

# NC-213

## 1999 ANNUAL PROGRESS REPORTS

January 31, 1999

### MARKETING AND DELIVERY OF QUALITY CEREALS AND OILSEEDS

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## NC-213 Progress Report for 1999

From: Cereal Quality Laboratory  
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By: L. W. Rooney  
J. Betran  
R. D. Waniska

NC-213 Objective: A

Procedure: 1a

Project Objective: Evaluate physical, chemical and processing properties of sorghum and develop improved food quality sorghums. Determine differences in alkaline cooking properties of corn and sorghum that relate to kernel characteristics and physical properties. Determine alkaline cooking properties of corn hybrids and improved value added types. Evaluate factors affecting staling of corn tortillas and how to control it. Determine milling and baking quality of wheat breeding lines.

Results for 1999: The availability of identity preserved food sorghums in West Texas is a significant output from this project. Food sorghums produce grains with tan secondary plant color and straw glumes that permit optimum decortication via abrasive milling. Some of these hybrids with outstanding grain yields are grown on significant but limited acreage for identity preserved marketing. Milling properties are affected by environmental conditions. High humidity during maturation causes stained kernels that yield off color flour and reduced milling yields.

Mexican style cookies containing 50% sorghum flour and 50% wheat flour had excellent organoleptic properties. The texture of 100% sorghum flour cookies was soft but this could be improved significantly by addition of 5% pregelatinized waxy cornstarch. The pregelatinized starch apparently covers the sorghum particles reducing their sharp edges and binds them together.

Brown, black and red sorghum bran fractions contained relatively high levels of phenols with the brown sorghum bran equivalent to blueberries in catechin equivalents, ORAC values and total phenol content. The brown sorghum bran contained 44% dietary fiber which was mostly insoluble. The brown bran produced bread with excellent brown color at the 10% level of substitution. Gluten was added to produce bread with good loaf volume and texture. Tortilla chips from sorghums high in phenols have significantly different colors; some produce very attractive red and blue chips. These results illustrate that sorghum can be used in production of functional foods including those with high levels of anti-oxidants. Prototype commercial products have been made.

Native soy flour retarded the staling of corn tortillas and may have a significant synergistic effect when combined with CMC. The structure of tortillas containing 5% soy was significantly different and the starch changes during storage were changed. Likewise addition of 1% vital wheat gluten reduced staling by improving rollability and flexibility of tortillas. Other additives including fibers from wheat bran are being tested. The low cost of tortillas precludes use of expensive additives.

High protein and other modified corn hybrids from university and commercial companies were evaluated for alkaline cooking characteristics using our laboratory and pilot plant procedures. Corn proteins may affect the structure and properties of masa and the staling of tortillas. Use of enzymes and grain with differing levels of protein are under evaluation. Our texture measurements are effective in measuring small differences in properties of tortillas.

Environmental SEM continues to be an effective method to evaluate a wide variety of foods and processed intermediates to solve production problems. The ability to view samples without removal of water and oil is a significant advantage.

A new hard red wheat was released from the TAES wheat improvement program. More than 1,800 preliminary wheat nursery samples were analyzed for hardness, milling and mixing properties. The single kernel hardness tester effectively eliminates a large proportion of some experimental wheat lines in early stages of selection. The data presented prior to fall planting permits elimination of undesirable quality progeny.

Whole kernel NIR is being applied to breeding for quality of wheat. Standardization of whole kernel NIR for sorghum, maize and their products is continuing.

Presentations on maize and sorghum quality were made to numerous end users and overseas grain buyers sponsored by the Grains Council or other groups.

Plans for 2000: Investigate the milling properties and flour quality of new and special black, brown and red sorghums for use in nutraceuticals and other foods. Evaluate factors affecting alkaline cooking quality of corn and sorghum. Determine factors affecting the staling of flour and corn tortillas. Develop calibration equations for use of NIR on whole grains of sorghum, maize and their products, e.g., masa, chips, tortillas etc. Determine quality of wheat samples from the breeding programs emphasizing early generation progeny.

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### Book Chapters

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Leach, Michelle. 1999. The effects of thermal processing on properties of fundamental food polymers in commercial Asian and experimental sorghum noodles. Undergraduate Research Fellows Program. Texas A&M University, College Station, Texas. 49 pp.

Lobeira, Rodrigo. May 1999. Alternative methods to produce fresh corn masa and tortillas. PhD Dissertation. Texas A&M University, College Station, Texas. 112 pp.

Miranda-Lopez, Rita. May 1999. Effect of some anti-staling additives, pH and storage on the staling of corn tortillas. PhD Dissertation. Texas A&M University, College Station, Texas. 113 pp.

Quintero-Fuentes, Ximena. May 1999. Characterization of corn and sorghum tortillas during storage. PhD. Dissertation. Texas A&M University, College Station, Texas. 109 pp.

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Issue: 1) Sorghum has been considered as a feed in the Western World. Its use in food is severely restricted because of a poor image and the lack of acceptable quality grains for processing. New markets for sorghum are possible provided good quality grain is available.

2) Corn quality for alkaline cooking and tortilla staling. Fresh corn tortillas have excellent taste and texture but most consumers have never tasted a fresh tortilla. Methods to maintain texture and taste during storage are needed.

What's been Done: 1) New sorghum hybrids with significantly improved food characteristics have been developed by incorporation of genetic material from the world collection. We devised methods to evaluate sorghum milling and food properties that were used to select food types of sorghum.

2) New methods to measure texture and other changes during staling of corn tortillas were devised. These methods were applied to determine factors affecting staling of corn tortillas. Addition of 5% native soy flour enhances tortilla rollability, flexibility, and nutritional value significantly.

Impact: 1) The new sorghums are being grown by some producers who have received from 10 to 25 cents per bushel more for the grain. The high yields under irrigation combined with slightly higher grain prices have encouraged some producers to plant food sorghums. Value added products for ethnic and dietary markets are being sold with excellent acceptance. A source of good quality sorghum is available for use in food and feed products. Applications in bakery products, brewing, etc are feasible with the new grain types. Additional new earlier maturing hybrids are required for wider applications.

2) The understanding of what happens during staling will lead to improved flavor and texture of tortillas which could significantly increase their consumption since they are low in fat and contain significant levels of calcium and fiber. Our techniques for evaluation of alkaline cooking properties of maize are used by seed companies, corn suppliers, tortilla and snack food companies to procure optimum quality corn for processing.

## NC-213 Progress Report for 1999

From: The Ohio State University, Ohio Agricultural Research and Development Center, Department of Horticulture and Crop Science

By: Richard C. Pratt  
Linda Pollak

NC-213 Objective: A

Procedure: 1a

Project Objective: Determine the effects of genetic traits, climatic factors, agronomic practices, pest populations, machine harvesting, and drying on the quality of cereals and oilseeds.

Results for 1999: S<sub>2</sub> progeny selections derived from the Germplasm Enhancement of Maize (GEM) FS8A(S):S09 population were testcrossed to elite maize inbred LH185. One set of selections was made in Iowa by Dr. Pollak's team, and one set of selections was made by Dr. Pratt's team in Ohio, from the same 441 FS8A(S):S09 S<sub>1</sub> progenies grown in the respective locations during the 1998 season. The resulting testcrosses (hybrids) from the Iowa selections were evaluated at the OARDC Western Branch and those from the Ohio selections were tested at the OARDC Northwest Branch. All testcrosses also were planted in replicated short-row plots near Wooster, Ohio.

The Western Branch site experienced considerable drought stress and yields were markedly reduced. The Northwest Branch site experienced some drought stress, but yields were excellent. Mean stalk lodging values for the testcross populations (n = 74 for IA selections and n = 92 for OH selections) were 3% or less at both locations. The testcrosses yielded selections at approximately the 10% level that were highly competitive with the commercial hybrids entered as replicated checks in the tests (mean of best 10% of all experimental testcrosses was 8.9 mg/ha for IA selections and 15.4 mg/ha for OH selections).

Kernel compositional and density values of grain samples from the replicated plots in near Wooster were determined using a Tecator 1225 near-infrared transmittance grain analyzer and the Composition Systems *System One* calibration.

The highest protein values in Iowa and Ohio testcrosses were 0.7 to 1.0 percentage points higher than the highest check and oil values were 0.3 to 0.4 percentage points higher. Starch composition and density values of testcrosses and checks were nearly identical. Please see tables 1a and 1b.

Table 1a. Agronomic performance and grain quality characteristics of GEM FS8A(S):S09 S2 progenies selected in Iowa, testcrossed to maize inbred LH185, tested in replicated plots near Wooster, Ohio during 1999.

	NO. ENTRY	DAYS		%		YIELD MG/HA	% PROTEIN	% OIL	% STARCH	DENSITY g/ml
		MID SILK	STALK LODGED	FIELD H2O						
<b>Experimental Average</b>	75	84	1	15.3	7.23	9.2	4.1	59.6	1.31	
<b>Check Average</b>	7	85	2	15.2	9.25	8.6	3.9	60.4	1.31	
<b>Experimental High</b>		87	11	16.6	10.67	10.0	4.5	60.7	1.32	
<b>Check High</b>		87	4	16.3	10.31	9.0	4.2	61.0	1.33	
<b>Experimental Low</b>		81	0	14.0	4.56	8.3	3.8	58.2	1.30	
<b>Check Low</b>		82	1	13.7	8.43	8.1	3.7	59.5	1.29	

Table 1b. Agronomic performance and grain quality characteristics of GEM FS8A(S):S09 S2 progenies selected in Ohio, testcrossed to maize inbred LH185, tested in replicated plots near Wooster, Ohio during 1999.

	NO. ENTRY	DAYS		%		YIELD MG/HA	% PROTEIN	% OIL	% STARCH	DENSITY g/ml
		MID SILK	STALK LODGED	FIELD H2O						
<b>Experimental Average</b>	93	84	1	14.5	8.53	9.0	4.0	60.5	1.31	
<b>Check Average</b>	7	85	2	14.4	9.71	8.9	3.9	60.7	1.31	
<b>Experimental High</b>		87	6	15.4	11.06	10.0	4.5	61.6	1.33	
<b>Check High</b>		87	5	15.2	11.57	9.3	4.1	61.7	1.32	
<b>Experimental Low</b>		81	0	12.7	4.74	8.0	3.7	59.1	1.30	
<b>Check Low</b>		82	1	13.2	8.93	8.4	3.8	59.7	1.29	

Plans for 2000: Evaluate selected topcross progenies and their respective parental inbred lines, and inbred testers, in replicated test in Iowa and Ohio.

Issue: Value-added grain quality traits of maize are needed to create more profitable market opportunities for U.S. producers.

What's been Done: OSU breeding programs have focused on the selection of adapted genotypes displaying value-added characteristics for production in the Eastern Corn Belt.

