

NC-151/NC-213

The History of a Multi State Research Project

In The Beginning

The first meeting of North Central (NC)-151 (later named NC-213) occurred on December 13 -14, 1978 at the Essex Hotel in Indianapolis, Indiana. The committee is celebrating its 25th year of existence in 2003. It has become the premier committee for providing scientific knowledge for issues related to quality and marketing of grains and oilseeds. Members of the committee have provided input for congressional testimony, national and federal agencies, state government officials, as well as industry and trade associations, elevator managers and farmers. The committee is unique among NC committees because it also has wide industry participation and an industry advisory committee.

Prior to the organization of the NC committee, the Anderson Agricultural Research Fund (AARF) supported research on grain quality improvement for a four-state region including Ohio, Michigan, Indiana, and Illinois. The impetus for the need of grain quality research came from Donald Anderson and others, and the Anderson family, which owned grain elevators in Champaign, IL, Delphi, IN, Toledo and Maumee, OH. Background of early grain quality research was provided in the AARF newsletters.

Organizational Beginnings

On November 22-23, 1977 a Corn Quality Conference was held in Champaign, IL. It was sponsored by the AARF, the OSU Development Fund, and the Illinois Agricultural Experiment Station. The AARF consisted of \$1 million donated by The Andersons to the Ohio State Development Fund. This conference was also a preliminary meeting of NCT-117 to create the later named NC-151 Committee. The writing committee consisted of Lowell Hill, Chair; Floyd Herum, Secretary; George Foster; Chester Mirocha; Ed Bagley; Fred Bakker-Arkema; and Roger Brook. A follow up meeting, chaired by Lowell Hill, was held January 19-20, 1978 at the King's Inn, in St. Louis, Missouri. Subcommittee chairs were: Objective A - Hill; B - Bakker-Arkema; C - Herum; D - Brook; E - Leath; and F - Schmidt.

On July 11, 1978 Dr. Roy Kottman, Administrative Advisor, notified NC-151 project leaders that the NC-151 committee was approved to begin October 1, 1978. Stan Watson was hired as a one-half time coordinator effective August 15, 1978. The first meeting of NC-151 was held at the Essex Hotel in Indianapolis, Indiana on December 13 -14, 1978. Dean Roy M. Kottman, Administrative Advisor, presided.

Original Forward by Marvin R. Paulsen

Reflecting back, one wonders if some problems are ever truly solved ... or if we just managed to get through them. Some of the recurring problems seem new, yet faces have changed. Perhaps problems appear new because it is a new generation of scientists, elevator managers, farmers, grain trade and government officials that are facing the problem. But each time around, the technologies are modernized and capable of collecting more and more data, more accurate and more precise than before. The true value of history is to allow the present to recognize the past.

But, as we peer forward to the next 25 years, it is apparent that NC-213 has indeed solved more problems than it has left unsolved. And, it is apparent that the NC-213 committee has very successfully brought together multi disciplines of problem-solving scientists with those in the agricultural industry, the grain trade, farmers, and governmental agencies. It has become the premier committee for providing scientific knowledge to issues related to quality and marketing of grains and oilseeds.

Original Final Note by Marvin R. Paulsen

In reviewing 25 years of history of grain quality with NC-151/ NC-213, it is remarkable to observe all of the problems related to grain quality that have surfaced and then later resurfaced. Each crop year is different. Weather conditions vary. Varieties evolve. Consumer attitudes change. Governments exert influence. Governmental agencies and trade groups effect changes in regulations. Each time, the grain markets show resilience and somehow continue to market the product available under the conditions provided.

Finally as one reads the many names in this history, the NC-151/ NC-213 Committee is forever indebted to the hundreds of researchers, industry personnel, government personnel, farmers, and many others who have generously donated their time to this committee and to the study of grain quality.

Marvin R. Paulsen presented the initial version of this material titled; "NC-151/NC-213" A History of the First 25 Years" at the NC-213 Annual Meeting on February 5-6, 2003, which covered the first twenty-five years and offered this footnote: "This History of NC-151 / NC-213 is a work in progress. It has not yet been peer reviewed and while accuracy of reporting was attempted, the author apologizes for any omissions of people and events that were equally news worthy. You may send comments or email your suggestions for improvement to Marvin R. Paulsen, Professor Agricultural Engineering; University of Illinois; 1304 W. Pennsylvania Ave., Urbana, IL. 61801; 217-333-7926 or mpaulsen@uiuc.edu." As of March 2003, the Administrative Advisor's Office will be responsible for updating this material.



**About 151/213: Andersons Agricultural
(Newsletters) Research Fund (AARF)**

NC-151-/NC-213

First AARF Newsletter

The first AARF Grain Quality Newsletter was edited by Fred Bakker-Arkema at Michigan State University in November 1975 as Vol 1 No. 1. It reported on projects funded by the AARF. The fourth Annual AARF meeting was held at Purdue University November 17-18, 1975. Over 50 people attended. Four states, Ohio, Michigan, Indiana, and Illinois, were involved. Research topics included: mechanical properties of corn, nutritive value of corn, effect of dryer design on corn quality, and optical detection of fungi and mycotoxins, brittleness as a measure of corn quality, and corn quality in world markets. Industries and agencies attending the conference included: The Andersons, Cargill, CPC International, Dekalb, Illinois Grain, Mid-States Grain Elevators, National Grain and Feed Association, National Corn Growers Association, U.S. Grain Marketing Research Center and the Illinois Agricultural Association.

Second AARF Newsletter

Another meeting was held January 19, 1976 at Urbana, IL with AARF researchers and Cargill. Conclusions were: 1) The most important corn quality factors to W. European buyers are homogeneity and consistency of quality; 2) Test weight is not important; FM is relatively unimportant, moisture and heat damage are important; 3) European buyers are more price conscious than quality conscious. They are concerned about continuity of supply; 4) The U.S. grading system is too sophisticated with too many factors; and 5) Moisture should be removed from the grade but included as a separate factor.

Third AARF Newsletter

The problem of grain quality in international markets was discussed by IL Representative Edward R. Madigan on the floor of the U.S. House on December 11, 1975. He reported on a 10-day fact finding trip to W. European Ports. There have been a disturbing number of serious dust explosions in grain elevators in Michigan, Texas and Indiana. Aflatoxin problems were presented and Michigan elevators were not happy with the corn test weight adjustment table published by Hall and Hill at Illinois. They claim the table over estimates final test weight after drying. Illinois rechecked data and confirmed the data as published. Neotec has a rapid accurate means of determining moisture, oil, and protein in grain with infrared light absorption and a 0.05% standard deviation on accuracy is achievable.

Fourth AARF Newsletter

The fourth newsletter in August 1976 mentioned a new review of the causes of fire and explosion protection in the grain industry and improvements in corn quality due to two-stage drying, rather than one stage drying.

Fifth AARF Newsletter

The fifth newsletter in October 1976 reported that the fifth annual AARF meeting would be held November 22-23, 1976 at the Fawcett Center in Columbus, Ohio. Attendance was by invitation only. The editor stated, "Some misunderstanding has arisen due to a mistaken assumption that the meetings are open to all interested individuals." "Meeting sizes of over 65 individuals preclude for all intent and purpose effective exchange of ideas between researchers and true discussion of on-going research." Two grain quality analyzers (GQA Model 1 and GAC Model 2) were used to determine protein in hard red winter wheat, correlation coefficients were 0.98 to 0.99. Literature on aflatoxin, *Aspergillus flavus*, and zearalenone in corn was cited.

The first NC-151 newsletter Vol 1 No. 1 was published September 1, 1979 by Stanley A. Watson, Coordinator. The newsletter reported that: the first summer workshop would be on "Corn Breakage Susceptibility" in Chicago on June 6, 1979; a Dust Symposium sponsored by USGMRL and Kansas State University was planned for Oct 2-4, 1979 at Manhattan; and that Purdue University has an ambitious corn quality improvement program with breeder Pete Bauman, mycologist John Tuite, cereal chemist Allen Kirleis, agricultural engineer George Foster, and economist Lee Schrader. Agriculture in Indiana was highlighted. Cornell University was first state outside the NC region to join NC-151.

November 1979 Vol 1 No 2

The second newsletter reported NC-151 had its first anniversary on October 1, 1979. A collaborative study on corn breakage susceptibility was planned.

February 1980 Vol 2 No 2

Wisconsin and Nebraska were added to the NC-151 regional project. Entomology research in Wisconsin, the CAST-issued aflatoxin report, Missouri's novel methods for mold detection, Iowa State's study of grain sampling probes, and USGMRL work is highlighted. President Carter embargoed 17 million tons of grain to the Soviet Union.

April 1980 Vol 2 No 2

The newsletter reported interest from The Andersons' Research Fund would provide \$50,000 annually for research projects. Proposals should emphasize "reduction of physical damage to grains or oilseeds in marketing channels as it relates to insect damage, mold, breakage, and dust formation, by genetic improvement, better harvesting, drying and handling, economic incentives, etc." Projects should be interdisciplinary and involve interstation cooperation whenever possible. Projects were limited to \$5,000 to 10,000 per year up to two years. The newsletter also reported that Illinois conducted a European price/quality study of imported grain, and that in 1979 twenty incidents of fire or dust explosions were reported. This was eight more explosions than in 1978. The National Grain and Feed Association funded projects in 21 areas where information was lacking relative to grain elevator explosions. Agriculture in Ohio was highlighted.

June 1980 Vol 2 No 3

The newsletter reported that the annual meeting was designed to review progress of all projects in the NC-151 program; and the midyear meeting or workshop was designed to explore in-depth specific areas to determine the status of research, actions that should be taken, and recommendations for future research. BCFM in corn and FM in soybeans and corn breakage susceptibility were reviewed as workshop topics. Agriculture in Minnesota was reviewed.

