. As usage of biofuel co-products increase, handling practices must be developed for these products. Collaborative projects between several NC-213 institutions have examined characteristics of cooling and hopper flow characteristics of dried distiller's grains (DDGS) – a major by-product of ethanol production. A second collaboration examined pack factors – a major factor in storage and inventory of grain. Bin and material properties were investigated and considered in the development and validation of the new packing model, using updated data. The former pack factor tables were based on data from the 1930s and 1940s. An updated procedure will be used by all U.S. farmers. The new model is expected to improve the management of over 9 billion bushels of grain with less than 1% error in inventory management, representing a savings of approximately \$840 million dollars nationally. The multidisciplinary background of the research team was a primary factor in their ability to update a long-standing management tool to address 21<sup>st</sup> century grain and oilseed production and storage practices.

Improvement in storage practices has application in several areas. Post-harvest storage systems play a major role in grain quality. The quality of grain is increasingly important in both domestic and international markets. Understanding economically efficiencies to supply quality grain is an important concern for U.S. producers, handlers, and processes. Several projects have examined how these changes influence domestic supply and demand, product risk, and production choices. Changing economic conditions, government policies, technical innovations, and biological barriers all provide opportunities for study and improvement of grain, oilseed, and by-product systems.

Advances in grain quality have created new and larger challenges for NC-213 researchers. Variable market and weather conditions along with increasing production, aging infrastructure, and a shortage of laborers with appropriate skills add further challenges. Additionally, as resistance to phosphine increases, determining feasible alternatives for post-harvest storage is critical. These challenges require a collaborative and multi-disciplinary research and extension approach. To address these challenges, a systems approach to delivery of a low-cost, safety-focused, and high-quality grain and oilseeds value chain for food, feed, fuel, and other products is required. Continued emphasis on collaboration between disciplines, funding agencies, institutions, regional centers, and industry will be organizational priorities in the 2018 to 2023 cycle.

Two major factors that influence the success NC-213 has been noted in past cycles. The first of these is the annual technical meeting. The NC-213 meeting provides an outstanding opportunity for academic and government researchers to interact with industry stakeholders through presentations, panel discussions, and networking during informal conversations. Through these interactions, practical ideas for solutions, policy, practice, and research emerge to address specific engineering, scientific, and economic issues associated with the project objectives. This interaction enhances the quality of research experiences and provides for the development of innovative research, opportunities for extramural funding, and mentoring of young professionals.

A second factor influencing the past successes of the NC-213 group is the strong industry participation and influence. Industry representative from grain handling, marketing, storage and processing companies, service suppliers, and equipment manufacturing play a significant role in each meeting. An Industry Advisory Board with five elected representatives and a chair that serves on the NC-213 executive committee has been in place since 2000. An industry panel discussion on current U.S. and global trends in grain marketing has been a part of the annual meetings since 2012. These discussions identify emerging research needs that are a part of both the annual research plans and the 5-year project cycle. Blending these diverse perspectives shapes the independent NC-213 participants into a unified and market-centered research team.

NC-213 has enhanced the efficiency of the U.S. grain industry and preserved value in the grain, oilseed, and coproduct supply chain since 1977. As many of the original researchers retire, a strong foundation has been laid for incoming researchers and scientists to address new challenges in grain quality. Collaboration between stations and the resulting shared expertise across multiple disciplines was an important factor in NC-213's first 40 years. These collaborations must continue to retain and develop current researchers to compete in the new, increasingly multi-disciplinary and diverse research environment. NC-213 facilitates these partnerships and will continue to guide emerging research ideas in marketing and delivery of quality grain products and bioprocess coproducts.

## Related, Current and Previous Work

*Related Work*

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NC-213 focuses on the supply chain for grains, oilseeds, and their processed co-products. With the global emphasis on food and feed safety, food security, environmental management, biosecurity, the importance of pre- and post-harvest quality concerns remain, increasing the need for the research generated by NC-213. No other multistate projects showed duplication in this area. A CRIS and NIFA search of other multistate projects that could potentially overlap with NC-213 objectives found no other similar projects.