Impact: Development of improved germplasm for release to the private sector and other researchers.

Funding sources:

USDA/ARS Specific Cooperative Agreement with The Ohio State University.

Contacts:

Rich Pratt, Maize Breeding (tel. 330-263-3972)

## NC-213 Progress Report for 1999

From: USDA, ARS  
Bioactive Agents Research

By: Robert A. Norton

NC-213 Objective: A

Procedure: 1a

Project Objective: Investigate chemical factors in corn kernels that affect resistance/susceptibility to *Aspergillus flavus* growth and aflatoxin production.

Results for 1999: Two areas were investigated this year: The effect of an inhibitor present at the site of initial infection by *A. flavus* when the fungus grows into a region lacking the inhibitor. This situation is likely to occur if only one tissue in a kernel produces a bioactive compound at significant levels. Experiments with two different inhibitors present in kernels,  $\alpha$ -carotene and delphinidin, gave results indicating that at least some inhibition was produced in mycelium that grew from inhibited tissue into noninhibited tissue. For  $\alpha$ -carotene inhibition was roughly similar for both regions at ca. 75%. However for delphinidin higher inhibition (99%) was found in the region containing inhibitor than in the uninhibited region (59%); indicating that the type of compound may be an important determinant. There is some evidence that at least part of the inhibition from  $\alpha$ -carotene was due to a volatile breakdown product.

I have previously shown that some sugars can inhibit utilization of triglyceride, the principle fungal nutrient in corn germ, for aflatoxin production. Additional work this year showed that talose, which does not occur in corn, was the most active sugar. The amount required for 50% inhibition (I50) of aflatoxin was 157  $\mu\text{g}/\text{ml}$ . The I50 for growth was ca. 410  $\mu\text{g}/\text{ml}$ . Xylose is a common plant sugar and occurs in corn primarily as a component of cell walls. As reported last year, it is also effective in inhibiting utilization of triglyceride by *A. flavus* for aflatoxin production. Mixtures of sucrose and xylose were investigated in medium containing corn oil to determine if the occurrence of xylose with sucrose, normally the dominant free sugar in germ, could decrease aflatoxin level. The presence of xylose increased inhibition by 8-15%. This was significantly less than when xylose was the only sugar present with corn oil: 21% for 0.5% xylose to 92% for 4% xylose.

Plans for 2000: (1) Evaluate kernel compounds previously found to inhibit *A. flavus* growth or aflatoxin production to determine if inhibition is due to the parent compound or to a volatile breakdown product. (2) Evaluate a collection of plant sterols for ability to inhibit *A. flavus* growth or toxin production. (3) In collaboration with D.T. Wicklow, evaluate the ability of selected atoxigenic *A. flavus* strain to inhibit aflatoxin production by selected toxigenic strains under laboratory conditions.

Publications:

Norton, R.A. 1999. Inhibition of aflatoxin B1 biosynthesis in *Aspergillus flavus* by anthocyanidins and related flavonoids. *J. Agric. Food Chem.* 47: 1230-1235.

J., C., Norton, R.A., Wicklow, D.T., and Dowd, P.F. 2000. Isoform patterns of chitinase and beta-1,3-glucanase in maturing corn kernels (*Zea mays* L.) associated with *Aspergillus flavus* milk state infection. *J. Agric. Food Chem.* (In Press).

Moreau, R.A., Singh, V., Eckhoff, S.R., Powell, M.J., Hicks, K.B., and Norton, R.A. 1999. Comparison of yield and composition of oil extracted from corn fiber and corn bran. *Cereal Chem.* 76: 449-451.

Moreau, R.A., Norton, R.A., and Hicks, K.B. 1999. Phytosterols and phytostanols lower cholesterol. *Inform* 10(6): 572-577.

Cui, Y., L. Wang, R.A. Norton, J. Zheng, and D. Guo. 1999. Biotransformation of 24-alpha-methylcholesterol and 24-beta-methylcholesterol by yeast mutant GL7. *J. Asian Natural Products Research* (In Press).

Issue: Control of aflatoxin contamination in corn can be most efficiently approached by utilizing natural plant chemical defenses to either inhibit growth of *Aspergillus flavus* or inhibit production of toxin after infection. The goal of this research is to determine if naturally-occurring compounds in corn kernels can be utilized for control. Levels of inhibitors in a range of corn lines can then be evaluated to determine if enough variability exists in corn lines to select for effective levels of inhibitors.

What's been Done: Previously we have shown that several compounds in kernels are able to significantly decrease aflatoxin production. This year we demonstrated that aflatoxin inhibitors localized in one region can inhibit toxin production when the fungus invades a region lacking inhibitor.

Impact: The use of naturally-occurring compounds such as sugars and carotenoids to decrease the level of aflatoxin production in infected corn should encounter less public resistance than other approaches.

Funding sources:

USDA-Agricultural Research Service base funds

## **NC-213 Progress Report for 1999**

From: USDA, ARS  
Grain Marketing and Production Research Center

By: Donald B. Bechtel

NC-213 Objective: A

Procedure: 1a

Project Objective: Develop fast reliable methods for the identification of quality traits of wheat starches.

Results for 1999: A starch isolation method and digital image analysis system were developed to accurately measure size distributions of the starch populations in wheat. The image analysis system was coupled directly to a light microscope equipped with computer controlled step stage and automatic focus. Automation of data acquisition and processing eliminated some of the labor intensive steps previously required for analyzing starch size distributions. This system was used to standardize starch isolation methods and compare variation and reproducibility of the system. Operational variations were determined and statistically assessed. The number of fields of view required for low standard errors and acceptable speed of analysis was determined to be fifty. A major advantage of the system has been the increased resolution. The use of higher magnifications and stage automation allowed the analysis of starch granules as small as 0.84 m in diameter while analyzing thousands of starch granules per sample.

Plans for 2000: Apply the newly developed starch isolation and image analysis methods to wheat samples. Determine the amount of variation in starch size distributions in wheats differing in end use properties.

### Publications:

Bechtel, D. B., and Wilson, J. D. 2000. Variability in a Starch Isolation Method and Automated Digital Image Analysis System Used for the Study of Starch Size Distributions in Wheat Flour. Cereal Chem. (In press).

Issues: Most predictors of wheat quality are centered on protein quality. About 70% of the starchy endosperm mass is composed of starch, yet little is known about the effect of wheat starch on end use quality.

What's been Done: Scientists have shown that the size of wheat starch granules affect end use qualities of the flour in baking systems. We have developed methods and procedures to analyze wheat starch size distributions by light microscopy and image analysis. These methods will be used to routinely characterize wheat samples for starch size distributions.

Impact: We have previously shown that the size distribution of wheat starch is greatly affected by the environment. Measuring the size distribution of wheat starch could lead to predictive methods of wheat quality when used in conjunction with other quality tests.

## NC-213 Progress Report for 1999

From: Indiana (Purdue University)  
Agricultural & Biological Engineering  
Agronomy

By: Dirk E. Maier  
Jason D. Reising  
Kelly M. Day  
Phil DeVillez  
Ellsworth Christmas

NC-213 Objective: A

Procedure: 1a

Project Objective: To develop and maintain a database of intrinsic quality properties and end use value of corn hybrids and soybean varieties for Indiana.

Results for 1999: Corn and soybean samples were taken in 1998 as part of the yield sampling survey conducted by the Indiana Agricultural Statistics Service, West Lafayette. Samples were analyzed in a NIR whole grain analyzer (Infratech 1229) at the Grain Quality Laboratory, Purdue University. Soybean subsamples had to be combined in order to make the samples large enough for analysis.

For corn, the overall state protein average decreased 1.4 percentage points to 6.5% (GQ-40) from the 1997 value. This was a significant decrease from previous years, which were almost unchanged. The spread between the minimum and maximum protein content narrowed to 6.3 points, compared to 7.4 points in 1997, but it was still larger than the 5.4 point margin in 1996 and 4.0 points in 1995. Generally, protein content is negatively correlated to starch content. While the protein average decreased in 1998, the starch content increased 2.2 percentage points to 64.1. Starch ranges widened to 10.0 points in 1998, compared to 9.6, 6.2, and 4.9 points for 1997, 1996, and 1995, respectively. The average oil content decreased 0.1 percentage points to 3.2. However, average oil content has essentially remained unchanged for the past four years, although seven high oil corn samples were included in the 1998 survey. Density is considered an indication of kernel hardness. There was a slight decrease of 0.003 g/ml to 1.299 g/ml in density when compared to the 1997 data. The range of points in 1998 showed that the spread narrowed for the second straight year.

For soybeans, the 1998 statewide data showed that the average statewide protein content increased by 0.4 percentage points (GQ-41) from the previous year, which was the second increase in a year since 1996. The spread between minimum and maximum protein values decreased from 11.6 percentage points in 1996 and 11.2 points in 1997, to 5.5 points in 1998, which is a 51% drop in variability. Average oil content increased 0.5 percentage points from 1997 to 18.2%, which was 0.9 points higher than the 1996

average. The spread between the range of oil values was 2.7 points, down from 4.3 points in 1996 and 5.4 points in 1997. Average fiber content was 5.3%, up 0.2 points from 1997, but still 0.3 points lower than the 1996 average. The spread between the range of fiber values decreased slightly, from 0.9 points in both 1996 and 1997 to 0.8 points in 1998.

Plans for 2000: (1) Expand the analysis of corn and soybean samples from Indiana private, county and statewide variety test plots. (2) Quantify the Estimated Processed Value (EPV) per bushel for corn and soybean samples. (3) Confirm observed trends over multiple years and maximize the end-use value through better variety selection and improved site-specific farming practices.

Publications:

Maier, D.E., Reising, J., and Gann, R.W. 1999. 1998 Indiana Corn Composition Data. GQ-40. <http://www.agcom.purdue.edu/AgCom/Pubs/GQ/GQ-40.html>

Maier, D.E., Reising, J., and Gann, R.W. 1999. 1998 Indiana Soybean Composition Data. GQ-41. <http://www.agcom.purdue.edu/AgCom/Pubs/GQ/GQ-41.html>

Issues: The value-added chain is driven by end users, who consider a grain or oilseed of higher value if a specific attribute (trait) is produced and delivered with a consistent quality in sufficient quantity. With the availability of near infrared whole grain analyzers at the first point of sale to rapidly quantify desired quality traits, such as composition (protein, oil, starch, fiber), the traditional grade-based marketing system is being converted to one based on traits. During this transition period it is critical for producers and handlers to learn how they can maximize end use value of their crops.

What's been Done: Through input from producers, handlers and processors who are part of our Grain Quality Liaison Committee, the Purdue University Grain Composition Analysis Service was established. The project has actively promoted the adoption of near infrared transmittance scanners (NIRT), analyzed samples from private and public plots to establish a data base of compositional traits, and educated Indiana grain and oilseed producers about the end use value of their crops.