August 1980 Vol 2 No 4

Electronic moisture meters show larger error at high moisture levels than at lower moistures. Hurburgh at Iowa State analyzed 20,000 samples of high and low moisture corn in common moisture meters and with the air oven. An Iowa-Illinois Moisture Meter Task Force requested moisture meter manufacturers to calibrate to the official USDA 72-hour air oven method.

October 1980 Vol 2 No 5

Resistance of white corn hybrids to cracking and kernel hardness was studied at Missouri. A drought-caused aflatoxin problem in the southeastern states and sunflowers as an oilseed crop in North Dakota is highlighted. Karl Norris with the USDA Instrumentation Research Laboratory in Beltsville was elected to the National Academy of Engineering for developing a narrow slit filter system for infrared reflectance analysis in cereal grains.

December 1980 Vol 2 No 6

Charles R. Kruger became the Administrative Advisor for NC-151, replacing Roy M. Kottman. Corn grading discrepancies between New Orleans port elevators and inland elevators were discussed. GEAPS became a member of the NC-151 Advisory Committee. Near infrared instruments (Neotec 51, Technicon Infra Alyzer 500, Trebor 90) were displayed at the 1980 AACC Convention. Agriculture in Illinois – “*The Heartthrob of the Grain Industry*” was highlighted.

February 1981 Vol 3 No 1

The USDA Northern Regional Research Center work with “industrial utilization of agricultural raw materials” was highlighted. The Andersons and Ferrel-Ross Blount concurrent flow dryers with improved grain quality and higher energy efficiency were discussed. EPA proposed a ban on use of ethylene dibromide (EDB) as a grain fumigant.

May 1981 Vol 3 No 2

Dust suppression with oil and water was studied at USGMRL. Safety in the grain industry was highlighted. Corn is being bred for faster dry down rates. There were 44 grain elevator and feed mill explosions reported in 1980, up from 29 in 1979.

July 1981 Vol 3 No 3

Fast green dye test for spectrophotometrically determining pericarp damage in corn was developed at Iowa State. Damage from rotary and conventional combines were evaluated at Illinois. Lowell Hill reported on increase in BCFM on shipments of corn to European ports. A report on strategies for improving corn quality through breeding was given. Corn snack food processors use selected varieties and require corn be low-temperature dried and have low pericarp cracks.

September 1981 Vol 3 No 4

A modified Stein tester was developed at Ohio, Missouri has the ‘corn cracker’, but the Wisconsin breakage susceptibility tester was selected for further development. Carbon dioxide evolution and dry matter loss in corn storage was reported. The General Accounting Office (GAO) issued a report critical of farmer-owned grain reserves due to farm-stored grain that has become musty, sour, damaged and insect infested. Southeastern states had their fifth year of droughty conditions and aflatoxin was again found. A study on feeding mold-damaged corn to broilers and livestock was reported. Moisture meter controversy was being resolved by new calibrations recommended by the Iowa-Illinois Moisture Meter Task Force. Alaskan agriculture was highlighted.

November 1981 Vol 3 No 5

A two-year collaborative study with eight laboratories with six samples on seven different breakage susceptibility testers. The modified Stein tester and the Wisconsin tester had coefficient of variations of 10 and 3%, respectively. Near infrared reflectance methods were used to determine fiber in grain products. Northern Regional Research Center (NRRC) found significant variations in sequences of zeins with similar molecular weights. Odette Shotwell (NRRC) studied aflatoxin, zearalenone and ochratoxin in corn and wheat samples in Virginia over five years. None of these mycotoxins were found in wheat. Aflatoxin was found in corn every year. Ken Gilles, Administrator of FGIS, gave an AACC paper stating that purpose of grain grading standards was to facilitate marketing, storage, financing, and trade. End-use properties might have benefits, but the market disruption that such a change would cause would inevitably make it highly unlikely that new standards will be added until technology is available to provide analysis at the first receiver, the country elevator. In a second paper, Gail Jackson, FGIS Regional Director, stated that current standards do not provide incentives to produce and market high quality grain. Donald Wicklow and Bruce Horn at NNRC identified primary sources of inoculum in *Aspergillus flavus* invasion and contamination of corn. The Crop Dryer Manufacturers Council had 34 member companies. They work with energy ratings and EPA emission standards for crop dryers.

January 1982 Vol 4 No 1

Robert Gustafson, R. Vance Morey and Mahmoud at Minnesota found that tempering corn in a crossflow dryer reduces breakage susceptibility. Richard Stroshine at Purdue found significant differences in drying rate, breakage susceptibility, test weight, storability, and milling quality among corn inbreds and hybrids. The American Soybean Association was highlighted.

April 1982 Vol 4 No 2

Status of grain storage in the U.S. shows that on-farm grain storage has grown to new levels. Robert Gustafson was appointed Chair of the NC-151 Project first 5-year renewal writing committee. Highlights of the Annual meeting in Minneapolis and the visit to Cargill Corporate Headquarters were given. Research on accumulation of fines in spout lines in bins, resistance to airflow and design of aeration systems for more uniform airflow was reported. Peter Bloome spoke at the Illinois Grain Conditioning Conference on legal and physical means of restoring moisture to very dry grain. FDA ruled that white mineral oil might be used for dust control on wheat. Dickey-john purchased Motomco, Inc. Ethanol consumption will quadruple to 340 million gallons per year by 1983. The American Corn Millers Federation was highlighted.

June 1982 Vol 4 No 3

The new NC-151 Administrative Advisor is Dr. Clive Donoho, Jr. Richard Garner will replace Robert Christensen as the USDA/CSRS representative. 1982 winter wheat harvest was delayed by wet weather, test weight was light, and protein was in the low 11% range, compared to 1981 that averaged over 13%. Soft wheats were also low in protein, which is desirable; but in hard wheat high protein is desirable. Purdue conducted a study of changes in corn spoilage and quality changes for barges moving inland to gulf ports.

August 1982 Vol 4 No 4

Cargill Grain Laboratory will build 22 Wisconsin type corn breakage susceptibility testers. K. Finney's report of hard winter wheat quality for the 1953 wheat crop was given. Research presented at the 1982 Grain Storage workshop was highlighted.

November 1982 Vol 4 No 5

NNRC used supercritical CO₂ to extract vegetable oils. NNRC used reverse-phase HPLC to separate wheat proteins based on hydrophobicity. A review of NC-129 Occurrence of Mycotoxins and Quality Changes in Stored Wet Corn were reviewed.

February 1983 Vol 5 No 1

Iowa State measured weight loss during corn handling and found low-temperature and high-temperature drying systems averaged 0.78 and 0.87% weight loss, respectively. A drawing of the Wisconsin breakage susceptibility tester was given. Marvin Paulsen et al. evaluated 13 genotypes that were low- and high-temperature dried for breakage susceptibility, ratio of vitreous-to-floury endosperm, floaters, and true density. High-temperature drying increased breakage susceptibility by 2 to 6 times over corn that was low-temperature dried. Lloyd Bullerman found mold counts in grain dust samples at country and terminal elevators averaged 9.5 million colony forming units (CFU) /g and farm samples averaged 32 CFU/g. *Aspergillus* and *Penicillium* molds were predominant. Since the 1980 grain embargo to the Soviet Union, Argentina increased their grain exports to the Soviet Union to 16 million tons in 1982. Technicon is using infrared to measure CO₂ from as little as one live rice weevil in 20,000 grains of wheat.

June 1983 Vol 5 No 2

FGIS provided a review of wheat standards. Lowell Hill and Marvin Paulsen compared harvesting, drying, grain inspection and marketing practices in Argentina to the U.S. NNRC studied ammonia and sulfur dioxide as mold suppressants in corn. Minnesota used trickle flow ammonia in corn. Nebraska used potassium sorbate for mold inhibition on corn. Purdue used trickle flow SO₂ gas. Ammonia darkened the corn while SO₂ left a bright yellow color. Kentucky developed a Grain Bin Inspection Manual, which was very popular for providing Integrated Pest Management information needed for the large amounts of grain stored on farms. Florence Dunkel and Phil Harein at Minnesota developed a computer program to determine economic loss due to infested grain. USGMRL worked with application of water and oils on grain to control dust. Cargill Grain Laboratory found that explosive dust concentrations are nearly always present inside the housing of a bucket elevator. National Grain and Feed Association supported research on explosion panel venting, monitoring shaft bearings and flame suppression devices. Illinois studied problems with European buyers that have higher soybean oil refining losses than do U.S. processors.

October 1983 Vol 5 No 3

The NC-151 project was approved for another five years. Conditions that favor aflatoxin production by *Aspergillus flavus* are moisture stress on the corn plant, daytime temperatures of 100°F or higher during the grain development period, followed by warm nights. These conditions were experienced in Indiana, Illinois, Iowa, Missouri and parts of Ohio in 1983. Loads should not be rejected by BGY fluorescence alone, but should be confirmed by a mini-column or thin-layer plate technique. Concerns were for pockets of drought damage where aflatoxin could be at very high levels and if low-temperature drying systems were used under warm conditions, grain may not dry fast enough to suppress *A. flavus* growth. The summer workshop on “Managing moisture in cereal grains and oilseeds” was highlighted. There was considerable discussion on the standardized bushel concept, which would allow grain to be marketed based on the amount of dry matter delivered.

Lowell Hill stated the Four Principals determining grain value. Principal No. 1 “Farm prices of grain are set by the value of the final products and competitive charges for services in the marketing channel.” Principal No. 2 “The division of income between farmers and elevators is determined by competition not by the grade standards or moisture base.” Principal No. 3 “Water in grain has very little intrinsic value.” Principal No. 4. “Farmers respond to the economic incentives created by the country elevator.”