Other multistate projects do not relate.

#### *Current, Previous Work and Impacts*

NC-213 scientists have developed and are continuing to refine non-invasive techniques using Near Infrared Spectroscopy (NIR), X-ray, X-ray microtomography and other image analysis tools to determine the quality and processing characteristics of grain, oilseeds, and associated food products. A primary impact of these advancements is to create uniformity and reduce analytical support costs of measurement in the grain and oilseed industry while enhancing safety and quality.

NC-213 scientists lead research on automated detection of wheat kernels damaged by fusarium head blight (FHB), which results in yield reductions of up to 50% and over \$1 billion in crop losses in the U.S. Another hazard of FHB is the toxins produced, which are subject to FDA guidelines. The new technology will be used to rapidly screen new wheat lines for FHB resistance and enhance the ability to detect FHB in wheat, improving the safety of the U.S. food supply and preserving key export markets.

NC-213 scientists created an innovative insect measurement system using electrical conductance. The system has low costs and is rapid, inspecting a 1 kilogram sample of product in less than one minute. The system was created through a partnership with an industrial partner. Production and marketing is in progress and the commercial version of the technology is currently being adopted by a major food manufacturing company.

NC-213 scientists built and tested a low-cost wheat sorting device using a personal computer and a color camera. The accuracy of the device is 15 to 20 percent higher than existing sorting devices and programming techniques are used to increase a high throughput while keeping costs low.

NC-213 scientists have continued to test near Infrared transmission analyzers to enhance the ability of the instruments to measure the composition of corn, wheat, soybean and barley samples. Additionally, soybean meal, distiller's grains, and bakery meal have also been added to the database. Nine machines have been tested at least once, and several have been used for more than one crop. The more instruments are able to be used by the USDA Grain Inspection packers and Stockyards Administration (GIPSA) without a loss in consistency, the lower testing costs for the grain and oilseed market chain will be.

NC-213 researchers created face-to-face training and distance education modules to train FDA Regulatory personnel on the grain and oilseed handling and processing system. As a result, 225 FDA inspectors have gained a practical knowledge of agricultural bulk commodity handling and processing facilities, to better meet the requirements of the Food Safety Modernization Act.

NC-213 scientists created a guidance document for the application of ISO 22000, Food Safety Management Systems in bulk processing and handling operations. The document was developed as part of the American Association of Cereal Chemistry's Food Safety Task Force.

NC-213 researchers have focused on the development of rapid, non-destructive technologies to reduce aflatoxin levels in maize samples, especially at elevators and other grain collection points. The aim is to identify and divert contaminated grain into alternative uses, protecting the food and feed supply and increasing producer profitability and consumer safety. Recent efforts have focused on the use of fluorescence multispectral imaging to detect fungal infection and aflatoxin contamination.

NC-213 scientists have examined pre-milling interventions to reduce the microbial load of wheat. Saline-organic acid solutions and organic acids with sodium chloride were tested as antimicrobial treatments. A reduction in microbial contamination in flour was validated in two market classes of wheat with known pathogens. These results represent an important step toward providing a safe, ready-to-eat flour for products untreated with heat, and therefore, at risk for consumption by consumers.

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NC-213 scientists have investigated pretreatment and extraction protocols for use of flaxseed and flaxseed extracts in fermented foods. The use of flaxseed has nutritional benefits, but little was known about the stability during food processing techniques. Findings indicate that flaxseed lignans and phenolics are stable to fermentation processes when used in a fermented juice process.

NC-213 scientists have also investigated the effect of a delayed harvest on the quality of durum wheat. Durum wheat is important commercially, as it is used in pasta production. Delayed harvest resulted in a decreased yield and lower quality of several attributes. The magnitude of the quality loss varied with cultivar, but the research illustrates the importance of timing for optimum yield at harvest.