Impacts: The Grain Composition Analysis Service has analyzed over 25,000 corn, soybean, soybean meal and wheat samples free of charge to Indiana producers and handlers since October 1996, including samples from high oil corn contracts paying Indiana farmers over several \$100,000 in premiums. The efforts of the service has also resulted in the establishment of a public database (accessible via the world wide web) of composition values for county corn and soybean variety plots (in collaboration with county extension educators) and statewide variety trials. Over 5,000 Indiana producers, handlers and processors have been made aware of the value of intrinsic traits from Indiana crops during more than 50 extension education meetings and field days during the past 3 years, and through press releases and extension publications. The economic

gain in marketing specific quality traits to Indiana corn and soybean producers is significant. Premiums totaling between \$9-35 million go largely unclaimed annually (assuming 10% of the crop would be marketed based on premiums of 10-40 cents/bu). The Grain Composition Analysis Service received a Blue Ribbon Award as an innovative extension method in the 1999 ASAE Educational Aids Competition.

Funding sources:

Indiana Commissioner of Agriculture's Value Added Grant Program, Consolidated Grain & Barge Company

Contacts:

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URL: <http://www.GrainQuality.org>

## NC-213 Progress Report for 1998

From: The Ohio State University, Ohio Agricultural Research and Development Center, Department of Horticulture and Crop Science

By: Richard C. Pratt  
David M. Jordan  
James E. Beuerlein

NC-213 Objective: A

Procedure: 1a

Project Objective: Determine the effects of genetic traits, climatic factors, agronomic practices, pest populations, machine harvesting, and drying on the quality of cereals and oilseeds.

Results for 1999: One grain sample of each soybean cultivar entered in 1 test in the appropriate maturity region, and 4 samples of each maize hybrid in 1 test within each of 3 regional tests, were analyzed using the Tecator 1225 whole grain near-infrared transmittance analyzer and Compositional Systems *System One* calibrations. Three-Hundred and nineteen corn, and 253 soybean compositional values from the respective state variety performance tests are reported in tables 1-2. The data show highest corn protein levels were again observed in the northwest regional test. While protein and oil concentration were similar to those of last year, starch values showed a nearly a two point increase this year in the southwest and western region trial. Roundup Ready and conventional soybean grain quality characteristics were nearly identical, with the normal beans showing a bit wider range in protein concentration..

Plans for 2000: A database documenting regional and seasonal variations in compositional data in Ohio will be generated.

### Publications:

1999 Ohio Corn and Soybean Performance Trials. Ohio's Country Journal, December 1999. Dept. of Horticulture and Crop Science: Soybean Series 212 and Corn Series 215.

Issue: New market opportunities are being created by the sale of specialty hybrids with value-added traits such as elevated grain protein or oil composition. Objective evaluations are needed so that producers will know the compositional characteristics, as well as the agronomic characteristics, of cultivars. Information is also needed to ascertain trends attributable to season or region of production.

What's been Done: Grain samples of varieties included in soybean and maize performance tests were analyzed and reported. Producers and seedsmen now have an information base from which to evaluate the value of different cultivars for various end-uses.

Impact: Greater awareness of grain compositional traits of varieties has been created. Linkages between producers and end-users of value-added crops have been fostered.

Funding sources:

Ohio Agricultural Research and Development Center, OSU Extension.

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Table 1. Grain Quality of Corn Hybrids in Ohio, 1999.

Region or location	----Number----		----- Protein % --		----- Oil % -----		----- Starch % -	
	hybrids	locat.	mean	range	mean	range	mean	range
Southwestern and West Central	103	3	7.8	6.9 - 9.2	3.9	3.3 - 4.4	63.3	61.6 - 65.0
Northwest	126	3	8.1	7.4 - 9.2	3.9	3.5-4.4	63.2	61.5 - 64.2
Northcentral and Northeastern	90	3	7.6	6.8 - 8.6	3.8	3.4-4.1	63.0	60.5 - 64.9

Compositional data are expressed at 15.0% moisture basis.

Table 2. Grain Quality of Soybean Cultivars in Ohio, 1999.

Entry Type	no. of entries	----- Protein % - ----		----- Oil % ---- ----		----- Seeds/Lb. -- --	
		mean	range	mean	range	mean	range
Roundup Ready	158	37.2	34.8- 38.7	19.3	17.9- 20.7	3129	2550- 3780
Normal	95	36.7	34.2- 39.8	19.5	18.3- 20.6	2959	2040- 3440

Compositional data are expressed at 13.0 % moisture basis.

## NC 213 Progress Report for 1999

From: Iowa State University  
Agronomy  
Agricultural and Biosystems Engineering

By: Charles R. Hurburgh Jr.  
K. E. Zeigler  
B. K. Voss

NC 213 Objective: A

Procedure: 1a

Project Objective: Maintain a database of corn and soybean quality, by hybrid/variety.

Results for 1999: Hybrids for the 1999 Iowa Corn Yield Test and varieties from the 1999 Iowa Soybean Yield Test were analyzed for composition. Data is available from county extension offices and through links off the Iowa Grain Quality Initiative website (<http://www.iowagrains.org>). Corn was average in composition this year; soybeans were very low in protein and average in oil.

Plans for 2000: Continue providing this information. Assess the coverage of entries in the tests relative to varieties actually planted by Iowa producers. Prepare interpretive procedure for soybean processors to use in recommending varieties to quality for premiums.

### Publications:

Zeigler, K. E., W. H. Vinson, and D. E. Carrol. 1999. 1999 Iowa Crop Performance Test – Corn. Publ. Pm-660 – 1, 2, 3, 4, 5, 6, 7-98. Cooperative Extension Service, Iowa State University, Ames, IA 50011.

Voss, B. K., and J. Schlafke. 1999. Iowa Crop Performance Test – Soybeans. Publ. AG-18. Cooperative Extension Service, Iowa State University, Ames, IA 50011.

## NC 213 Progress Report for 1999

From: Iowa State University  
Food Science  
Agronomy

By: L. A. Johnson  
L. M. Pollak

NC 213 Objective: A

Procedure: 1a

Project Objective: Evaluate Latin American corn populations for value added quality traits.

Results for 1999: Forty-nine accessions from the Latin American Maize Project (LAMP), two commercial hybrids (Pioneer 3394 and Pioneer 3487), and two Corn-Belt inbreds (B73, Mo17) were evaluated for their compositional, physical, and wet-milling properties. The LAMP accessions had high grain yields for the Germplasm Enhancement Maize Project (GEM). The GEM selections had lower starch contents (65.9-69.1% versus a mean of 72.2% for two commercial hybrids) and greater protein contents (12.0-14.4% versus a mean of 8.2% for commercial hybrids) than the Corn-Belt material. Absolute densities were consistently higher for the GEM accessions compared to the commercial hybrids (1.320 versus 1.265 g/cc, respectively).

In laboratory wet milling, mean dry basis starch yields were only 54.3% for the GEM accessions versus 64.8% for the commercial hybrids. Residual protein levels in the starches recovered from the GEM accessions were much greater (0.45-2.03% db) than for commercial corn hybrids (< 0.3%). Gluten yields were much greater for the GEM accessions than for the commercial hybrids due to higher starch contents of the gluten fractions. Traits that made them less suitable for wet milling may make them more suitable for other uses, however.

The thermal, pasting, and gelling properties varied widely among starches from the GEM accessions. In general, the values for gelatinization, temperatures and peak height indices for starches recovered from GEM accessions were greater than for typical corn but heats of gelatinization were less. On average, retrogradation properties were similar, although there were specific GEM accessions which possessed modestly different retrogradation enthalpies. Peak viscosities, final viscosities, and viscosity breakdowns were greater for the GEM accessions starches than for the commercial hybrid starches. Pasting temperatures were about the same for all starches recovered from the GEM accessions. Although all differences in starch properties were statistically different, only the high gel strengths of the starches recovered from the GEM accessions were of practical significance.

The two Corn-Belt inbreds were then crossed with 10 GEM accessions selected for unusual starch thermal and pasting properties. Starches were recovered and their functional properties were tested. The thermal properties of starches recovered from the GEM x B73 and GEM x Mo17 crosses were much less variable than those from the GEM accessions. Crossing the GEM accessions with B73 and Mo17 inbreds gave similar starch thermal properties. Mid-parent and high-parent heteroses were greater in the GEM x B73 crosses. All pasting properties increased over the values for either parent. One-day gel strengths were slightly less in the GEM x Corn-Belt inbred crosses than for the GEM accessions but greater than for either Corn-Belt inbred. Seven-day gel strengths were considerably reduced in the GEM x Corn-Belt inbred crosses, but greater than for either Corn-Belt inbred alone. Crossing B73 and Mo17 with GEM accessions resulted in high pasting viscosities but reduced the high gel strengths observed in GEM starches.

Plans for 2000: Publish results. Develop a strategy for directing accessions to optimal end-use. White and Pollak are crossing with proprietary inbreds and are finding greater variation.

Publications:

Four in progress.

## NC 213 Progress Report for 1999

From: Iowa State University  
Agricultural and Biosystems Engineering

By: Charles R. Hurburgh Jr.

NC 213 Objective: A

Procedure: 1a

Project Objective: Maintain a database of corn and soybean intrinsic quality by hybrid/variety and location.

Results for 1999: The United Soybean Board annual soybean quality survey was completed on November 23, 1999. The Iowa State University Grain Quality Laboratory analyzed 1,059 samples from 29 states, as contributed by soybean producers in response to a survey request. This was a response rate of 29%, nearly the same in 1998.

The data is given in the accompanying table. Compared to a 10-year average, protein content was 1.0 percentage point lower, and oil content was nearly equal to the 10-year average level. The typical pattern of increasing protein northwest to southeast was present. All states except those in the southeast region were below their averages in protein. Speculation is that delayed planting and rainfall shortages in August were contributing factors.

Average meal yields are estimated at 41.9 pounds of 48% protein meal per bushel, down 1.5 lbs/bu from 1998. Average oil yields are estimated at 10.9 pounds of oil per bushel, more if as-received moisture is less than 13%. This year protein will be the limiting nutrient, rather than fiber. Processors will have increased millfeed volumes but meal should be lower in fiber than average. Overall, 1999 crush will be a sharp contrast to the record outputs from 1998 soybeans.

In the Western Corn Belt, processors will have difficulty making 48% meal on a consistent basis; some hipromeal will be in the 46.0-47.0% protein range. In a departure from normal, even processors using Illinois soybeans may experience reduced meal yields.

The variability (standard deviation) of both protein and oil was the highest in the 14 years of the survey. This indicates that localized weather conditions probably had a very large impact on production in 1999. This would also indicate that buyers will experience larger than normal lot-to-lot differences in 1999 soybeans. Because the variations tended to be clustered within a state, selective sub-regional buying patterns are expected as users become aware of composition distribution.