April 1984 Vol 6 No 1

Wisconsin Breakage Tester received U.S. Patent No. 4,422,319 entitled “Apparatus for testing grains for resistance to damage.” It was issued to Marshall Finner and S. Singh at the University of Wisconsin. U.S. Grains Council President, Darwin Stolte, spoke to NC-151 and emphasized importance of quality in rebuilding U.S. grain export markets. A particle size index (PSI) method and an NIR method for determining wheat hardness were discussed. A new hard winter wheat variety called Arkan has soft wheat in its parentage. Visual inspection is difficult. Arkan is graded as soft wheat by FGIS but in milling and baking tests it behaves like hard wheat causing considerable consternation, because soft wheat is priced below hard wheat in many markets. Fred Bakker-Arkema reported corn dried in an in-bin counterflow dryer with a biomass furnace using wood chips and corn cobs had no greater contamination with polycyclic aromatic hydrocarbons or heavy metals than that dried with direct heated fossil fuels. Off-farm commercial grain storage in the U.S. increased to 8.1 billion bushels. There are a total of 14,706 grain storage facilities in the U.S. The five states of Illinois, Iowa, Kansas, Texas, and Nebraska, account for 53% of the off-farm storage. The average rate of return of agricultural research investments to the public sector have been 30 to 50% annually since the late 1930’s.

October 1984 Vol 6 No 2

Cargill Grain Laboratory completed manufacture of 24 Wisconsin Breakage Tester units. They were sold at cost for \$1600. A collaborative sieving study with 11 laboratories indicated hand sieving on a 12/64-inch round whole sieve did not have enough precision. Either the Strand or Gamet sieve shaker should be used for the next collaborative breakage susceptibility study. Mack Leth reported on chemical and physical properties of corn and soybean fine material. Keith Behnke reported on dust properties of small grains. Robert Gustafson reported that moisture gradients are more important than temperature gradients in causing stresses within a corn kernel that is drying. The entire summer workshop on fine material in grains and oilseeds was highlighted.

February 1985 Vol 7 No 1

Charles Hurburgh at Iowa State found a 5 to 6% point range in protein and 4% point range in oil for soybeans tested on NIR. A second part of the Fine Materials in Grains workshop held in July 1984 was highlighted.

July 1985 Vol 7 No 2

Stan Watson announced his intention to retire on September 30, 1985. The summer workshop on "Technologies for Grain Quality Evaluation" at Toledo and the third part of the Fine Materials in Grain workshop was highlighted. Sunflower seed quality in storage was discussed. In the first 6 months of the 1984-85 corn crop, FGIS has received 45 complaints. Corn in 1984 was harvested wetter than normal and temperatures in Soviet ports were higher than normal. Problems were compounded by elevators that 'blended' high and low moisture corn. European and Japanese soybean buyers were complaining about receiving 13% moisture soybeans instead of the 12% often received in previous years. There was more mold damage and beans arrived with high free fatty acids which reduces yield of refined oil. NIR is being used to measure wheat hardness by Karl Norris, USDA-ARS. Particle size of hard and soft wheat that is ground varies. Hard wheat grinds more coarsely and absorbs more infrared light. Using filters at 1680, 1940 and 2310 nm he could correctly detect Arkan wheat as soft and Arthur wheat as hard. Flour millers are having problems staying below the maximum level of 50 insect fragments per 50 g of flour which was established in 1980, a year when little wheat was stored. The previous level was 100 fragments/ 50 g. FDA does not distinguish between parts coming from live or dead insects, but U.S. Wheat Grading Standards only recognize presence of live insects.

December 1985 Vol 7 No 3

The talk by Richard Anderson, Partner and General Manager of The Andersons, on "What's happening to U.S. agriculture?" was highlighted from the summer workshop held in Toledo. He gave a good explanation of how increasing oil prices and plunge of the dollar enabled more export of U.S. grains in the 1970's, followed by lower exports in the 1980's due to tight money policy to control inflation and a rising dollar. Then U.S. acreage available for crop production was relatively constant while Brazil, Argentina, South Africa, Canada and Australia increased crop acreages and gained market share. Wheat yields in China doubled and the European community increased wheat and coarse grain production. The Advisory Committee of FGSI voted unanimously to request FGIS to request public comments on whether U.S. Standards should be amended to show dockage to the nearest 0.10%. Dockage from 0.1 to 0.49 was listed as 0; while that from 0.5 to 0.99 was listed as 0.5% dockage. An ELISA test method was developed by Patrick Hart and James Pestka, Plant Pathologists at Michigan State University for testing for aflatoxin B₁, M₁, T-2, zearalenone and vomitoxin. The kits were being field tested by Neogen Corp.

March 1986 Vol 8 No 1

On March 31, 1986 Stan Watson retired as coordinator of NC-151. It announced Dr. N. David Schmidt would be the new coordinator of NC-151 in June 1986. This was the last newsletter edited by Stanley Watson. Lowell Hill and Charles Hurburgh are representing NC-151 on the North American Export Grain Association (NAEGA) sponsored grain quality task force. Illinois conducted a study on changes in corn quality for corn exported from New Orleans to Japan. A rewriting committee consisting of Larry Seitz, Richard Strohshine and Marvin Paulsen polled the membership on their three most important research areas for the next five years. Responses were included in the newsletter. Max Spenser, Vice President of Continental Grain, spoke to NC-151 Annual Meeting and his talk was presented in full. He mentioned six topics suggested for change: wheat dockage, wheat protein, corn moisture, infestation, end-use quality factors, and ship loading procedures. Presentations from the Summer

Workshop on "Technologies for Grain Quality Evaluation" were highlighted. David Funk described moisture measurement with dielectric moisture meters. Charles Hurburgh reported on need for national moisture meter standardization. FGIS reported on the Karl Fischer moisture reference method and on their moisture meter calibration program. Lowell Hill reported on moisture measurement methods used by other countries. NGFA is opposed to changing the USDA moisture reference method. Karl Norris spoke on use of NIR for measuring moisture. Allen Kirleis, Purdue, stated the two most important factors related to dry milling quality were corn hardness and breakage susceptibility. He also described his short flow dry milling procedure. Off-farm commercial grain storage totaled 8.25 billion bushels in 1986, up 1.7% from 1985.

September 1986 Vol 8 No 2

David Schmidt was the new editor of this newsletter. A summary of the Summer Workshop in Kansas City on "Focusing Research on Grain Grading Standards" was given. Representative Cooper Evans (R-Iowa) gave the keynote address. He said "the world is awash with grain and we are going to be that way for a long time." We have to improve our quality to regain US market share of exports. There was a large attendance of industry, government and trade associations. Mike Phillips from the Office of Technology spoke on their responsibilities and plan of action to improve grain quality. Following industry talks, a NC-151 panel of researchers made specific recommendations for research needs. They concluded the overall objective of NC-151 should be "to develop and promote the implementation of technology which will enable the U.S. to provide grain and oilseeds of competitive quality for the same (or lower) price while maintaining (or reducing) current production costs." In order to meet the objective, NC-151 developed a strategic plan with five activities. The activities listed were a) uniformity and consistency in current tests, b) marketing analysis to determine potential savings/costs of quality, c) application of current technology (involvement of extension, publications, recommendations on policy), d) introduce new end use quality tests (improve end use value through variety selection and breeding), and e) seek support of Federal Special Grants and industry pooled funds.

Four bills affecting grain quality were introduced by congress. HR5407 would redefine the purpose of grading standards. HR5354 would define an "optimal grade" for all grains. S2682 would prohibit export of any grain into which any dockage or foreign material has been added or reintroduced. S1121 would prohibit addition of dockage or foreign material at export and port elevators except to meet export contract terms. W. Kurt Miller was nominated to replace Ken Gilles as Administer of FGIS.

March 1987 Vol 9 No 1

W. Kurt Miller, Administrator of FGIS was the banquet speaker at the NC-151 Annual Meeting in St. Louis. He spoke on the Grain Quality Improvement Act which was made into law on November 10, 1986. It states that as of May 1, 1987 dockage or FM (and dust) once removed can not be recombined with grain. It provides for tighter insect tolerance and a revised Cu-Sum plan for ship loading. There was further review of the past summer's workshop on "Focusing research on grain grading standards". Gail Jackson, Head FGIS Standardization Division, spoke on end use and that "as a nation we are at crossroads and that our standards are due to change in time as we are switched from a sellers' to a buyers' market." Lowell Hill spoke on perspectives of foreign complaints. Max Spencer spoke on NAEGA recommendations for changes in the grade standards.

December 1987 Vol 9 No 2

Starting July 30, 1987 Broken corn and FM will be determined and reported separately. Broken corn will be all matter passing through the 12/64-inch sieve but retained by the 6/64-inch sieve. FM will be matter passing through the 6/64-inch sieve and non corn material that is retained by the 12/64 inch sieve. The speech of Edward Lowe, Iowa Department of Agriculture, and speaker at the summer workshop was presented.

June 1989 Vol 10 No 1

The Fine Material Symposium was held on February 15, 1989 ahead of the Annual Meeting. Richard Stroshine arranged the program, selected topics and edited an NC-151 committee publication based on the papers presented. Lowell Hill received an Anderson Award for "A conference to develop international uniformity in measuring grain quality." Office of Technology Assessment issued its Grain Quality report. FGIS is starting soybean protein and oil testing as of September 4, 1989. Six commercially available aflatoxin tests were compared. Dust explosions numbered 11, the lowest level for many years. Illinois Crop Improvement started the Identity Preserved Grain Laboratory. In 1988 drought-stressed corn had problems with aflatoxin.