NC-213 scientists have completed a risk assessment to determine the food safety risk of mycotoxins in the Pacific Northwest, given recent climate variability. The Pacific Northwest region provides a broad sample of different climates relatively close together, and therefore, was an ideal region to study how climate conditions influence crop toxin and disease development in the region.

NC-213 scientists have played a leading role in the development and delivery of the Food Safety Preventive Controls Alliance course on Preventive Controls for Animal Food. The course was offered four times to 60 participants each. Offerings were targeted at feed ingredient suppliers, regulatory personnel, and fuel ethanol producers.

NC-213 scientists have lead training sessions on the mitigation of grain dust explosions. Training has been conducted for over 400 workers in five states. The training emphasized engineering controls, properties of grain dust, and other mitigation strategies of use to grain handling workers. After completion of the training, workers had an increased awareness of preventive operations needed to mitigate grain dust explosions in the grain handling environment.

NC-213 scientists evaluated the efficacy of sealed storage structures to control insect pests in fumigated grain. Fumigant concentrations, insect bioassays, and pressure half-life decay times were measured. Findings revealed an adult mortality of higher than 99% in all insect bioassays, which included some resistant strains.

NC-213 scientists completed a revision of *Grain Drying, Handling, and Storage Handbook, Third Edition*. The book is distributed nationally and internationally by the Midwest Plan Services at Iowa State University, maximizing its influence and impact among extension engineers, grain storage practitioners, grain handling equipment manufacturers, farmers, and university and community college faculty and students.

NC-213 scientists estimated costs and risks associated with chemical-based and integrated pest management (IPM) pest control strategies in stored grain facilities. Findings indicated that sampling-based IPM strategies can be economically effective under certain conditions by partially replacing fumigation in controlling insects within stored grain facilities.

NC-213 scientists have tested strategies to determine the rate of grain spoilage by measuring the effective diffusion coefficient of carbon dioxide. The study measured corn at three temperature and three moisture content levels. The study increased knowledge on the movement of CO<sub>2</sub> in corn – identified as an important component of further development on an effective and commercially feasible technique for using CO<sub>2</sub> sensors to monitor grain quality in storage bins and silo bags.

NC-213 scientists used reflectance based sensors to measure the quality of canola seed. Specific traits tested included rancidity, free fatty acids, extraneous material, number of green seeds and erucic acid content. The scientists found that a flat-bed scanner can be used to detect foreign material in canola, near infrared techniques can be used to estimate rancidity in canola when free fatty acids and peroxide content were also measured, and that erucic acid content can be effectively estimated with near infrared techniques.

NC-213 scientists tested the effect of pre-cleaning shelled corn to reduce mycotoxin levels in corn processed into ethanol and distillers grains. They found that pre-cleaning strategies such as screen cleaning, density sorting, and color sorting were found to be effective at lowering mycotoxin levels, but researchers questioned whether the costs associated with these methods were too high as compared with reduction levels. Research has continued on other approaches to removing mycotoxins from dried distillers grains and DDGS co-products.

## Objectives

1. To measure, model, and assess factors which influence quality and safety attributes in the post-harvest usage, drying, handling, and distribution of cereal grains and oilseeds.

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2. To improve management and operational systems to increase efficiency, retain quality, enhance value, and preserve food safety in the farm-to-user supply chain.
3. To work with multi-institutional colleagues to improve the cereal grain and oilseed supply chain by creating measurable impacts that preserve quality, increase value, and maintain food safety / food security.

## Methods

The NC-213 project focuses on the farm-to-user supply chain for grains, oilseeds, and their co- and processed products. A global emphasis on food safety, biosecurity, environmental management and post-harvest quality management increases the need for systems-based approaches to handling and processing problems. Collaborations between institutional and industry participants has been a key driver of research outputs, competitive grant proposals, and large scale impacts, both in the U.S. and internationally.