Plans for 2000: Continue survey. Compile 2 years of amino acid and fatty acid data.

Publications:

Popular press and [www.iowagrains.org](http://www.iowagrains.org).

UNITED SOYBEAN BOARD 1999 SOYBEAN QUALITY SURVEY DATA						
Region	State	Number of Samples	Protein		Oil	
			Percent Average	Std. dev.	Percent Average	Std. dev.
Western Corn Belt (WCB)	Iowa	209	34.39	1.64	18.41	0.95
	Kansas	24	33.60	1.72	18.33	1.23
	Minnesota	109	33.61	1.55	18.35	0.84
	Missouri	53	34.18	2.08	19.04	1.05
	Nebraska	65	34.59	1.53	18.13	1.01
	North Dakota	8	33.48	1.40	17.78	1.09
	South Dakota	40	32.92	1.59	18.50	0.94
Averages	Western Corn Belt	508	34.06	1.72	18.42	0.99
Ranges	Western Corn Belt		(25.3-40.0)		(15.0 - 23.9)	
Eastern Corn Belt (ECB)	Illinois	180	34.14	1.69	19.01	1.13
	Indiana	88	34.83	1.67	18.81	0.93
	Michigan	34	35.91	1.54	18.39	0.96
	Ohio	78	35.45	2.02	18.53	0.89
	Wisconsin	20	35.14	1.96	18.38	0.94
Averages	Eastern Corn Belt	400	34.75	1.85	18.79	1.05
Ranges	Eastern Corn Belt		(28.3 - 40.3)		(15.9 - 22.4)	
Midsouth (MDS)	Arkansas	38	35.37	1.63	18.90	1.02
	Kentucky	14	35.49	2.27	18.50	1.22
	Louisiana	9	37.13	1.55	19.13	1.46
	Mississippi	22	35.15	2.27	19.03	1.57
	Oklahoma	5	34.24	1.29	18.56	0.91
	Tennessee	17	34.96	1.48	19.02	1.14
	Texas	3	34.17	1.86	19.03	1.15
Averages	Midsouth	108	35.34	1.90	18.90	1.22
Ranges	Midsouth		(30.1 - 40.4)		(15.2 - 21.4)	
Southeast (SE)	Alabama	7	38.13	1.74	18.17	1.31
	Florida	0	—	—	—	—
	Georgia	2	37.15	3.18	18.80	1.27
	North Carolina	8	36.86	0.84	17.81	0.65
	South Carolina	3	36.00	0.82	19.37	0.76
Averages	Southeast	20	37.21	1.55	18.27	1.07
Ranges	Southeast		(34.9 - 40.9)		(16.6 - 20.2)	
East Coast (EC)	Delaware	2	36.15	1.20	19.10	0.99
	Maryland	6	36.37	1.52	18.63	0.31
	New Jersey	5	36.56	1.44	18.66	0.52
	Pennsylvania	6	35.52	2.21	18.65	0.88
	Virginia	4	34.70	1.20	18.83	0.42
Averages	East Coast	23	35.88	1.66	18.72	0.58
Ranges	East Coast		(32.1 - 38.5)		(17.5 - 19.9)	
USA	Averages	1059	34.55	1.88	18.61	1.05
	Ranges		(25.3-40.9)		(15.0-23.9)	
	10-Year Averages		35.55		18.48	

Basis 13% moisture

## NC 213 Progress Report for 1999

From: Iowa State University  
Agricultural and Biosystems Engineering  
Iowa Grain Quality Initiative

By: Charles R. Hurburgh Jr.  
Darren Jarboe

NC 213 Objective: A

Procedure: 1a

Project Objective: Maintain a database of corn and soybean intrinsic quality, by hybrid/variety.

Results for 1999: The 1999 Iowa Gold High-oil Corn test evaluated 12 TopCross™ blends, 5 widely grown checks and 8 grain parents of respective high-oil blends. The high-oil blends yielded 10% and 9% less relative to the grain parents and checks, respectively.

**Table 1. Summary data from the 1999 Iowa Gold Corn Tests**

Statistic	High Oil Blends (n=12)	Grain Parents (n=8)	Widely-grown Checks (n=5)
Yield avg. (bu/a)	155.2	171.9	169.7
Yield range	145-163	159-186	159-180
Oil content avg. (% db)	7.5	4.6	4.7
Oil range	6.8-8.4	4.4-5.0	4.4-4.9
LSD, yield (bu/a)	12.6	12.6	12.6
LSD, oil (% pts)	0.4		

LSD – Least significant difference (P=0.05), 4 reps/entry

Plans for 2000: Continue the Iowa Gold Test.

Publications:

Iowa Gold High-Oil Corn Test. Iowa Farmer Today, December 20, 1999. And PM 1782.  
Iowa State University, University Extension. Website: [www.iowagrains.org](http://www.iowagrains.org).

## NC-213 Progress Report for 1999

From: Ohio State University, OARDC  
Horticulture and Crop Science

By: Peter R. Thomison  
Allen B. Geyer

NC-213 Objective: A

Procedure: 1a

Project Objective: To evaluate the agronomic performance and select grain quality attributes of high oil TC Blends adapted to Ohio growing conditions and commercially available to corn growers.

Results for 1999: High oil corn TC Blend tests were performed at two Ohio locations in 1999 - the OSU OARDC Western Branch Research Farm near South Charleston in southwest Ohio and the OSU OARDC Northwest Branch Research Farm near Hoytville in northwest Ohio. Sixteen high oil TC Blends representing eight seed companies were planted at each site. The normal grain parents of three of the TC Blend entries were included in the trials as checks. Grain yields of TC Blends ranged from 139 to 159 Bu/A at Hoytville and 128 to 159 Bu/A at S. Charleston. TC Blend yields averaged about 6% (9 Bu/A) less and about 3% more (4 Bu/A) than yields of the checks at Hoytville and S. Charleston, respectively. At Hoytville, half of the TC Blend entries produced yields that were not significantly different from the top yielding check hybrid; only three TC Blends yielded less than the lowest yielding check hybrid. At S. Charleston, six TC Blends significantly out yielded two of the check hybrids. Only one of the checks produced yields that were not significantly different from the top yielding six TC Blends. All 16 TC Blends produced yields greater than or comparable to the lowest yielding check hybrid.

TopCross grain produced by the TC Blends was characterized by higher oil content than grain of normal corn hybrids (7.3% vs. 3.6% at Hoytville; 7.3% vs. 3.9% at S. Charleston). There were significant differences in grain oil content among the 16 TC Blends at each location with oil levels ranging from 6.6% to 8.4% at Hoytville and 6.6% to 8.2% at S. Charleston. The TC Blends with the highest and lowest grain oil content were the same at Hoytville and S. Charleston. Estimates of metabolizable energy for nonruminants were consistently greater in TopCross high oil grain than in grain of normal hybrids. Grain protein levels of TopCross and normal grain were comparable at Hoytville but protein levels averaged 1.5 percentage points higher in grain of normal corn than in TopCross grain at S. Charleston. Estimates of lysine content were higher in TopCross grain than in grain of normal corn hybrids at both locations, whereas starch levels were lower in TopCross grain compared to grain of normal corn.

Plans for 2000: Conduct additional evaluations to provide multi-year data that will help define consistency of yield and composition across a range of production environments.

Publications:

Thomison, P.R. and A.B.Geyer. 1999. 1999 High Oil Corn TC-Blend Performance Tests.  
OSU Extension Fact Sheet AGF136-99  
(<http://www.ag.ohio-state.edu/~hocorn/af13699.htm>)

High Oil Corn (HOC) Production & Marketing Guide Web Site at  
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## NC-213 Progress Report for 1999

From: USDA, ARS  
National Center for Agricultural Utilization Research

By: D. T. Wicklow  
H. W. Gardner

NC-213 Objective: A

Procedure: 1a; 1b

Project Objective: Improve corn resistance to *Aspergillus flavus* and aflatoxin.

Results for 1999: (1) Seed Coat Tearing and Aflatoxin Susceptibility - A set of 43 commercial corn hybrids and 34 inbreds was grown near Monmouth, IL, in 1998 & 1999, and hand-pollinated ears were wound-inoculated with *A. flavus*. Kernels in grids surrounding (but not including) the wound-sites were collected and these kernel samples separated into BGYF and non-BGYF portions of each sample. The data has been evaluated for the 1998 planting. Generally, most of the aflatoxin in the total grid sample came from the BGYF kernels as expected. Removing the BGYF kernels from the sample substantially reduced the aflatoxin level for many hybrids of different genetic backgrounds. While only 12 of the 43 hybrids tested had aflatoxin less than 20 ng/g when the BGYF kernels were included in the sample, 28 of 43 hybrids had aflatoxin less than 20 ng/g in the portion of the sample without BGYF kernels. The number of BGYF kernels/grid for the different hybrids ranged from 0.015 to 2.03, suggesting that there is genetic variability for susceptibility to invasion of the germ by *A. flavus*. Estimates of the average effect of each inbred when used in hybrids were calculated by an unbalanced ANOVA, and also suggest that some inbreds have the effect of reduced BGYF kernels in their hybrids. Correlation between the number of BGYF kernels observed vs. the aflatoxin levels was poor for both hybrids and for the estimated effects of inbreds. While reducing the number of BGYF kernels may be an effective strategy for improving aflatoxin resistance in some genetic backgrounds, it seems that it may not be effective for others. 1999 results will be used to confirm the relative differences in the frequency of BGYF kernels between different hybrids and that these differences can be related to the use of certain inbreds (with L.C. Marshall, Holden's Seeds-Monsanto); (2) Classification and Segregation of BGYF kernels - NIR spectra were acquired for 200 intact BGYF corn kernels and 300 other kernels, randomly selected as unknowns, from grain sampled at harvest from ears of Pioneer 3394 that we wound-inoculated with *A. flavus*. The individual kernels are presently being evaluated for aflatoxin content (ng/g). The research is an effort to develop a calibration to separate the highly aflatoxin contaminated BGYF kernel fraction from non-BGYF kernels. (with T. Pearson, ARS, WRRRC, Albany, CA; F. Dowell, ARS, USGMRL, Manhattan, KS); (3) Plant Lipoxigenase and Psi Factors - Soybean may be resistant to *Aspergillus* infection because of the potent lipoxigenase pathway enzymes present in the seed that inhibit spore germination. One of the lipoxigenase products, the 13-hydroperoxide of linoleic

acid, inhibited aflatoxin gene expression in *Aspergillus parasiticus*. The development of conidiophores and sclerotia in *Aspergillus flavus* is affected by linoleic acid and linoleic acid seed-derivatives hydroperoxylinoleic acids (9S-HPODE and 13S-HPODE) which may mimick sporulation signals known as "psi factors." Psi factors produced by *Aspergillus* are 8-hydroxy- and 5,8-dihydroxy-linoleic acid. Unravelling this host-pathogen signal interaction may be key to understanding why corn is so susceptible to fungal infection (with N.P. Keller, Texas A&M University).