December 1989 Vol 10 No 2

Mini-column and thin-layer chromatography aflatoxin methods were replaced by approved aflatoxin test kits and field locations on October 1, 1989. The NC-151 Regional Publication, "Fine material in grain," is being peer reviewed and will come out in 1990. Proceedings of the 1988 Summer Workshop on "Enhancing Grain Quality for Foreign and Domestic Trade" were presented. A working definition of grain quality was provided by Richard Stroshine.

May 1990 Vol 11 No 1

Estimated process value of soybeans determined by Brumm and Hurburgh, Iowa State University. Quality preferences of soybean processors surveyed by Bender and Hill, UIUC. Florence Dunkel moved from Minnesota to Montana.

October 1990 Vol 11 No 2

A review of the "Uniformity by 2000" International Workshop on Maize and Soybean Quality was provided. The manuscripts of the entire workshop were published in a book edited by Lowell Hill.

June 1991 Vol 12 No 1

John Foltz, Administrator FGIS-USDA spoke at the NC-151 Annual Meeting on the Grain Quality Improvement Act of 1990 and its affect on grading standards.

November 1991 Vol 12 No 2

Corn Utilization Research Database (CURD) was started at KSU.

September 1992 Vol 13 No 1

Highlights of the Annual Meeting on "Marketing and maintenance of quality in the market channel" by Jude DeJean, Regional Operations Mgr, Continental Grain were given.

December 1993 Vol 14 No 1

Highlights of summer workshop in New Orleans. Dirk Maier became the new Station Representative for Indiana. Purdue has released ten Grain Quality Fact Sheets.

April 1994 Vol 15 No 1

The NC-151 committee was renamed NC-213. Soybean standard revisions were published in the March 7 Federal Register. OSHA did not extend the 1/8 "dust rule beyond primary elevator areas. Grain dust explosions in 1993 were 13 up 1 from 1992.

October 1994 Vol 15 No 2

A review of the Summer “Identity Preserved Shipments of Cereals and Oilseeds” workshop in Bozeman was given.

January 1995 Vol 16 No 1

CSRS and ES were reorganized as CSREES.

April 1995 Vol 16 No 2

Review of Carrol Bolen’s, Vice-President and Director Pioneer Hi-Bred International Inc., speech at the Annual Meeting indicates there is a move away from commodity focus to value-added traits; Bruce Roskens, Quaker Oats, reported food manufacturers require more stringent ingredient specifications, supply path documentation, to guarantee HACCP, ISO 9000, and international requirements. Food safety and quality rather than lower cost is of foremost importance. An ELISA test for lysine is available. Fact sheet No. 21 on “Keeping cold grain cold” is available from Purdue.

August 1995 Vol 16 No 3

A review of the Summer Workshop on “End use and product utilization” at NCAUR was reported.

April 1996 Vol 17 No 1

Grain Quality Task Force Fact Sheet on 1995 Indiana corn quality survey for composition data was included.

August 1996 Vol 17 No 2

The 1996 Annual Corn Dry Milling Conference was highlighted.

April 1997 Vol 18 No 1

Joe Brocklesby, Central Soya, described the perfect soybean as presented at the Annual Meeting in Columbus, OH.

June 1997 Vol 18 No 3

This was David Schmidt’s last newsletter. University of Illinois research on Tofu-quality soybeans for Korean taste preferences was highlighted. Proceedings of the 38th Annual Corn Dry Milling Conference in Peoria were summarized.

February 1999 Vol 19 No 1

William Ravlin is the new newsletter editor. NC-231 prepared a proposal for a “National Center of Cereals and Oilseeds” as part of the Fund for Rural America. Only one Center proposal out of 34 received was supported by USDA-CSREES. This one was not selected but review comments were very positive.

August 1999 Vol 19 No 2

Lowell Hill received the first Anderson Research Award. The impact of NC-213 on science highlighted research by Tim Herrman, Alan Dowdy and Floyd Dowell.

February 2000 Vol 20 No 1

Donald Anderson, “Founding Father” of NC-213 received a commemorative award. An Internet literature project by Donna Schenck-Hamlin and Tim Herrman was developed to provide access to thousands of literature citations.

July 2000 Vol 20 No 2

Charles Hurburgh received the second Anderson Research Award. Tim Herrman and Charles Hurburgh led the efforts to prepare an IFAFS proposal.

December 2000 Vol 20 No 3

The IFAFS proposal was one of 970 and was not successful. Tim Herrman and Dirk Maier received the first Anderson Research Grant for Team Competition. Their \$100,000 project was entitled “Grain facility system analysis to improve adoption of value-enhanced grain handling and marketing in the U.S.”

August 2001 Vol 21 No 1

Fred W. Bakker-Arkema received the third Anderson Research Award. Donna Schenck-Hamlin at Kansas State University has developed a comprehensive literature database for cereals and oilseeds. Point your web browser to <http://www.ksu.edu/issa/databases.htm>.

November 2001 Vol 21 No 2

The Summer Workshop in Big Sky Montana was highlighted.

March 2002 Vol 22 No 1

Marvin Paulsen received the fourth Anderson Research Award. Charles Hurburgh won the GEAPS Industry Leader Award.

July 2002 Vol 22 No 2

Catherine Woteki, Iowa State University Dean of Agriculture, spoke on food safety for the Summer Workshop banquet. Charles Hurburgh and Eluned Jones were asked to lead the NC-213 proposal rewriting for the October 1, 2003 to September 30, 2008 period.

November 2002 Vol 22 No 3

The Purdue Post Harvest Grain Quality & Stored Product Protection Program and the upcoming 2004 International Quality Grains Conference being organized by Dirk Maier was highlighted. A white paper on “Traceability in the U.S. grain and plant protein feed ingredient industries” is available by emailing Tim Herrman at tjh@wheat.ksu.edu.

February 2003 Vol 23 No 1

Lloyd Bullerman received the fifth Anderson Research Award. Review of Annual Meeting held in Indianapolis, IN. Article on Industry Advisory Committee growth (Foss N.A., Cargill, Illinois Crop Improvement, Quaker Oats Company). 2002 Anderson Research Program Team Competition Winners (Scott Bean, Tim Herrman, David Jackson).

July 2003 Vol 23 No 2

An overview of the new Work Plan for NC-213 was highlighted. The NC-213 Summer Workshop was the Wheat Quality Short Course, offered by the Department of Grain Science and Industry at Kansas State University-Manhattan. Draft Program Agenda for NC-213 Annual Meeting/Winter Technical Session was included.

November 2003 Vol 23 No 3

An overview of the International Quality Grains Conference was highlighted. Other articles included a “Farewell” article to Karen Bender, winners of awarded grants for The Andersons Research Grant Program – 2003, research conducted by Floyd Dowell, and NC-213 participants involved with the ESA Meeting held in Cincinnati, Ohio.

February 2004 Vol 24 No 1

An overview of the NC-213 Annual Meeting/Winter Technical Session was highlighted. Other articles included the announcement of the GMPRC annual report being released, Kansas State University receiving a \$500,000 competitive grant from NRI, and Dr. Bhadriraju Subramanyam, Kansas State University, receiving the EPA Protection Award.

July 2004 Vol 24 No 2

An overview of the 2004 International Quality Grains Conference was highlighted. Another article regarding research appearing in Research Kernels appeared (O.K. Chung, S. Bean, M. Casada, F. Dowell and D. Koeltzow were contributing authors). A technical report dealing with The Methyl Bromide Technical Options Committee (MBTOC) and their work on residual products appears, being reprinted from the publication; "Methyl Bromide Alternatives."

November 2004 Vol 24 No 3

NC-213 Meeting overview. "New Frontiers in Grain Quality Technology & Informatics A National Roundtable" Conference overview. Article on Tim Herrman's move to Texas A & M University. Article regarding Florence Dunkel's Andersons' Research Grant Program – Poster Overview.

February 2005 Vol 25 No. 1

A recap of the Annual Meeting with special emphasis on Richard Stroshine, winner of the Andersons Research Award. The Third International Wheat Quality Conference was showcased with conference information. A story focusing on eight Brazilian government and university officials who were guests of the Purdue University Post-Harvest Education and Research Center (PHERC) for a five-day workshop on Grain Storage Facilities Certification. A story also appeared that centered on providing clear, defined impact statements.

July 2005 Vol 25 No. 2

An article announcing: The Purdue University Post-Harvest Education & Research Center, the Oklahoma State University Stored Products Research & Education Center, and the Kansas State University Department of Grain Science & Industry in collaboration with the U.S. Quality Grains Research Consortium (NC-213) are pleased to announce the dates for the first National Workshop on Stored Product Protection of Organic Grains and End Products. This Workshop will also serve as the NC-213 Summer Workshop. NC-213 research was focused; this research was also shared in the GMPRC Research Kernels. An overview of Texas A&M training on Hazard Analysis Critical Control Point was highlighted. Anderson Research Program was highlighted with latest RFP and brief history.

November 2005 Vol 25 No. 3

NC-213 Annual Meeting with GEAPS is announced. Bob Smigeskli's retirement from The Andersons is announced. Dr. Okkyung (Okky) Kim Chung's retirement is announced. Anderson Grant Program – Team Competition winners are announced. Other, miscellaneous articles appeared.

February 2006 Vol 26 No. 1

Dr. Don Wicklow, Lead Scientist, Mycotoxin Research Unit, USDA, received the 2006 Andersons Cereals and Oilseeds Award of Excellence. 9th International Working Conference on Stored Product Protection, Sao Paulo, Brazil is announced. The NC-213 Annual Meeting recap story appeared. Two proposals received awarded in the September 2005 Anderson Research Grant Program: Dr. Klein Ileleji and Dr. Richard Stroshine are awarded P.I.s.