The annual technical meeting, managed by NC-213 personnel at The Ohio State University, has had an important influence on establishing informal collaborations and partnerships. Research presentations have historically created opportunities for interactions and exchanges that are not always measured in formal ways, but have resulted in wide technology advancement dissemination and adaptation. The integration of the NC-213 group with industry groups such as the Grain Elevator and Processing Society (GEAPS) and the U.S. Wheat Council has broadened the perspective of both industry and academic professionals.

Each objective below emphasizes advancements falling under the three stated objectives. The following section will describe both existing projects and potential projects to be formalized in the next NC-213 cycle. The NC-213 administered Anderson Grant Research Program will target emphasis areas and continue to provide funding for preliminary and pilot research concepts.

**Objective 1. To measure, model, and assess factors which influence quality and safety attributes in the post-harvest usage, drying, handling, and distribution of cereal grains, oilseeds, and their co-products.**

- 1.1) Examine factors influencing wheat quality and baking properties of wheat flour (ND, NE)
- 1.2) Develop non-invasive imaging techniques (Near infrared, soft x-rays, X-ray microtomography) and various pre-treatment processes to characterize quality traits and measure resulting processing characteristics of grains, oilseeds, and co-products (AR/IA/IL/IN/KS/KY/MS/ND/NE/TX/USDA)
- 1.3) Develop in-line near infrared calibrations for measuring quality components of wheat corn, rice, and soybean products and co-products destined for industrial applications (IA/IN/ND/NE/USDA)
- 1.4) Assess and report economically viable attributes for corn, soybeans, and wheat for use in conducting cost/benefit analyses and market impacts resulting from the measurement of novel value-added attributes (IA/MT/ND/OK/USDA)
- 1.5) Develop a stored grain ecosystem model to evaluate the cause of deficient fumigations in storage bunkers (USDA/KS)
- 1.6) Evaluate the effect of preprocessing methods and dry grind processes on corn utilized in ethanol production (IL/IN/IA/ND)
- 1.7) Investigate physical and chemical methods of reducing fungal growth and mycotoxins in grain and oilseeds and their associated co-products (AK/IL/MS/ND/NE/TX/USDA)
- 1.8) Develop lower cost systems for inventory control of large grain storage structures and improve the post-storage quality of grains stored in these structures (IN/KY/USDA)

**Objective 2. To improve management and operational systems to increase efficiency, retain quality, enhance value, and preserve food safety in the farm-to-user supply chain.**

- 2.1) Utilize advanced experimental and mathematical simulations to validate and assess drying, storage, and chilling operations of grain, rice, and oilseeds (AR/ID/IN/MT/USDA)
- 2.2) Examination and evaluation of strategies for managing large-scale organic grains and oilseeds (IN/KY)
- 2.3) Determine the influence of grain packing on critical inventory metrics with conventional and specialty grain products (IN/KS/KY/OK/USDA)
- 2.4) Develop standards for food safety risk analysis and traceability in bulk grain and grain product supply chains (IA/TX)
- 2.5) Evaluate and model the feasibility of existing tolerance levels for non-genetically modified (GM) corn (IA/IN)
- 2.6) Develop and test novel methods for drying, handling, and storage of post-harvest corn, rice, soybeans, and wheat in the U.S. and in developing countries (AR/IA/IL/IN/KY/OK/USDA)
- 2.7) Investigate the operational and economic feasibility of conventional and non-conventional options for mitigation, prevention, and control of stored product insects and pests in grain and food processing facilities (AR/IA/IL/IN/ND/NE/KS/KY/MS/OK/USDA)
- 2.8) Assess the role of environmental, human, production, and machinery conditions on in-field drying, harvest losses, harvest logistics, and supply chain robustness and risk management. (IA/KY)
- 2.9) Reduce biohazard risk, quality and quantity losses, cost of distribution, and cost of regulatory compliance using information technologies that facilitate supply chain traceability and communication (IA/IN/OK/ND)
- 2.10) Identify and evaluate the influence of environmental and economic factors on sustainable grain handling

practices (IA/ID/IN/OK/ND/USDA)

**Objective 3.** To work with multi-institutional colleagues to improve the cereal grain and oilseed supply chain by creating measurable impacts that preserve quality, increase value, and maintain food safety / food security.