Plans for 2000: (1) We plan to study the differences in BGYF kernel frequency in the progeny of breeding populations made by crossing lines that are relatively high (poor) for BGYF kernels with lines that are low (good), to see whether good lines can be recovered, and whether these "good" lines tend to result in reduced aflatoxin levels from hybrids made with these lines (with L.C. Marshall, Holden's Seeds-Monsanto); (2) Complete aflatoxin analyses of individual kernels and evaluate the data to determine the feasibility of building spectral features of classification into computer models for automatic detection and segregation of aflatoxin contaminated kernels. (with T. Pearson, ARS, WRRRC, Albany, CA; F. Dowell, ARS, USGMRL, Manhattan, KS); (3) Continue isolations of different linoleic acid-derived sporulation pheromones' called psi factors and test them for their ability to inhibit sporulation and aflatoxin production in *Aspergillus*. Purify the enzymes (oxygenases) involved in the production of these psi factors (with N.P. Keller, Texas A&M University).

Publications:

Calvo, A.M., Hinze, L.L., Gardner, H.W., and Keller, N.P. 1999. Sporogenic effect of polyunsaturated fatty acids on development of *Aspergillus* spp. *Appl. Environ. Microbiol.* 65: 3668-3673.

Gardner, H.W. 1998. 9-Hydroxy-traumatol, a new metabolite of the lipoxygenase pathway. *Lipids* 33: 745-749.

Gardner, H.W. 1999. Biosynthesis of hydroxyalkenals by plants. *Recent Res. Develop Lipid Res.* 3:15-21.

Gardner, H.W., Grove, M.J., and Keller, N.P. 1998. Soybean lipoxygenase is active on nonaqueous media at low moisture: A constraint to xerophilic fungi and aflatoxins? *J. Am. Oil Chem. Soc.* 75: 1801-1808.

Gardner, H.W. and Hou, C.T. 1999. All (S) stereoconfiguration of 7,10-dihydroxy-8(E)-octadecenoic acid by *Pseudomonas aereuina*. *J. Am. Oil Chem. Soc.* 76: 1151-1156

Gray, L.D., Gardner, H.W., Weisleder, D., and Leib, M. 1999. Production and toxicity of 2,3-dihydro-5-hydroxy-2-methyl-4H-1-benzopyran-4-one by *Phialophora gregata*. *Phytochemistry* 50:1337-1340.

Hou, C.T., Gardner, H.W., and Brown, W. 1998. Production of polyhydroxy fatty acids from linoleic acid by *Clavibacter* sp. ALA2. *J. Am. Oil Chem. Soc.* 75:1483-1487.

Issue: In the Midwestern corn belt, the bulk of the U.S. corn crop is at risk during sporadic outbreaks of aflatoxin contamination of preharvest corn (*Zea mays* L.). Aflatoxin is a metabolite produced by the fungus *Aspergillus flavus*. The overall goal of this research program is to attempt to control *A. flavus* infection of pre-harvest corn through an integrated approach to disease management. Procedure 1a evaluates corn genotypes for resistance to kernel infection and aflatoxin; Procedure 1b investigates the potential role of soybean lipoxygenase products in suppressing aflatoxin production in transgenic corn.

What's been Done: Demonstrated that removal of BGYF kernels from the grain sample substantially reduced the aflatoxin level for many hybrids of different genetic backgrounds and produced evidence suggesting that some inbreds have the effect of reduced BGYF kernels in their hybrids.

Impact: Selecting for reduction in the frequency of BGYF kernels in conventional maize breeding programs may result in lines with reduced susceptibility to seed coat tearing and thus provide protection against *A. flavus* and possibly other kernel molds. Using the frequency of BGYF as a selection tool may be less expensive and more convenient than using actual aflatoxin levels. Lipoxygenases and their products could be important in controlling fungal sporulation and aflatoxin contamination of susceptible plants like peanuts and corn.

Funding sources:

USDA-Agricultural Research Service base funds.

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## NC 213 Progress Report for 1999

From: Iowa State University  
Agronomy  
Agricultural and Biosystems Engineering

By: Mark E. Westgate  
W. D. Batchelor  
Charles R. Hurburgh Jr.

NC 213 Objective: A

Procedure: 1b

Project Objective: Identify environmental impacts on soybean composition.

Results for 1999: Previous research and unpublished data on environmental interactions with soybean quality were reviewed. Table 1 summarizes results for seed size, protein and oil.

Relationships among quality factors and yield were also reviewed with the following major conclusions.

- The primary factors influencing composition appear to be environment and genetics.
- Genetic rankings are relatively consistent across years.
- In commercial production, relationships between yield and composition are inconsistent.
- Essential amino acid levels are somewhat correlated with protein, but do not change as rapidly with changes in protein.
- A variety selection strategy based on above-average yield and above-average composition identifies about 20% of present varieties as high value.

Table 1. Seed component response to temperature increases and drought severity during seed filling (Summary of research reports)

Seed Characteristic	Temperature	Drought	
		Early	Terminal
Seed Weight	-	+	-
% Protein	+ 0 -	-	+
% Oil	+ -	+	-

+ Increase  
 0 No change  
 - Decrease

Plans for 2000: Expand review to include trace subunits. Test existing and proposed mathematical models with on-site data.

Publications:

Westgate, Mark E., E. Piper, W. B. Batchelor and C. R. Hurburgh, Jr. 1999. Effects of cultural and environmental conditions during soybean growth on nutritive value of soy products. Proc. Soy/Swine Symposium, World Soybean Research Conference, United Soybean Board, St. Louis, MO.

## NC-213 Progress Report for 1999

From: Kansas State University  
Department Grain Science and Industry

By: Tim Herrman

NC-213 Objective: A

Procedure: 2

Project Objective: Assess the capability of Kansas country grain elevators to segregate hard winter wheat.

Develop a preharvest quality prediction system for Kansas hard winter wheat.

Results for 1999: Characterization of 4 country grain elevators was performed during 1999 as part of the project designed to facilitate the adoption of hard white (HDWH) wheat. Two elevators were able to provide complete ticket summary data and identify one-hour breaks between scale tickets. These data were used to assess the percent utilization of the receiving system. Additionally, stopwatch time study data were collected and included in a simulation model developed. Simulations were run and costs assessed for delay time associated with segregating HDWH.

Using a spreadsheet record of all country grain elevators in Kansas (Kansas Grain and Feed Directory), likely sites for the adoption of HDWH was created. The scheme included consideration of cropping patterns that were conducive to the introduction of HDWH wheat. This plan of adoption was approved by representative from the Kansas grain industry.

Work on developing a pre-harvest wheat quality prediction system included model development using data from varietal performance plots.

Plans for 2000: Using KS Ag. Statistic samples, I will develop protein prediction models for KS.

### Publications:

Baker, S., Herrman, T.J., and T. Loughin. 1999. Segregating hard red winter wheat into dough factor groups using single kernel measurements and whole grain protein analysis. *Cereal Chem.*76(6):884-889.

Baker, S., Herrman, T.J., and T. Loughin. 1999. Use of regression and discriminant analyses to develop a quality classification system for hard red winter wheat. *Cereal Chem.* 76(6):890-893.

Herrman, T.J., M. Boland, and A. Heishman. 1999. Economic feasibility of wheat segregation at country elevators. The Second Annual National Wheat Industry Research Forum pp 13-16.

Herrman, T.J. 1999. Identity preservation: operational aspects of a value-enhanced marketing strategy. GEAPS 70th Annual International Technical Conference and Exposition pp. 59-70. March 6-9, 1999 Tampa, FL.

Issues: Maximize the value of HDWH wheat.

Avoid mixing of different wheat classes (HDWH and HRW) during the commercial introduction of HDWH in western Kansas.

Develop tools by which the Kansas grain industry (producers, handlers, merchandisers, and processors) can capture value associated with superior quality wheat.

Impact: One company that has adapted/adopted study results has begun segregating wheat. During 2000, they intend to segregate 14 million bushels of HRW wheat.

## NC-213 Progress Report for 1999

From: USDA, ARS  
National Center for Agricultural Utilization Research

By: D. T. Wicklow  
C. E. McAlpin

NC-213 Objective: A

Procedure: 2a

Project Objective: Investigate the microbial ecology and epidemiology of *Aspergillus flavus* in Midwestern crop field soils and the biocontrol potential of sclerotial mycoparasites.

Results for 1999: (1) Toxin-producing ability of *Aspergillus flavus* Genotypes - DNA fingerprinting was performed on a population of *A. flavus* isolates from a crop field in southern Georgia for which B.W. Horn (ARS, NPRL, Dawson, GA) has determined their vegetative compatibility group (VCG). Our DNA probe pAF28 (McAlpin & Mannarelli, 1995) successfully matched all but two of the *A. flavus* strains belonging to a similar VCG; (2) Intraspecific competition - Within the central corn belt only @ 40% of the *A. flavus* strains isolated from field soil produce aflatoxin, and our research seeks to determine if the severity of aflatoxin outbreaks in such fields are dampened' as a natural outcome of intraspecific competition. Corn ears were wound-inoculated with a mixed conidial suspension of *A. flavus* strains representing both aflatoxin-producers and non-aflatoxin producing strains according to the DeWit replacement series. A significant reduction in aflatoxin was recorded when the non-aflatoxin producer represented 80% of the total inoculum but not at lower relative densities (i.e. 20%, 40% or 60%); (3) Mycoparasites as Sources Antifungal Antibiotics, etc. - Mycoparasites that kill *A. flavus* sclerotia that we buried in corn fields are being examined as a source of novel biologically active chemicals of particular interest to the fields of agriculture and medicine. Bioassays using *A. flavus* and *Fusarium moniliforme* as test organisms have guided our discovery of novel antifungal metabolites. Some of these extracts have also shown activity against fall armyworm larvae (with J.B. Gloer University of Iowa & P.F. Dowd, NCAUR).

Plans for 2000: (1) Contrast intraspecific competitive abilities for the more common vs. less frequently recorded *A. flavus* genotypes isolated from Midwestern crop fields; (2) Continue bioassay guided isolation of novel antifungal metabolites with activity against *A. flavus* and/or *Fusarium moniliforme*.

Publications:

Bartelt, R.J. and Wicklow, D.T. 1999. Volatiles from *Fusarium verticillioides* (Sacc.) Nirenb. and their attractiveness to nitidulid beetles. *J. Food Agric. Chem.* 47: 2447-2454.

Dorner, J.W., Cole, R.J. and Wicklow, D.T. 1999. Aflatoxin reduction in corn through field application of competitive fungi. *J. Food Protection* 62: 650-656.