July 2006 Vol 26 No. 2

Joe Needham, The Andersons, Inc. to the NC-213 membership through an in-depth article titled; “In his own words...” An overview of research being conducted the The Ohio State University in the arena of wheat-breeding was included. NC-213 Web site updates were highlighted. These updates included awarded research grants for competitions and timely messages aimed directly towards official participating members. Dr. Don Koeltzow, a long time member of NC-213, retired from the USDA. His career was highlighted in this issue.

November 2006 Vol 26 No. 3

NC-213 Annual Meeting with The Wheat Quality Council is announced. An overview of the 9th International Working Conference on Stored Product Protection (IWCSPP) held in Campinas, Brazil. NC-213 research from participating members was highlighted. The Feed Industry Hazard Analysis and Critical Control Points (HACCP) training was highlighted as being available online by the Department of Soil and Crop Sciences at Texas A&M University.

February 2007 Vol 27 No. 1

Dr. Dirk Maier, Purdue University, received the 2007 Andersons Cereals and Oilseeds Award of Excellence at the Annual Meeting held in Kansas City, Missouri. Arvid Hawk, a grain industry veteran who worked at the Grain Research Laboratory at Cargill, Inc. and NC-213 participant, received the Grain Elevator and Processing Society (GEAPS) Industry Leader Award. This article outlined his career and contribution to his field. The NC-213 Annual Meeting in review article was highlighted, as was research conducted by NC-213 participants.

July 2007 Vol 27 No. 2

Feed Industry HACCP Training that is available online is showcased. An article regarding the renewal approval process is included. The premier of “News from our industry partners...” article highlights Consolidated Grain & Barge. An announcement of the 2007 Andersons Research Grant is included in the “Calendar items of interest” section.

November 2007 Vol 27 No. 3

The upcoming Annual Meeting article appeared. The meeting will take place at the Omaha Hilton and a joint banquet with GEAPS will be held February 26, 2008. An article appeared regarding the International Grain Quality and Technology Congress, to be held in Chicago, IL July 15-18, 2008. An article letting readers know about the newly unveiled GEAPS Purdue distance education course.

February 2008 Vol 28 No. 1

Dr. Timothy Herrman, Office of the State Chemist, Texas A&M University, received the 2008 Andersons Cereals and Oilseeds Award of Excellence at the Annual Meeting held in Omaha, Nebraska. A review of the annual meeting, held with GEAPS Exchange 2008, was included. An article telling readers that Dr. Dirk Maier was named head of Kansas State University’s Department of Grain Science and Industry appeared—start date April 1, 2008. The following individuals had awarded grants in the 2007 Andersons Research Grant Program:
Dr. Charlene Wolf-hall, Dr. Klein Ileleji, and Dr. Dirk Maier.

July 2008 Vol 28 No. 2

A recap of the International Grain Quality and Technology Congress was featured. Research from The University of Iowa was highlighted; the research was focused on NIRS spectra from different models of spectrometers. The Andersons Research Grant Program: Team Competition was announced. The due date of proposals was September 1, 2008.

November 2008 Vol 28 No. 3

The winning team of The Andersons Research Grant Program: Team Competition was announced. The winning team is lead by Dr. Mark Casada, USDA-ARS, GMPRC, Manhattan, Kansas with "Incidence and Spread of Insects from Bucket Elevator Leg Boots." An overview of the upcoming Annual Meeting was given. Meeting dates of February 18, 19, 20, 2009 were announced along with a preliminary program. An article appeared letting readers know that the NC-213 website was undergoing some changes; another article appeared letting readers know that 2008 Annual Progress Reports from Participation Stations were due and should be submitted with the new format.

February 2009 Vol 29 No. 1

A recap of the Annual Meeting was given and David S. Jackson, University of Nebraska-Lincoln was awarded the 2009 Andersons Award of Excellence. Florence V. Dunkel, University of Montana-Bozeman, was awarded MSU President's Award for Excellence in Service Learning. Dale Jude Pardo Moog, University of Manhattan, Kansas passed away unexpectedly. Latest research from USDA-ARS, GMPRC, Manhattan, Kansas was shared.

July 2009 Vol 29 No. 2

This issue of the Grain Quality Newsletter focuses on stories related to Objective 1. We had contributions from Texas A&M University's professor Dr. Christian Nansen. Her article titled: "Considerations Regarding the Use of Hyperspectral Imaging Data in Classifications of Food Products, Exemplified by Analysis of Maize Kernels" contained excerpts from her paper of the same title. This paper appeared in the Journal of Agricultural and Food Chemistry 2008. Another article came from North Dakota State University's Dr. Senay Simsek. Her articles shared information on production and processing factor regarding semolina and pasta and structural variation of Arabinoxylans in Hard Red Spring Wheat. We also featured an abstract of a presentation by Larry Svajgr given in 2007. Many international events were also announced in this issue. Beginning with this issue, we will include one "NC-213 Impact" statement. This issue's impact statement shared news about a low-cost sorting device for wheat.

November 2009 Vol 29 No. 3

This issue of the Grain Quality Newsletter focuses on stories related to Objective 2. Articles that appear share research and processes for preserving food after harvest for food security and transportation and logistical challenges of biotechnology. Both of these articles were used with permission from outside interests. This issue announced the latest GEAPS-KSU distance-learning courses for 2010. This issue's impact statement shared news about funding sources that made impacts.

February 2010 Vol 30 No. 1

This issue of the Grain Quality Newsletter gave a review of the NC-213 Annual Meeting/Technical Sessions that was held February 3-5, 2010 in Kansas City, Missouri. The highlight of the meeting was the Andersons Award of Excellence, which was awarded to Dr. Lawrence A. Johnson, Iowa State University. Upcoming training; "Feed Industry Hazard Analysis and Critical Control Point (HACCP) Auditor Training" was announced. Training to be held March 29-April 2, 2010. University of Nebraska-Lincoln is seeking an Assistant or Associate Professor-Food Safety Microbiologist/Toxicologist-Molds and Mycotoxins. This issue also announced a new stored-product insect research book by Dr. Bh. (Subi) Subramanyam. There also appeared an update on GEAPS-KSU distance education courses. As in previous issues, GMPRC Research Kernels was the supplier of research being conducted by NC-213 participants.

July 2010 Vol 30 No. 2

This issue featured an article on the Global Feed Forum held in Cancun, Mexico in April 2010. Courses offered through the Distance Education program through Kansas State University and GEAPS was also featured. Kansas State University advertised two open positions at their institution. In addition, a research article on carbon dioxide sensing technology from Kansas State University appeared.

November 2010 Vol 30 Nr. 3

This issue featured an in-depth article on the change at USDA GMPRC to CGAHR. The article included CGAHR researchers' latest work, CGAHR researchers' awards, meetings and conferences attended by CGAHR faculty, and individual department/unit name changes.



**Our Structure: Work Plans
 Officers
 Meetings**

Every five years the NC-151/ 213 Committee evaluated grain quality needs and developed a Work Plan of Specific Objectives that was believed to be appropriate for the next five years. Objectives changed as new problems evolved. They are summarized below.

Oct 1, 1978 through Sept 30, 1983

Title: Marketing and delivery of quality cereals and oilseeds in domestic and foreign markets

The writing committee consisted of Lowell Hill, Chair, Floyd Herum, George Foster, Chester Mirocha, Ed Bagley, Fred Bakker-Arkema and Roger Brook.

Specific Objectives:

To identify quality, safety, and health factors of economic significance to producers, marketers, and end users of grains.

-To relate quality factors to urgent problems of safety and health such as dust explosions, mycotoxins, and heavy metal contamination.

-To develop instrumentation and procedures for improving the detection and quantification of quality factors in market channels.

-To develop equipment, procedures, and varieties to reduce quality deterioration due to processing, storage and handling throughout the marketing system and determine their economic feasibility.

-To measure and evaluate the quality of grain between points in the marketing channels from producer through the final user, domestic and foreign.

-To propose and evaluate alternative marketing systems that provide incentives for maintaining original quality throughout the grain marketing channels; domestic and foreign.

Objective	List of Co-Chairs
A	Lowell Hill, IL
B	Fred Bakker-Arkema, MI
C	Floyd Herum, OH
D	Roger Brook, IN
E	Mack Leath, IL
F	S.C. Schmidt, IL

Oct 1, 1983 through Sept 30, 1988

Title: Marketing and delivery of quality cereals and oilseeds in domestic and foreign markets.

The writing committee was chaired by Robert Gustafson

Specific Objectives:

-To identify quality factors and determine their economic significance to producers, marketers, and end users of grains.

-To relate quality factors to urgent problems of safety and health such as dust explosions, mycotoxins, and chemical (pesticide) contamination.

-To develop techniques and instrumentation for improving the detection and quantification of quality factors in market channels.

Biological Aspects.

-To develop equipment, procedures, and grain varieties to improve quality throughout the production and marketing system and determine their economic feasibility.

Physical/ Chemical Aspects.

-To develop equipment, techniques, and grain varieties to improve quality throughout the production and marketing system and determine their economic feasibility.

-To measure and evaluate changes in marketing systems and pricing practices that provide incentives for maintaining and improving grain quality.

Objective	List of Co-Chairs
A	Richard Strohshine, IN
B	Odette Shotwell, NCAUR
C	Charles Hurburgh, IA
D(I)	Larry Seitz, USGMRL
D(II)	Fred Bakker-Arkema, MI
E	C.J. Nicholas, USDA; Lowell Hill, IL

Oct 1, 1988 through Sept 30, 1993

Title: Marketing and delivery of quality cereals and oilseeds.

The rewriting committee consisted of Richard Strohshine, Chair; Larry Seitz, and Marvin Paulsen.