- 3.1) Conduct outreach activities emphasizing research findings and educational trainings for students, extension professionals, industry professionals, academic researchers, and other stakeholders (All participating stations)
- 3.2) Increase the awareness of industry professionals on grain production and handling hazards through continuing education training programs, including grain dust explosion mitigation, grain engulfment, and chemical safety hazards (IA/IN/KY/OK/TX)
- 3.3) Develop spreadsheet tools to facilitate inventory management of stored grain in conventional and horizontal storage structures (KY)
- 3.4) Develop and adopt a common set of calibration update protocols, user practices and databases to be published as standard methods in one or more Methods Compendia (All participating stations). These will be available first to NC-213 members, then other public users, and then to private sector users
- 3.5) Expand current industry-funded organizations and programming to distribute grain operations training and enhance collaborations in applied problem solving on emerging grain quality related issues (IA/IN/KS)
- 3.6) Assist regulatory personnel on cost effective regulatory compliance and extend Food Safety Modernization Act training to industry professionals in food and feed safety (IA/IN/KS)
- 3.7) Expand grain analysis services in grain composition, storage susceptibility, quality attributes, and toxin identification (IA/IN/TX/USDA)
- 3.8) Revise the Midwest Plan Service publication on managing dry grain in storage (AED-20) (IA/IN/KY/ND/OK)

## Measurement of Progress and Results

### Outputs

- Objective 1 Comments: • Increased knowledge of efficient and effective processing and milling practices to optimize the baking properties of wheat flour • Indicators of post-harvest storage quality and processing properties will be identified and measured in a non-destruction way • Near infrared (NIR) calibrations will be validated through multi-institutional laboratories, potentially increasing the number of NIR instruments that can be used to measure quality attributes • Quality factors of grain, oilseeds, and co-products will be identified and measured in more efficient and effective ways, which in turn will facilitate greater economic value for grain and oilseed products and co-products • Determine post-harvest storage fumigation methods that are most effective, in terms of pest control, environmental impacts, and cost efficiency • Identify preprocessing and dry grind processes that increase the usable yield of corn and corn starch in ethanol production • Development and evaluation of effective physical and chemical methods of reducing growth of fungus and toxins in grains, oilseeds, and coproducts • Create lower costs methods of storing large amounts of grain and enhance the ability to preserve the quality of grains stored in large structure
- Objective 2 Comments: • Develop and validate new methods to enhance scientific knowledge of the quality and safety of grain and oilseeds in drying, storage, and chilling operations • Identification, measurement, and validation of methods for managing commodity-scale organic grain and oilseeds • Development and validation of parameters relating to grain pack factors with commodity and specialty grain products • Creation of a standards-based system for traceability in bulk grain and grain product supply chains • Development of a feasible tolerance level for non-GM corn in the bulk corn supply chain • Creation and adoption of low cost and low energy methods for post-harvest drying, handling, and storage of corn, rice, soybeans, and wheat • Development of effective and low cost ways of controlling stored product pests and insects post-harvest • Quantification of the role played by environmental, human, production, and machinery conditions on in-field drying, post-harvest loss, harvest logistics and supply chain risk management
- Objective 3 Comments: • University students, extension and industry professionals, academic researchers, and other stakeholders will update their knowledge and skills in post-harvest grain handling, storage, and processing through a variety of mediums, including the annual meeting, web-based, online training, and hands-on workshops • Industry professionals will have an increased safety orientation as a result of face-to-face training programs focused on grain engulfment, mitigation of grain dust, and other physical and chemical safety hazards • Industry professionals will learn advanced inventory management through new, relevant spreadsheet tools • Updated and common calibration update protocols will be published for use by one or more Methods Compendia • Existing programming will be expanded to include industry-funded training and short course programming to address practical problems faced by the grain industry • Preventative Controls Qualified Individual training for animal feeds and human foods will be delivered to relevant industry and regulatory personnel • Grain analysis services will validate new instrumentation, pre-processing methods, and toxin identification for use in industrial and regulatory settings To accomplish the outputs identified above, at least four research proposals per year that involve two or more NC-213 participating entities will be submitted to national or other peer-reviewed sources other than those managed by NC-213. Other funding sources include state and national commodity groups, foundational and industry groups, state and national extension programs, and other government agencies at national and international levels.