Joshi, B.K., Gloer, J.B., and Wicklow, D.T. 1999. New verticillin and glisoprenin analogs from cultures of the sclerotial mycoparasite *Gliocladium catenulatum*. *J. Nat. Products* 62: 730-733.

Joshi, B.K., Gloer, J.B., Wicklow, D.T., and Dowd, P.F. 1999. Sclerotigenin: A new antiinsectan benzodiazepine from the sclerotia of *Penicillium sclerotigenum*. *J. Nat. Products* 62: 650-652.

Soman, A.G., Gloer, J.B., and Wicklow, D.T. 1999. Antifungal and antibacterial metabolites from the sclerotium-colonizing isolate of *Mortierella vinacea*. *J. Nat. Products* 62: 386-388.

Wicklow, D.T. 1999. Influence of *Aspergillus flavus* strains on aflatoxin and bright greenish yellow fluorescence of corn kernels. *Plant Dis.* 83: 1146-1148.

Issue: In the Midwestern corn belt, the bulk of the U.S. corn crop is at risk during sporadic outbreaks of aflatoxin contamination of preharvest corn (*Zea mays* L.). Aflatoxin is a metabolite produced by the fungus *A. flavus*. The overall goal of this research program is to attempt to control *A. flavus* infection of pre-harvest corn through an integrated approach to disease management. In Procedure 2a we examine the origins of fungal infective inoculum in corn fields and management practices to prevent a population build-up leading to mycotoxin contamination.

What's been Done: (1) DNA fingerprinting of an *A. flavus* population from Georgia crop field provides the strongest evidence to date of our pAF28 DNA probe's ability to identify *A. flavus* strains belonging to the same VCG; (2) Demonstrated that to produce a significant reduction in aflatoxin in wound-inoculated pre-harvest corn, conidial inoculum from non-aflatoxin producing strains of *A. flavus* must outnumber conidia from a toxigenic strain by a ratio of @ 4:1; (3) ARS and University of Iowa scientists have discovered numerous novel metabolites produced by mycoparasites of *A. flavus* sclerotia.

Impact: (1) The ability to characterize and monitor genetically identical strains within *A. flavus* populations will better enable one to determine how the fungus is spread and which of the subpopulations are associated with aflatoxin-contaminated seeds at harvest; (2) The potential use of non-aflatoxin producing biocompetitive' strains of *A. flavus* to control aflatoxin in pre-harvest corn may require unrealistic levels of inoculum; (3) We continue to distribute fungal extracts for company testing in the area of animal health products. Our research was featured in the Journal Highlights section of ASM News (1999).

Funding sources:

USDA-Agricultural Research Service base funds; National Science Foundation; Biotechnology Research and Development Corporation, Peoria, IL

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## NC-213 Progress Report for 1999

From: USDA, ARS  
ERU, GMPRC, Manhattan, Kansas

By: C. S. Chang  
J. L. Steele

NC-213 Objective: B

Procedure: 1a

Project Objective: Develop and evaluate automatic grain aeration control strategies.

Sub-Title: Develop a programmable aeration control system and evaluate aeration control strategies.

Results for 1999: Data collection continued through May 1999 on the aeration control strategy under test in 1998. The data will be used to evaluate the control strategy and validate long term grain bin temperature and moisture simulations. Analysis of the data has not been completed.

Plans for 2000: Analyze and report performances of selected grain aeration strategies. Consider the applicability of an aeration control system which maintains the moisture content of stored wheat at higher levels but within the safe storage moisture - temperature guidelines.

Issues: Grain aeration management. Grain aeration is frequently used to cool new harvest wheat during months where the atmospheric potential for cooling is marginal. Optimization strategies are needed to manage fan operation time during favorable periods until the cooling front has moved through the grain mass. Improved, automatic, optimum and energy efficient management strategies are needed.

What's been Done: Optimum aeration management strategies were determined with grain temperature simulations and based on fan operation times and historical weather data. Full scale testing of selected strategies is underway at the ARS grain storage facilities.

Impact: The potential to reduce energy consumed for grain cooling is estimated at 25-50 percent. Major impact is assurance of grain cooling and prevention of grain quality losses through deterioration and insect infestations. Other impacts relate to proper use of aeration rather than no aeration or improper management of aeration.

## NC-213 Progress Report for 1999

From: University of Minnesota  
Biosystems & Ag. Engineering  
Plant Pathology

By: William F. Wilcke  
Klein Ileleji  
R. Vance Morey  
Deborah J. Hansen  
Richard A. Meronuck

NC-213 Objective: B

Procedure: 1a

Project Objective: 1. Verify or improve predictions for effect of changing temperature and moisture on the storability of shelled corn. 2. Re-examine the effects of different sample storage methods on results of grain storability tests. 3. Develop strategies for using aeration during humid weather to recondition overdry soybeans in storage. 4. Evaluate storability of varieties such as Bt corn or high-oil corn compared to storability of conventional varieties.

Results for 1999: 1. In storage tests where corn temperature or corn moisture was changed part way through the storage period, we found that mathematical models that researchers have been using to predict the effect of temperature or moisture changes on allowable storage time gave results that were reasonably close to the measured values. 2. Storability tests on wet corn samples that were tested immediately after harvest gave results that were very similar to results for samples that were stored at harvest moisture in a freezer and to those that were dried, stored in a freezer, and then rewet to harvest moisture. Results were similar for samples that were stored for 0, 4, 8, and 22 months after harvest. 3. Computer simulations of soybean rewetting using 30 years of upper Midwest weather data indicated that it should be possible and cost effective to bring the moisture content of overdry soybeans back to market moisture by aerating beans during humid weather. It would be important, however, to either stir the beans or to remove layers of reconditioned beans during the reconditioning process to avoid bin damage and to avoid rewetting beans to levels that are too high for safe storage. 4. Samples of several Bt and several high-oil corn varieties were collected during fall 1999 harvest for preliminary storability tests to be conducted during 2000. More tests will be conducted if funding can be secured to support this work. No results are available at this time.

Plans for 2000: We plan to conduct preliminary storability tests on high-oil and Bt corn varieties and to seek funding for expanded work with these and other value-enhanced varieties.

Publications:

Wilcke, W.F., H.F. Ng, R.A. Meronuck, P. Gupta, and J.P. Lang. 1999.

Storability of wheat infected with Fusarium head blight. Transactions of the ASAE 42(3): 733-742.

Gupta, P., W.F. Wilcke, R.V. Morey, and R.A. Meronuck. 1999. Effect of dry matter loss on corn quality. Applied Engineering in Agriculture 15(5): 501-507.

Wilcke, W.F., R.V. Morey, D.J. Hansen, and R.A. Meronuck. 1999. Aeration strategies for reconditioning dry soybeans. ASAE Paper No. 996046. Presented at Annual ASAE Meeting, Toronto, Canada, July 18-21. St. Joseph, MI: ASAE.

Issues: 1. Although research and extension personnel have long been using mathematical procedures to adjust allowable storage time predictions when corn temperature and/or moisture change during the storage period, no tests had actually been conducted to verify the predictions. This study was conducted to either verify that the mathematical models give acceptable results or if necessary, to develop improvements for the models. 2. Grain storability tests indirectly measure the growth of storage fungi on wet grain. Since fungi grow rapidly on wet, freshly harvested grain, storability tests must either be conducted right at harvest time, or samples must be dried or frozen to temporarily arrest growth of the storage fungi. Questions are frequently raised as to whether results of storability tests are the same for samples that have been frozen, or dried and rewet, compared to the results that would have been obtained for samples tested immediately after harvest. This study was conducted to answer these lingering questions about sample storage. 3. Many years in the upper Midwest, dry weather leads to harvest of soybeans at moisture contents well below 13% wet basis - the moisture content used for normal marketing and handling. Reconditioning soybeans to moisture levels closer to 13% would greatly improve their value. Adding liquid water to crops at elevators and on-farms is illegal, but aerating crops during humid conditions is acceptable. This study was conducted to identify fan operation and soybean management strategies that would result in cost effective reconditioning of soybeans without causing bin damage or excessive rewetting. 4. There is some concern that high-oil corn does not store as well as corn varieties that contain normal amounts of corn and there is some speculation that Bt corn might have different storage characteristics than conventional corn. Extension personnel, stored grain managers, and crop breeders need more information about the storage characteristics of these newer corn varieties.

What's been Done: 1. We measured carbon dioxide produced by fungi growing on stored corn to compare predicted deterioration rates to measured deterioration rates for corn samples exposed to changing temperature and moisture conditions. 2. We used carbon dioxide production by fungi growing on stored corn and fungal colony counts to compare deterioration rates and level of fungal infection for corn samples that were tested at harvest with samples that were tested after 4, 8, and 22 months of storage in a freezer at harvest moisture, and with samples that were dried, stored in a freezer, and then rewet to harvest moisture. 3. We modified a natural-air corn drying simulation model to simulate soybean rewetting and then used 30 years of upper Midwest weather data to determine energy use and layer by layer moisture content in aerated storage bins. We simulated different airflow rates, use of different fan controls, and different soybean management strategies. 4. We collected Bt and high-oil corn samples for use in storage tests to be conducted in 2000.

Impact: 1. Our finding that the currently used mathematical models do a reasonably good job of predicting deterioration rates of corn exposed to changing temperatures or moistures gives us greater confidence in current drying and storage recommendations, which were developed using these models. 2. Our finding that storage test results for corn samples that were tested after many months in storage were very similar to results for freshly harvested samples gives us confidence that current sample storage techniques used by grain storage researchers are acceptable. 3. Our simulation results produced a set of soybean and fan management strategies that should result in safe, cost-effective reconditioning of overdry soybeans to market moisture. Farmers and other stored soybean managers should be able to use this information to reduce economic losses associated with overdry soybeans. 4. No results are available at this time, but future results are expected to indicate whether Bt corn and high-oil corn need to be managed differently from conventional corn varieties to prevent losses in storage.

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: C. S. Chang  
J. L. Steele

NC-213 Objective: B

Procedure: 1a

Project Objective: Develop a programmable aeration control system and evaluate aeration control strategies.

Sub-Title: Develop and evaluate automatic grain aeration control strategies.

Results for 1999: Data collection continued through May 1999 on the aeration control strategy under test in 1998. The data will be used to evaluate the control strategy and validate long term grain bin temperature and moisture simulations. Analysis of the data has not been completed.

Plans for 2000: Analyze and report performances of selected grain aeration strategies. Consider the applicability of an aeration control system which maintains the moisture content of stored wheat at higher levels but within the safe storage moisture - temperature guidelines.

Issues: Grain aeration management. Grain aeration is frequently used to cool new harvest wheat during months where the atmospheric potential for cooling is marginal. Optimization strategies are needed to manage fan operation time during favorable periods until the cooling front has moved through the grain mass. Improved, automatic, optimum and energy efficient management strategies are needed.