Specific Objectives:

-Determine the effects of genetic traits, abiotic environmental conditions, and handling practices on the quality of cereals and oilseeds.

-Assess the effects of microbial growth, insect infestation and handling on quality of cereals and oilseeds.

-Quantify and define quality of cereals and oilseeds for various end-use markets.

-Determine the economic impact of improving the quality of cereals and oilseeds.

Objective	List of Co-Chairs
A	Richard Pratt, OH; Don Wicklow, NCAUR
B	Florence Dunkel, MT; David Sauer, USGMRL
C	Bruce Litchfield, IL; Keith Behnke, KS
D	Lowell Hill, IL; Mack Leath, ERS

Oct 1, 1993 through Sept 30, 1998

Title: Marketing and delivery of quality cereals and oilseeds.

Specific Objectives:

-Determine the effects of genetic traits, abiotic environmental conditions, and handling practices on the quality of cereals and oilseeds.

-Assess the effects of microbial growth, insect infestation and handling on quality of cereals and oilseeds.

-Quantify and define quality of cereals and oilseeds for various end-use markets.

-Determine the economic impact of improving the quality of cereals and oilseeds.

Objective	List of Co-Chairs
A	Richard Pratt, OH; Don Wicklow, NCAUR
B	Florence Dunkel, MT; David Sauer, GMPRC
C	Lloyd Bullerman, NE; Tim Herrman, KS
D	Lowell Hill, IL; Mack Leath, ERS

Oct 1, 1998 through Sept 30, 2003

Title: Marketing and delivery of quality cereals and oilseeds.

The writing committee was chaired by Richard Pratt

Specific Objectives:

- Determine the effects of genetic traits, abiotic environmental conditions, and handling practices on the quality of cereals and oilseeds.
- Assess the effects of microbial growth, insect infestation and handling on quality of cereals and oilseeds.
- Quantify and define quality of cereals and oilseeds for various end-use markets.
- Determine the economic impact of improving the quality of cereals and oilseeds.

Objective	List of Co-Chairs
A	Richard Pratt, OH; Don Wicklow, NCAUR
B	Florence Dunkel, MT; William Wilcke, MN
C	Lloyd Bullerman, NE; Tim Herrman, KS
D	Lowell Hill, IL; Mack Leath, ERS

Oct 1, 2003 through Sept 30, 2008

Title: Management of Grain Quality and Security in World Markets.

The writing committee was chaired by Charlie Hurburgh, Jr.

Specific Objectives:

- Develop practices and technologies to support quality management systems for production, distribution, processing, utilization of quality grains and oilseeds.
- Develop basic knowledge, science-based standards, and technologies that promote crop quality, food security and food safety in grain markets.
- Create and disseminate scientific knowledge that will enhance public confidence in market-driven quality management systems for grain.

Objective	List of Co-Chairs
A	Florence Dunkel, MT; Don Wicklow, NCAUR (Until end of 2005) David Jackson, NE (Feb 2007)
B	Tim Herrman, KS; Charlene Wolf-Hall, ND
C	Dirk Maier, IN; Mike Montross, KY

Oct 1, 2008 through Sept 30, 2013

Title: Marketing and Delivery of Quality Grains and BioProcess CoProducts

The writing committee was chaired by Mike Montross

Specific Objectives:

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

Objective	List of Co-Chairs
A	M.K. Lee, Texas A&M University; Senay Simsek, ND
B	Leland McKinney, KS; Charlene Wolf-Hall, ND
C	Brian Adam, OK; Charles Huburgh, Jr. IA

List of Officers

Year Beginning Oct 1 – Sep 30	Chair	Vice-Chair	Secretary
1978	Lowell Hill	Y. Pomeranz	Robert Gustafson
1979	Y. Pomeranz	Robert Gustafson	Floyd Niernberger
1980	Robert Gustafson	Floyd Niernberger	Lee Schrader*/ John Tuite
1981	Floyd Niernberger ^{&} / John Tuite	John Tuite/ Wendell Burkholder	Wendell Burkholder/ Floyd Herum
1982	John Tuite/ Wendell Burkholder	Wendell Burkholder/ Floyd Herum	Floyd Herum/ Odette Shotwell
1983	Floyd Herum	Odette Shotwell	Marvin Paulsen
1984	Odette Shotwell	Marvin Paulsen	Larry Seitz
1985	Marvin Paulsen	Larry Seitz	Richard Stroshine
1986	Larry Seitz	Richard Stroshine	Mack Leath
1987	Richard Stroshine	Mack Leath	Leslie Backer
1988	Mack Leath	Leslie Backer	Charles Hurburgh
1989	Leslie Backer	Charles Hurburgh	Charles Martin
1990	Charles Hurburgh	Charles Martin	Florence Dunkel
1991	Charles Martin	Florence Dunkel	Richard Pratt
1992	Florence Dunkel	Richard Pratt	Don Wicklow
1993	Richard Pratt	Don Wicklow	Bill Wilcke
1994	Don Wicklow	Bill Wilcke	Linda Mason
1995	Bill Wilcke	Linda Mason	Alan Dowdy
1996	Linda Mason	Alan Dowdy	Tim Herrman
1997	Alan Dowdy	Tim Herrman	Terry Arbogast
1998	Tim Herrman	Terry Arbogast	Mark Casada
1999	Terry Arbogast	Mark Casada	Lloyd Bullerman
2000	Mark Casada	Lloyd Bullerman	Dirk Maier
2001	Mark Casada	Lloyd Bullerman	Dirk Maier
2002	Lloyd Bullerman	Dirk Maier	Marvin Paulsen
2003	Dirk Maier	Marvin Paulsen	Eluned Jones
2004	Marvin Paulsen	David Jackson	Michael Montross
2005	David Jackson	Michael Montross	Charlene Wolf-Hall
2006	Michael Montross	Charlene Wolf-Hall	Stephen Kells
2007	Charlene Wolf-Hall	Stephen Kells	Mark Casada
2008	Stephen Kells	Mark Casada	Leland McKinney
2009	Mark Casada	Leland McKinney	Brian Adam
2010	Leland McKinney	Brian Adam	Carol Jones

* replaced Lee Schrader who moved away; [&] was transferred

List of Meetings and Workshops

Year	Annual Meeting Location	Date	Summer Workshop Location	Date
1977	Urbana, IL Preliminary organizational meeting	Nov 22	No meeting held.	
1978	NCT-117 St. Louis – King’s Inn	Jan 19 – 20	No meeting held.	
1978	First Meeting of NC-151 Indianapolis – Essex Hotel	Dec 13 – 14	No meeting held.	
1979	No meeting held.		Corn Breakage Susceptibility Testing – Chicago	Jun 6
1980	Kansas City – Travel Lodge KCI airport	Jan 3-4	Grain Grading & Standards - O’Hare American Inn Chicago	May 28-29
1981	Peoria – Holiday Inn Brandywine	Feb 17-19	“Breeding for kernel integrity & mold resistance” - Memorial Union Bldg. Ames	Jun 3-4
1982	Minneapolis – Curtis Hotel (had tour of Cargill Headquarters)	Feb 17-18	Monitoring insects & mold in stored grains & oilseeds – St. Louis King’s Inn Hotel	Jul 22-23
1983	St. Louis – King’s Inn	Feb 2-4	Managing Moisture in Cereal Grains & Oilseeds – St. Louis King’s Inn	Jul 20-22
1984	St. Louis - King’s Inn	Feb 1-3	Fine Material in Grains & Oilseeds - Kansas City Hilton Plaza Inn	Jul 18-20
1985	St. Louis – King’s Inn	Feb 6 – 8	Technologies for Grain Evaluation Toledo Ramada Inn Southwyck	Jul 24 - 26
1986	St. Louis, King’s Inn	Feb 5 – 7	“Focusing research on grain grading standards” Kansas City Hilton	Jul 16 - 18
1987	St. Louis, King’s Inn	Feb 18 – 20	“Relating grain quality to end use value” Ames Holiday Inn Gateway	Jul 15 -17
1988	St. Louis, King’s Inn	Feb 10-12	Enhancing Grain Quality for Foreign & Domestic Trade Washington DC Embassy Square Hotel	Jul 14 - 15