### Outcomes or Projected Impacts

- Objective 1 Outcome / Impact 1: Grains with specialized traits well suited for baking, ethanol production, and other specialized end uses will be easier and less expensive to identify and measure. In addition to adding value

to low-value commodity crops, a more efficient and effective identification of specialized traits means that higher quality grain can be delivered in a cost effective way to consumers and end users. Outcome / Impact 2: Near infrared spectroscopy (NIR) calibrations are an important component of non-destructive evaluation of quality attributes in grain and oilseeds. As the process of NIR calibration increases its accuracy, these advanced analytical techniques will become a more routine way to evaluate the quality and food safety aspects of grains and oilseeds. Trade will become more efficient because low quality grain, oilseed and co-products with food safety concerns can be removed from the supply chain. Outcome / Impact 3: More effective fumigation methods will reduce the need for chemical intervention and reduce costs for grain and food processors. Improved chemical and physical methods for detecting the growth of fungi and toxins reduces the food safety hazard in grains and co-products and allows regulatory agencies to prioritize their interventions toward products processed of higher value.

- Objective 2 Outcome / Impact 1: Updated parameters related to the grain packing factors will be used for specialty grains and other factors influencing inventory management (loading/unloading cycles and aeration). Existing assumptions of the grain packing model will be validated and a new spreadsheet tool will be tested. These findings are expected to lead to a more effective method of tracking handling losses of vertical and horizontal structures on large farms and at commercial grain handling facilities. Outcome / Impact 2: Improved methods for handling, drying, and storing grain, rice, and oilseeds will facilitate improved quality and safety of processed grain, rice, and oilseed products. Understanding the role of environmental, human, production and machinery conditions is expected to improve the quality of grain and oilseed products and co-products, potentially increasing the trade value of products in the domestic and international market. Outcome / Impact 3: Development of a standards-based system to guide traceability and food safety practices within the bulk grain, oilseed, and co-product supply chain. Grain handling operations will be able to optimize food safety management and compliance with FSMA and other regulatory requirements. A critical examination of the feasibility of tolerance levels, which play a critical role in traceability and segregation of identity preserved products, will be completed. Findings could potentially implicate the ease by which non-GM corn can be handled and stored in commercial grain facilities and in the non-GM supply chain.
- Objective 3 Outcome / Impact 1: Educational programming will be expanded in areas of compliance (FSMA, food safety regulatory requirements), worker safety related to grain quality (grain dust, chemical safety, grain engulfment), and grain storage and handling (drying, aeration, post-harvest handling). Several hundred workers and supervisors in grain handling and processing facilities will have updated information on food safety compliance, grain dust hazards, grain engulfment, chemical safety, and grain handling and storage practices. Outcome / Impact 2: Grain quality analysis services will provide new information to grain handlers and processors on NIR instrument calibration models and best practices in post-harvest handling, storage, and processing through collaboration and interaction with industry and non-industry professionals. Facilities for teaching and education purposes will be completed and used for continuing education. Standards and methods will be updated for use by industry, research, and regulatory professionals.