What's been Done: Optimum aeration management strategies were determined with grain temperature simulations and based on fan operation times and historical weather data. Full scale testing of selected strategies is underway at the ARS grain storage facilities.

Impact: The potential to reduce energy consumed for grain cooling is estimated at 25-50 percent. Major impact is assurance of grain cooling and prevention of grain quality losses through deterioration and insect infestations. Other impacts relate to proper use of aeration rather than no aeration or improper management of aeration.

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: C. S. Chang  
R. T. Noyes  
J. L. Steele

NC-213 Objective: B

Procedure: 1a

Project Objective: Reduce dust emission during transfer of grain into grain elevator dump pits.

Sub-Title: Develop improved grain elevator dump pit baffles for dust emission control.

Results for 1999: The functionality and dust control performance of a proposed mechanical baffle for truck dump pits was confirmed. Four of 24 modules of a proposed mechanical 'Z' baffle system were designed, fabricated, installed and observed for installation fit and effectiveness of operation with grain flow in a full scale prototype test. The installation and testing of these four modules revealed several design deficiencies, but the observations on expected dust control effectiveness confirmed the projected performance potential. Dump pit structural assembly and grain flow characteristics were observed during three days of prototype module testing. A video of the sub-assemblies mounted to the truck grate support beams was useful in analyzing important modifications which need to be made during assembly and how some on-the-spot revisions of brackets worked. Also, the video of about 150 bushels of corn dumped through the baffles revealed sound levels higher than anticipated. Current pivot baffle designs will be changed to heavier metal to deaden the sound through the added mass. Additional wear plates will be added to the fixed inclined baffle component to increase mass and wear life in the primary dumping area. A cooperating country elevator in Oklahoma has been identified and selected for the Phase IV and V tests.

Plans for 2000: Project ends, September 30, 2000. Complete the research outlined in Phases III, IV and V by finalizing and testing the modular assembly of the prototype 'Z' baffle at GMPRC, comparing the results with Phase I and Phase II tests, field testing the modular assembly in an Oklahoma grain elevator, developing a small negative air handling system that is suitable for this baffle design and most country elevators, and prepare drawings of the assemblies for preparation of the Final Report..

Issues: Effective economical methods for control of grain dump pit dust emissions are not available. Methods for compliance with OSHA and EPA standards are required.

What's been Done: A new mechanical concept, "Z" baffle, for grain dump pit dust control has been designed. Preliminary testing of an existing dump with and without conventional pit baffles has been completed. Fabrication and preliminary testing of the "Z" baffle module was completed. Presentations at GEAPS and other elevator meeting forums were made. The preliminary baffle design was provided to a major U.S. truck scale manufacturer for potential use in dust control in dump-through truck scales. The design was outlined and provided to an inland terminal grain company for use in meeting state department of environmental quality dust emission opacity limits on multiple truck dump pits.

Impact: Preliminary data were provided to government regulatory agencies for support and evidence of grain dump dust emission levels and were used in setting the current emission standards. The "Z" baffle concept is projected to be an adequate, effective and economical method for dump pit dust emission control. If so, grain handlers will not spend thousands of dollars to install expensive and ineffective alternatives.

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: C. Bern  
J. L. Steele  
W. Wilcke

NC-213 Objective: B

Procedure: 1a

Sub-Title: Confirmation of Carbon Dioxide Production from Shelled Corn Exposed to Changing Conditions

Project Objective: Determine the carbon dioxide production of field-shelled corn under controlled step-change temperature and moisture conditions with exposure time. Compare the carbon dioxide production measurements on shelled corn using the University of Minnesota and the Iowa State University procedures. Validate or determine the failure of customary mathematical translations of existing constant condition carbon dioxide data to correctly predict the results obtained in the step-change temperature and moisture condition tests.

Results for 1999: In tests conducted at ISU during 1999, carbon dioxide production was determined for corn at 18, 22 and 26% moisture under the following temperature conditions: constant 15, 20 and 25C; the first half of the storage period at 15C and the second half at 25C; and the first half of the storage period at 25C and the second half at 15C. UMN researchers performed similar tests on samples from the same lot of corn in 1998. UMN researchers did not conduct any additional temperature change tests in 1999, but have prepared their 1998 work for publication in a refereed journal. ISU researchers compared their experimental results to those predicted using recommended procedures for changing temperature conditions and to those obtained by UMN researchers. The general shapes of the experimental dry matter loss vs. storage time curves and the measured storage times to 0.5% dry matter loss were similar to those predicted using mathematical equations and to those determined by the UMN researchers. The best agreement was found at 22 and 26% moisture. Based on these results, current methods for allowable storage time predictions for shelled corn held under changing temperature conditions are probably adequate. The greatest deviation between predicted and measured deterioration rates occurred at low levels of dry matter loss.

Plans for 2000: Extend the project six months to complete data analysis and report preparations.

Publications:

Zagrebenyev, D.A., Bern, C.J. and Bailey, T.B. 1999. Effects of temperature changes on deterioration of high-moisture shelled corn. ASAE Paper No. 99\_6158. Presented at the 1999 ASAE Annual International Meeting, July 18-21, Toronto, Ontario, Canada.

Issues: Grain deteriorates during artificial drying and storage at fast or slow rates depending on the temperature and moisture content of the grain. The procedures for predicting allowable storage times of shelled corn were based on measurements taken at constant grain temperature and moisture conditions. The current procedures for predicting allowable storage times under changing temperature and moisture conditions have never been validated with specific tests.

What's been Done: Equipment and tests have been completed to validate allowable storage time predictions for changing temperature conditions using two different carbon dioxide measurement methods and sites, University of Minnesota and Iowa State University facilities. UMN results validate that the current data and procedure for predicting allowable storage times for shelled corn are probably adequate. ISU tests were completed in 1999. UMN researchers have complete a draft manuscript and the ISU researchers prepared and presented an ASAE paper.

Impact: Grain drying and storage engineers can continue to use the current data and procedures with confidence. Extension engineers can continue to base drying, storage and aeration recommendations with confidence in the current data and procedures. The current procedures were adopted by the ASAE as a design and data standard.

## NC-213 Progress Report for 1999

From: Indiana (Purdue University)  
Botany & Plant Pathology  
Entomology  
Agricultural & Biological Engineering

By: Charles P. Woloshuk  
Linda J. Mason  
Dirk E. Maier

NC-213 Objective: B

Procedure: 1b

Project Objective: To determine the fungicidal and mortality effect of ozone in an integrated pest management system to prevent molds, mycotoxins and insects in stored products.

Results for 1999: The success of ozone fumigation in a field test to determine efficacy against stored-products pests in 350 bu of corn utilizing 3 of the 16 pilot bins of the Purdue University Education & Research Center led to the investigation of movement characteristics of ozone in tall laboratory barrels. The challenge of ozone fumigation is to produce enough ozone to successfully penetrate a grain mass as deep and quickly as possible. We determined an optimum fumigation velocity through shelled corn, which is attainable with current aeration equipment. Subsequent fumigation of pre-ozonated dry corn should be done at the same velocity, but concentrations in the grain mass will establish more rapidly due to Phase 2 fumigation characteristics.

Plans for 2000: (1) To establish optimal and realistic airflow rates with respect to penetration through various grains in order to develop a large scale ozone generator. (2) To conduct scale-up experiments to quantify the relationship between ozone half-life and mold inhibition and insect mortality further.

### Publications:

Kells, S.K., Mason, L.J., Woloshuk, C.P., and Maier, D.E. 1999. Scale-up considerations for field scale application of ozone as a fumigant against insects and mold in yellow food corn. Paper No. 99-6047. ASAE, St. Joseph, MI.

Issues: Protection of stored grains and oilseeds has in the past heavily relied on fumigants and residual chemicals. In many cases, insects have become resistant, products have been banned due to environmental or health concerns, and consumers have become more apprehensive. Research has to focus on alternative stored product pest control technologies that can be incorporated into an overall IPM strategy to maximize grain quality.

What's been Done: Preliminary ozonation experiments investigated the effect of ozone on mold spores and insects in petri dishes. The successful tests resulted in a second project phase that investigated the effectiveness of ozone in controlling molds and insects in small buckets filled with corn. The results of the ozonation experiments in the laboratory over two years resulted in the scaling up of this technology in 1988 utilizing 3 of our 16 pilot bins filled with corn. In 1999 additional ozone flow experiments were conducted through laboratory scale barrels to determine optimum fumigation velocities through corn.

Impact: The positive results of the scale-up tests in our pilot bins have attracted external project support and the interest of industry to commercialize the technology in the near future. The ozonation technology could become an inexpensive alternative pest control technology both on the farm and at commercial elevators. It can be generated on site, it does not require costly registration or operator licensing, and it is a technology that is safe for the applicator to use. Additional grant support has been received through USDA-NRI in 1999.

Funding source:

Indiana Commissioner of Agriculture's Value Added Grant Program, Private Industry, USDA-NRI

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URL: <http://www.GrainQuality.org>

## **NC-213 Progress Report for 1999**

From: University of Nebraska  
Food Science & Technology

By: Lloyd B. Bullerman

NC-213 Objective: B

Procedure: 1b

Project Objective: Determine the effects of preservatives on growth and mycotoxin production by selected molds.

Results for 1999: No results to report. No activity on this objective in 1999.

Plans for 2000: The work on this objective will be initiated in 2000. A post-doc and a Ph.D. level graduate student have been assigned to work in this area.

## NC-213 Progress Report for 1999

From: Departments of Entomology<sup>1</sup> and Plant Sciences<sup>2</sup>  
Montana State University, Bozeman, Montana

By: Florence V. Dunkel<sup>1</sup>  
Vanessa Watts<sup>1</sup>  
Luther Talbert<sup>2</sup>  
Phillip Bruckner<sup>2</sup>  
Debra Habernicht<sup>2</sup>

NC-213 Objective: B

Procedure: 2a

Project Objective: Evaluate postharvest resistance of Montana grown hard red spring and winter, hard white, and soft white wheat varieties to Montana strains of storage insects.

Results for 1999: Our study was undertaken to determine differences in genetic resistance to the lesser grain borer, *Rhyzopertha dominica* between varieties within a class of wheat. We tested the hypothesis that Montana-grown spring wheat varieties (Ernest, MT 9433, Hi-Line, McNeal, Newana, and Amidon) and Montana-grown winter wheats (Nuwest, Tiber, Rocky, Redwin, Vanguard, and Neeley), are genetically resistant to attack by the lesser grain borer to significantly varying degrees.