1989	St. Louis, Clarion Hotel “Fine Material Symposium” held Feb 15	Feb 15 – 17	“Marketing Soybeans by Protein & Oil Content” Ames, IA - Hotel Savery	Jul 19-21
1990	Kansas City, Hilton Plaza Inn - joint with NC-129	Feb 14 – 16	“International Workshop on Maize and Soybean Quality: Uniformity by 2000” Champaign IL Chancellor Inn	Sep 23-27
1991	Indianapolis – Hilton at Circle/ ½ day symposium on Physical Methods	Feb 6-8	“Insect Management in Stored Grain” - Manhattan	Jul 31 – Aug 2
1992	Chicago – O’Hare Airport Ramada Inn	Feb 12-14	“New measurement technologies for grain quality” Kansas City–Hilton Plaza KCI	Jul 22-24
1993	St. Louis – Hyatt Regency at Union Station	Feb 10-12	“Quality control in the export channel” New Orleans - Hotel Monteleone	Jul 15-17
1994	With GEAPS – Cincinnati	Mar 6-9	“Identity preserved shipments of cereals and oilseeds” Bozeman -Big Sky Resort	Aug 4-5
1995	With IA Corn Growers Des Moines – Hotel Savery	Feb 8-10	“End use and product utilization” with Dry Millers Peoria NCAUR	Jun 1-2
1996	With Wheat Quality Council - Kansas City Embassy Suites	Feb 22-23	“Responding to customer’s grain quality needs” With GEAPS in Manhattan	Aug 15-16
1997	Holiday Inn – Columbus, OH	Feb 4-6	With National Stored Product IPM – Purdue	Aug 18
1998	Nat Center for Cereals & Oilseeds Forum, Rosemont, IL - Clarion	Feb 4-6	No meeting held.	
1999	With Wheat Quality Council Kansas City Embassy Suits	Feb 11-12	“Will specialty grains change the markets or will the markets resist change?” Maumee OH	Aug 22-24
2000	Kansas City Embassy	Feb 16-18	No meeting held.	
2001	Kansas City Embassy	Feb 21-23	“Certifiable quality management systems for the U.S. grain handling industry” Big Sky, Montana	Aug 8-10
2002	Kansas City Embassy	Feb 20-22	Geaps Ames, IA – Sheeman Center	June 20, 2002
2003	Indianapolis - University Place Conference Center & Hotel at IUPUI	Feb 5-6	“Short Course on Wheat Quality” hosted by the Department of Grain Science & Industry, Kansas State University, Manhattan, KS	July 15-17, 2002
2004	Minneapolis Hilton with GEAPS	Feb 24-25	“International Quality Grains Conference” Indianapolis - University Place Conference Center & Hotel at IUPUI	Jul 19-22
2005	Kansas City Embassy Suites	Feb 23-24	Purdue University – West Lafayette, Indiana	Aug 23-25
2006	Renaissance Nashville Hotel with GEAPS	Feb 28 – March 1	No meeting held.	
2007	Kansas City Embassy Suites with Wheat Quality Council	Feb 21-22	No meeting held.	
2008	Omaha, Nebraska with GEAPS	Feb 26-27	International Grain Quality Technology Congress, Chicago, IL USA	July 15-19, 2008
2009	Kansas City Embassy Suites with Wheat Quality Council	Feb 18-20		
2010	Kansas City Embassy Suites	Feb 2-5		
2011	Kansas City Embassy Suites with Wheat Quality Council	Feb 16-17		

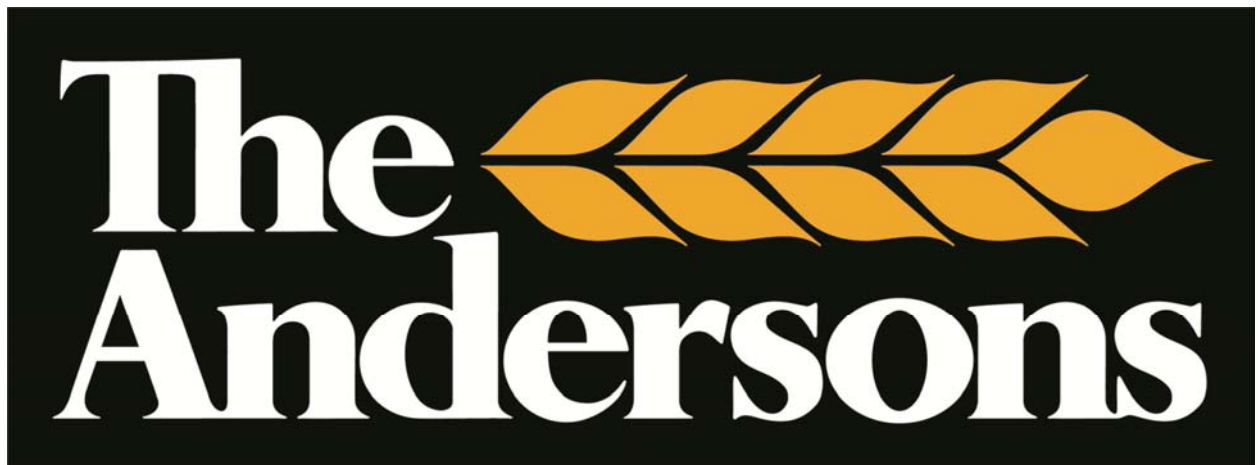
List of Coordinators, Advisors and Representatives

Year Beginning Oct 1 – Sep 30	Coordinator	Administrative Advisor	USDA-CSRS/CSREES
1978-1979	Stanley A. Watson	Roy Kottman	Lloyd Halvorson
1980	Stanley A. Watson	Charles R. Kruger	Lloyd Halvorson
1981	Stanley A. Watson	Charles R. Kruger	Robert Christensen
1982-1984	Stanley A. Watson	Clive Donoho Jr.	Richard G. Garner
1985-1986	Stanley A. Watson	Charles Johnston	Richard G. Garner
1987-1988	N. David Schmidt	H. Russell Conrad	Richard G. Garner
1989-1996	N. David Schmidt	James H. Brown	L. Frank Flora
1997-1998	F. William Ravlin	Thomas L. Payne	L. Frank Flora
1999-2000	F. William Ravlin	Thomas L. Payne	Merle Pierson
2001	F. William Ravlin	Steven A. Slack	Merle Pierson
2002	F. William Ravlin	Steven A. Slack	Ram Rao
2003-2008	F. William Ravlin	F. William Ravlin	Ram Rao/Hongda Chen
2008-2013	F. William Ravlin	F. William Ravlin	Hongda Chen

Industry Advisory Committee

An industry advisory committee is a unique aspect of the NC-213 committee. The advisory committee provides an opportunity for scientists to receive direct input from industry personnel who are directly affected by research related to grain quality.

Year	Chair
1978 - 1989	Donald E. Anderson – The Andersons
1990 - 1993	Ron Swanson – National Corn Growers Association
1994 - 1996	Bruce Roskens – Quaker Oats
1997 - 2003	Jim Stitzlein – Consolidated Grain and Barge
2004 - 2010	Jim Stitzlein – Consolidated Grain and Barge



Funding Opportunities and Recognition

The Andersons Award of Excellence

The Andersons Award of Excellence began in 1999 as a way to recognize outstanding research accomplishments in the area of quality cereals and oilseeds. The first recipient was Dr. Lowell D. Hill.

Year	Recipient
1999	Lowell D. Hill, University of Illinois at Urbana-Champaign
2000	Charles Hurburgh, Jr., Iowa State University
2001	Fred W. Bakker-Arkema, Michigan State University
2002	Marvin R. Paulsen, University of Illinois at Urbana-Champaign
2003	Lloyd Bullerman, University of Nebraska-Lincoln
2004	Florence V. Dunkel, Montana State University-Bozeman
2005	Richard L. Stroshine, Purdue University
2006	Donald T. Wicklow, USDA, ARS NCAUR Peoria, IL
2007	Dirk Maier, Purdue University
2008	Timothy Herrman, Office of State Chemist, Texas A&M University
2009	David S. Jackson, University of Nebraska-Lincoln
2010	Larry A. Johnson, Iowa State University

Books

Two books were written from proceedings of NC-151 conferences and workshops.

Uniformity by 2000, an International Workshop on Maize and Soybean Quality. 1991. Edited by L.D. Hill. Cushing Malloy, Ann Arbor, MI.

Fine Material in Grain. 1992. Edited by R.L. Stroshine. North Central 151 committee on "Marketing and delivery of quality cereals and oilseeds", OARDC Special Circular 141. NC Regional Publication 332. OARDC, Wooster OH.

Regional Publications

Several regional publications have been published by the committee.

Aflatoxin in Corn: New Perspectives. June 1991. Research Bulletin 599. NC Regional Publication 329. Iowa State University, Ames, IA.

Economic Evaluation of Quality Characteristics in the Dry Milling of Corn. 1991. Bulletin 804. NC Regional Publication 330. University of Illinois, Urbana-Champaign, IL.

Costs and Benefits of Redefining the Grade Factor Broken Corn and Foreign Material. December 1994. Bulletin 808. NC Regional Publication 336. University of Illinois, Urbana-Champaign, IL.

Proposals

In the later years, members of the NC-213 made several proposal-writing attempts to USDA for funding. Each was a major multi-disciplinary effort.

A proposal for \$4 million for a “National Center for Cereals and Oilseeds” to the USDA Funds For Rural America was submitted on March 17, 1998. Lead institutions were OARDC, Northern Crops Institute, KSU, ISU, USDA-ARS, Purdue and Grain Industry Alliance. Of 34 proposals for Centers, only one was funded and this proposal was not one of them.

In May 2000, NC-213 researchers led by Tim Herman and Charles Hurburgh and 21 researchers from other locations submitted a USDA-IFAFS Proposal entitled “Capacity Building in the United States Value-Enhanced Cereal and Oilseed Systems”. It was one of 970 others and while not funded, it represented a major team effort by the NC-213 committee.

In September 2003, Dirk Maier took the lead in submitting a USDA – ARS – NPA grant proposal to provide funding for the Global Symposium on Quality – Assured Grains and Oilseeds for the 21st Century at the 2004 International Quality Grains Conference.

In January 2004, Dirk Maier took the lead in submitted a USDA – NRI grant proposal (two) to provide funding for the Global Symposium on Quality – Assured Grains and Oilseeds for the 21st Century at the 2004 International Quality Grains Conference.

The Andersons Agricultural Research Grants Program

Team Research Competition

In September 2000, NC-213 initiated a research grant for Team Research, with the goal of “developing new approaches and technologies to maintain or improve the quality of cereals and oilseeds from harvest to delivery, while preserving the environment and maintaining consumer safety.” Dirk Maier, Purdue, and Tim Herman, Kansas State, with industry and NC-213 collaborators won the competition with their proposal on “Grain facility system analysis to improve adoption of value-enhanced grain handling and marketing in the U.S.”

2002, the Team of: Scott Bean, USDA, ARS-Manhattan, KS, Tim Herrman, Kansas State University, and David Jackson, University of Nebraska-Lincoln won the competition. Title: Factors governing the suitability of sorghum and maize for wet milling, dry milling, and alkaline processing.