#### Milestones

(2018):Expansion of distance education and face-to-face programming will begin with courses to be offered at Iowa State University in January 2018; NC-213 Annual Meeting held in February 2018 with U.S. Wheat Council

(2019):Standards for traceability of bulk grain and oilseed products created; NC-213 Annual Meeting hosted by Iowa State University in February 2019

(2020):: Improvements in fumigation methods and inventory management updates published; NC-213 Annual Meeting held with Grain Elevator and Processing Society (GEAPS) in Minneapolis, Minnesota (projected)

(2021):Risk analysis tools implemented for the bulk grain supply chain; Updated NIR calibrations released for public use; NC-213 Annual Meeting held in February 2021, location to be determined

(2022):Improvements in grain trait identification published and adopted for use in grain breeding; NC-213 Annual Meeting to be held in February 2022, location to be determined

## Projected Participation

[View Appendix E: Participation \(/appendix\\_e/project?id=18441\)](#)

## Outreach Plan

NC-213 has successfully engaged academic personnel from multiple disciplines and perspectives to disseminate and translate research findings into improved practices within the grain industry. NC-213 participants generally have split academic appointments in research, teaching, and/or extension. The Industrial Advisory Panel will continue to be involved in NC-213, playing a significant role in the annual meeting. Expansion of distance education opportunities will focus on grain industry professionals. The practical approach to research is also highlighted in the Andersons Research Grant Program. Two industry representatives evaluate research proposals to insure relevance.

Annual meetings will continue to be held, where investigators share research results from each of the NC-213 Objectives and discuss opportunities for potential collaboration during networking sessions. Some meetings will partner with industry groups such as the Grain Elevator and Processing Society (GEAPS) and the U.S. Wheat Council in alternating years. Distance education will play an increasing role in the extension and outreach of NC-213 research

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findings. Industry-foundation supporting centers at several of the NC-213 institutions will provide marketing and execution of training and outreach programs resulting from NC-213 research. The goal of resolving practical problems faced by the grain industry also addresses current and projected needs of the U.S. agricultural work force.

Traditional outlets for research and extension professionals will continue to be utilized. These include: journal publications, conference proceedings, extension fact sheets, webinars, and academic, industry and public meetings and trade shows. Annual reports from the 2013-2018 cycle indicate a large number of presentations and publications per year from NC-213 related projects, with 39 peer-reviewed papers published and 29 scientific and Extension presentations shared in 2016.

## 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>) (<http://www.nc213.org>).

The NC-213 Administrative Advisor serves as the Project Coordinator. This position will remain based at The Ohio State University's Agricultural Research and Development Center (OSU-OARDC). 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 USDA Representative. The Executive Committee sets the agenda for the annual business meeting, plans special meetings and conferences, oversees 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.

### Solicitation for Participation.

Currently, there are three agricultural economists on the NC-213 project, including the 2018-2019 Vice Chair, Anton Bekkerman. Our active Industry Advisory Committee provide valuable insights on marketing and economic considerations of the grain and bioproducts market. We will utilize the Industry Advisory Committee to identify marketing and economic experts to the project. Many of the projects completed and proposals written by participating researchers involve economists who are not included in the NC-213 project. However, the need for marketing and economic analysis in the marketing and delivery of quality grains and bioproducts is recognized by the group and we will continue to work with economists and to collaborate with economists but those individuals may not chose to be NC-213 members.

In addition, NC-213 Administrative Advisor/Coordinator along with the NC-213 Executive Committee will reach out to the NC-213 Community and encourage all researchers and partner U.S.D.A. Agencies and ask that they get in touch with economists/marketing experts in their field and share information about NC-213 and ask that they consider becoming a member via an Appendix E.

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## Attachments

### Land Grant Participating States/Institutions

AR, IA, ID, IL, IN, KS, KY, MS, MT, ND, NE, OK, TX

### Non Land Grant Participating States/Institutions

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





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