2005, the Team of Dirk Maier (Lead P.I.), Purdue University, Subi Bhadriraju, Kansas State University and Charlene Wolf-Hall, North Dakota State University. Title: Ozonation of corn, wheat and barley for the control of pests and spoilage agents, and the removal of off-odors in commercial grain storage structures.

2008, the Team of Mark Casada (Lead P.I.), USDA, ARS, Grain Marketing and Production Research Center, Manhattan, Kansas and Frank Arthur, USDA, ARS, GMPRC; Doug Johnson, Sam McNeill, Michael Montross, University of Kentucky; and Michael Langemeier and Bhadriraju Subramanyam, Kansas State University. Title: Incidence and spread of insects from bucket leg boots.

2010, the Team of that Klein E. Ileleji (Lead P.I.) Purdue, Senay Simsek, North Dakota State University, Richard Strohshine, Purdue University, and Victoria Siegel, Office of Indiana State Chemist’s. Title: Reduction of Mycotoxin Levels in Distillers Grains.

Regular Research Competition

Since the beginning of the NC-151 Committee in 1978, the Andersons Agricultural Research Fund has provided about \$50,000 per year which has enabled up to five projects to be funded for two-year periods. A large measure of the success of the NC-151/ NC-213 Committee over its 25-year existence is due to the research funds made available on a recurring basis by the Andersons Agricultural Research Fund. A summary of the funded projects follows:

1978-80

Project Title	Investigators
Corn varietal characteristics related to breakage susceptibility	Paulsen, Hill, White, Sprague - IL
Fungal growth and quality changes of various inbreds and hybrids as affected by drying	Okos, Stroshine, Bauman, Kirleis, Tuite - IN

1980-1982

Project Title	Investigators
Corn varietal characteristics related to breakage susceptibility	Paulsen, Hill, White, Sprague - IL
Effects of grain quality factors on accuracy of moisture determination in corn	Hurburgh, Bern, Sizer - IA
Effect of dryer design and time on reduction of breakage susceptibility by in-dryer tempering of corn	Gustafson, Morey, Mahmoud, Hall - MN
Evaluation of alternative grain breakability tester concepts for commercial and research applications	Herum, Hamdy, Dollinger, Bardall - OH
Fungal growth and quality changes of various inbreds and hybrids as affected by drying	Okos, Stroshine, Bauman, Kirleis, Tuite- IN

1982-1984

Project Title	Investigators
Differential grain speed crossflow dryer	Bakker-Arkema, Copeland, Harsh, Gusfason, Hines - MI
Corn quality factors and breakage susceptibility for dry milling and commercial use	Paulsen, Hill - IL
Study of heat and mass transfer characteristics of corn kernel components	Gustafson, Morey - MN
Calibration, precision, and operational characteristics of a prototype commercial grain breakage tester	Herum, Hamdy, Bardall, Dollinger
Investigation of differences in drying rate, milling quality, and storability of corn hybrids	Stroshine, Kirleis, Tuite. Bauman, Crane

1984-1986

Project Title	Investigators
Measurement of breakage susceptibility with near infrared reflectance	Hurburgh - IA
Fungicidal grain protectants to improve grain quality and profitability	White, Jacobson - IL
Commercialization of the quality factors influencing product yields in the corn milling industries	Paulsen, Hill - IL
Study of heat and mass transfer characteristics of corn kernel components	Gustafson, Morey - MN
Establishment of an impact breakage tester as an improved test method for the grain marketing industry	Herum, Hamdy, Dollinger - OH
Reduction of breakage susceptibility in corn by breeding and selection	Stroshine, Bauman, Crane - IN

1986-1988

Project Title	Investigators
Properties of fine material removed from corn	Bern, Hurburgh - IA
Costs and benefits of changing the foreign material in corn and soybeans in the market channel from farm to foreign destination	Hill, Paulsen, Shove, Steinberg, Weinzierl, Jacobson - IL
Fungicidal grain protectants to prevent storage molds during low temperature drying and long-term storage	White, Jacobson - IL
In vitro detection of storage mold resistance in corn and kernel traits associated with storage mold resistance, breakage susceptibility and drying rates	Crane, Stroshine, Tuite - IN
In-bin measurements of heat and moisture generated during grain spoilage	Lissek - MN
	Herum - OH

1988-1990

Project Title	Investigators
A conference to develop international uniformity in measuring grain quality	Hill - IL
In-bin measurements of heat and moisture generated during the spoilage of stored grains (one year)	Lissik - MO
Performance of the Ohio grain breakage tester and its adaptability for commercial grain breakage susceptibility testing.	Keener - OH
Genetic control of maize endosperm characteristics associated with improved grain quality	Pratt - OH

1990-1992

Project Title	Investigators
Development and testing of an automated grain breakage tester	Keener, Watson - OH
Moisture variability in corn	Hill, Paulsen, White - IL
Drying induced quality degradation in maize: Measurement of transient moisture profiles and structural changes by magnetic resonance microscopy	Litchfield, Paulsen - IL
Methods for identifying and upgrading preharvest sprouted wheat	Pomeranz - WA
Measurement of the storability of shelled corn	Stroshine, Tuite - IN

1992-1994

Project Title	Investigators
Price and quality competition in U.S. and international soybean markets	Baldwin, Rhodus - OH
Development of methods for detection of corn damaged by high temperature drying	Eckhoff, Rausch, Paulsen - IL
Drying induced quality degradation in maize: Development of advanced dryers and dryer controllers	Litchfield, Q. Zhang - IL
Evaluation of the range of breakage susceptibility in commercial corn to provide data for definition of brittle corn using an automated grain breakage tester	Keener, Hansen, Watson - OH
Incidence of and effects of processing on <i>Fusarium moniliforme</i> and fumonisins in corn and corn products	Bullerman - NE
Price and quality competition in U.S. and international soybean markets	Hill - IL

1994-1996

Project Title	Investigators
Developing the infrastructure to market value-added grains	Hurburgh - IA
Using chemical composition to predict relative corn storability	Wilcke - MO
Meeting the soybean challenge from Brazil	Bender, Hill - IL
Fate of fumonisins in heat processed food products	Bullerman, Hanna, Jackson, D., Jackson, L. - NE
Identification and analysis of corn hybrid chemical and physical factors which influence wet-milling product yields	Jackson, Wehling, Johnson - NE
Reduction in breakage susceptibility of commercial corn through statistical quality control of elevator and farm drying operations	Keener, Hansen, Watson (consultant) - OH

1996-1998

Project Title	Investigators
A chemical approach to identifying the relevance of protein and protein-starch interactions to processing performance	Jackson - NE
Price response to improved corn quality	Hill, Bender - IL
Incidence and stability of <i>Fusarium moniliforme</i> , <i>Fusarium proliferatum</i> and <i>Fusarium</i> subglutian metabolites in heat-processed corn-based foods	Bullerman - NE

1999-2001

Project Title	Investigators
Quality changes of specialty corn varieties during long-term, low moisture storage	Bern, Briggs - IA
CO ₂ monitoring for early detection of grain spoilage	Maier, Woloshuk, Mason - IN
Use of extrusion processing to reduce <i>Fusarium</i> mycotoxins in cereal grain	Bullerman - NE
Impact of storage on wheat milling performance	Herrman, Bramble, Gwartz - KS
Development of a single-kernel NIR system to detect insect infestation in wheat	Dowell, Baker, Thorne – USDA GMPC

2001-2003

Project Title	Investigators
Storability measurement of shelled corn as a means of improving stored grain management practices and preventing losses	Stroshine - IN
Implementing CO ₂ monitoring for early detection of grain spoilage	Maier, Woloshuk - IN
Using varietal differences in post harvest insect resistance of Northern Great Plains hard spring and winter wheat varieties to increase profit potential	Dunkel, Broughton, Bullerman - NE
Using temperature and humidity to control Indian Meal Moth larvae in stored grain facilities	Wilcke - MN
A decision support system for Mid-Atlantic wheat producers to locate value in the supply chain	Eluned Jones - TX

2003-2005

Project Title	Investigators
Biological evaluation of reduction of Fumonisin B ₁ Toxicity in corn grits by extrusion processing.	Bullerman , Ryu - NE
Development and optimization of a high-capacity continuous-flow dryeration process.	Dirk Maier - IN
Development and implementation of a thermal death kinetic model for management of Indianmeal moth and red flour beetle in food processing environments.	Bhadriraju Subramanyam - KS Sajid Alavi Fangneng Huang
Survey of the microbiological quality of the wheat crop from the northern Plains and evaluation of ozone for reducing microbial loads and mycotoxin content in the wheat.	Charlene Wolf-Hall - ND Frank Manthey Monisha Chakraborty

2005-2007

Project Title	Investigators
Physical and chemical properties of shelled corn related to conditioning and processing.	Richard Stroshine - IN
Investigation of methods to improve the flowability of distillers dried grains with solubles (DDGS) during processing, handling, storage and transport.	Klein Ilelji - IN

2007-2009

Project Title	Investigators
Multiplex, Quantitative, Real-Time PCR for Rapid Detection, Identification and Quantification of Mycotoxigenic <i>Fusarium</i> spp. In Durum Wheat	Charlene Wolf-Hall - ND
Evaluating Energy Efficient Strategies and Product Quality for Distillers' Dried Grains with Solubles (DDGS) in Dry Grind Ethanol Plants.	Klein Ilelji - IN
Scale Up of a Nitrogen Based Stored Product Pest Treatment System for Container Shipment of Specialty Grains and their Products	Dirk Maier - Kansas

2009-2011

Project Title	Investigators
Effects of Mycotoxins on Conventional and Modified Dry Grind Corn Processes for Ethanol Production	Vijay Singh - IL
Implementing and Evaluating Traceability Technology in Wheat Storage and Handling	Brian Adam - OK