*Rhyzopertha dominica* were obtained from a Miles City (eastern Montana) grain elevator and mass cultured in the Montana State University (MSU) Stored Grain Entomology Laboratory incubator (28 +/-1° C, 45 +/- 5% RH, 12:12::light:dark). Wheat varieties were selected and produced at the MSU Post Farm in Bozeman, Montana, by L. Talbert and P. Bruckner. Wheat was cleaned and equilibrated. Mean % moisture content prior to inoculation was similar to Montana conditions at harvest (8-10% depending on variety). Each vial, containing 5 g equilibrated sound wheat kernels, was inoculated with 20 (0-72 hour post adult emergence) insects and incubated thirty days.

To obtain additional data to determine which wheat varieties are most safe to store, a second test was constructed based on growth and development studies of McGaughey et al. (1990). Data were obtained from F1 and F2 generations with the same procedures (Figure 1) as the tests done on the parent generation. Into each assay container 50 g equilibrated, sound wheat kernels were placed and was inoculated with 15 (0-72 hour post adult emergence) insects and placed in the incubator. Adult insects were removed after two weeks and percent mortality was calculated. Vials were returned to incubator for 8 weeks until F2 emergence. Number of F1 /F2 adults were counted / evaluated. Behavior of each adult insect was evaluated and determined dead, moribund, or normal. Test weight (weight per unit volume)(micro-method) and the moisture content (oven dry whole kernel method 130° C 19 hrs [Hart et al. 1959]) were obtained before and after infestation to calculate dry weight loss.

There were nine significantly different groups of percent total protein levels within the 12 hard wheat varieties (Figure 2), indicating that these varieties represent a wide range of bread flour quality. Protein (amount and quality) is considered one of the most important wheat properties determining best functional use. Five significantly different groups of hardness levels were found within the 12 varieties. Of these Tiber and Ernest were the least hard. Amidon, MT 9433 and McNeal were the hardest. Since this kernel property has a direct relation to the ability of the insect attacker, in this case, *R. dominica*, to crush the endosperm, hardness is a good indicator of resistance.

Kernel hardness, therefore, should be one factor related to dry weight loss, and thus, an important factor when a wheat producer decides which variety is least likely to lose value when stored long term. As predicted, of all hard wheat varieties tested, Amidon had least dry weight loss and was the only variety to have significantly less loss than the sensitive control (soft white winter wheat)(Figure 3). Tiber, Ernst and Neeley had the most dry weight loss, but not significantly different than other varieties. This was expected since Tiber and Ernst also had the lowest significantly different hardness of all winter wheat varieties tested.

Parent mortality is a good indicator of the attacking insect population to thrive. After 4 weeks of infestation, parent *R. dominica*, during their reproductive period on the variety Ernst, had significantly lower mortality than most of the other hard wheat varieties tested. Thus, Ernst had the capability to support a higher population of *R. dominica* (Figure 4). Tiber had a higher number of *R. dominica* produced than in any other hard wheat variety. This is interesting in that Tiber one of its parents was Redwin and both Redwin and Tiber provided parent genetic material for Vanguard. The lowest total populations that developed were on McNeal, Hiline, and T9433 varieties. Although there were no significant differences in mean per cent severely damaged kernels among any hard wheat varieties, McNeal and Hiline were in the group with zero percent severely damaged kernels. Ernst and Amidon had the highest per cent severely damaged kernels.

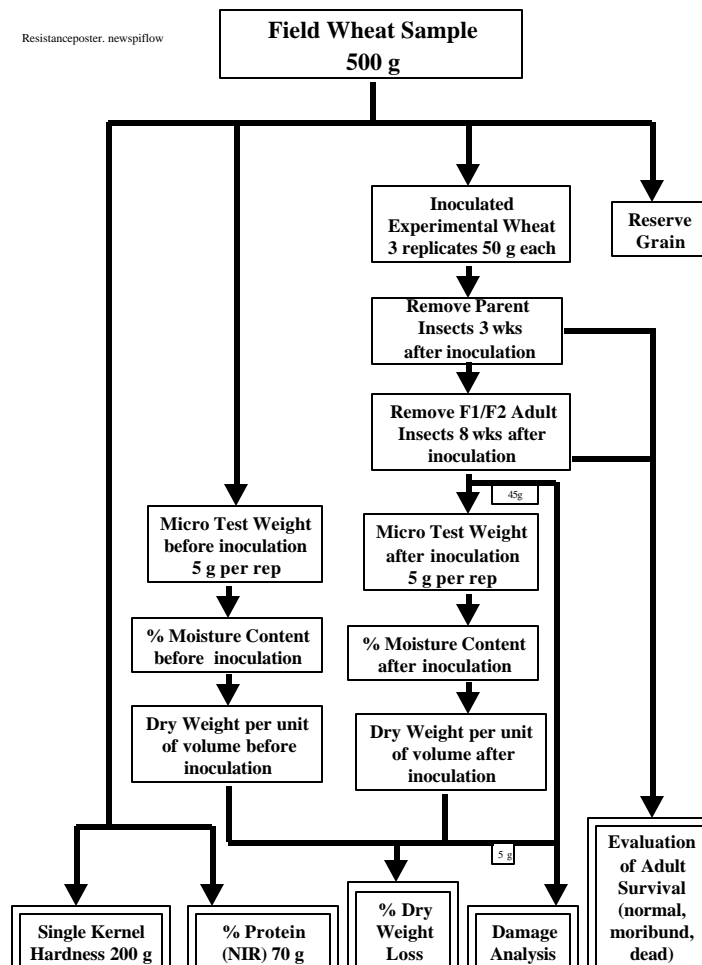
Thus, when deciding which hard wheat varieties to store long term in Montana, or in other dry environments, good choices are the varieties Hi-Line and McNeal. Our data indicate these are good choices because of: a) the low F1/F2 production in Hi-Line and McNeal; b) absence of severe kernel damage after 4 weeks incubation; and c) high mortality of *R. dominica* after 4 weeks. The most risky for long-term storage are probably the varieties Tiber and Ernest. This is based on our findings of: a) low mortality in first generation *R. dominica* on Ernest; b) highest number of F1/F2 on Tiber and Ernest after 9 weeks; and c) high dry weight loss with Tiber.

Plans for 2000: Complete peer refereed manuscript describing the 1998-1999 studies. In collaboration with the USDA-ARS Grain Marketing and Production Research Center, Manhattan, KS, conduct modeling studies to predict population development of *R. dominica* under Montana conditions.

Publications:

None. Project funding began in June 1998.

Figure 1. Flow chart indicating analyses completed on each field sample of each wheat variety (double outlined box indicates data analyzed).



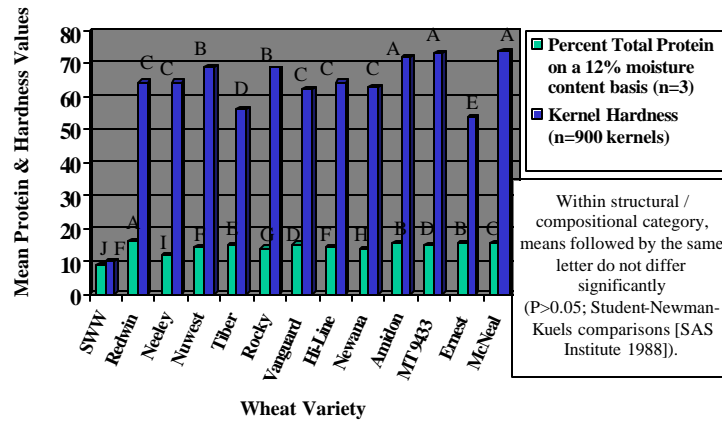


Figure 2. Single kernel hardness and total protein content of each variety tested.

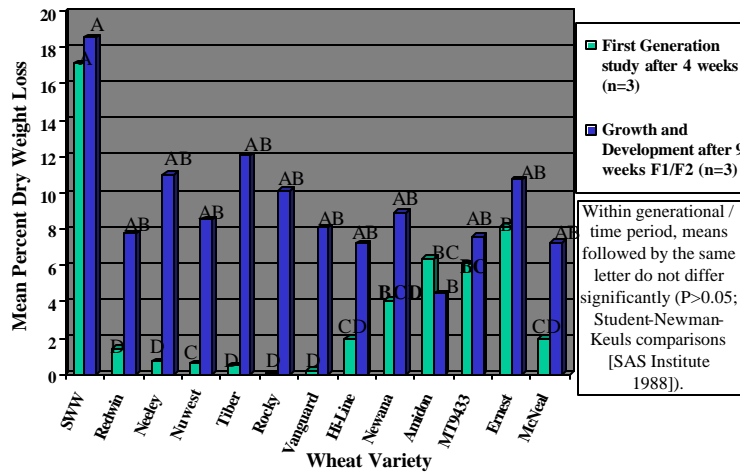


Figure 2. Percent dry weight loss after 4 and 9 weeks of infestation by *R. dominica*

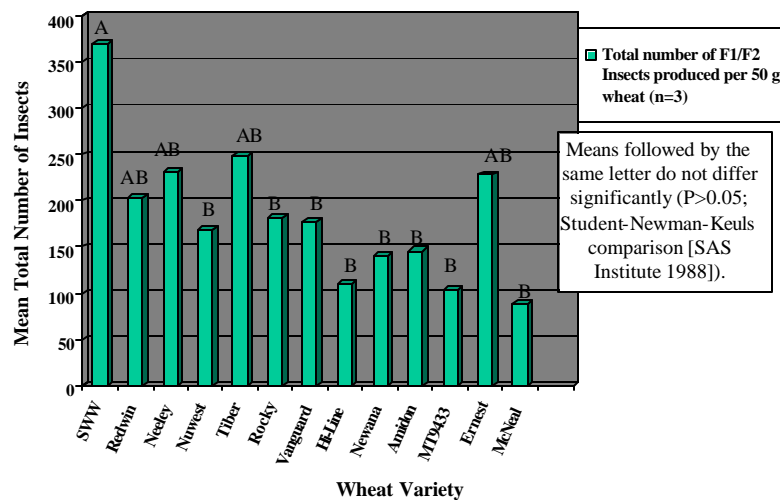


Figure 3. Total insects produced in 9 weeks

## NC-213 Progress Report for 1999

From: Department of Entomology Montana State University,  
Bozeman, Montana<sup>1</sup> and Mycotech Corporation, Butte, Montana<sup>2</sup>

By: Florence V. Dunkel,<sup>1</sup>  
Matthew J. Broughton,<sup>1</sup>  
Stefan T. Jaronski,<sup>2</sup>  
Jennifer B. Demony,<sup>1</sup>  
Karesa Fox<sup>1</sup>

NC-213 Objective: B

Procedure: 2b

Project Objective: Develop new biorational residual and fumigative applications for stored grain, oilseeds and other postharvest commodities from natural materials as novel management strategies for stored product insects.

Results for 1999: Cinnamic aldehyde (=cinnamaldehyde) is a monoterpenoid, the signature fragrance, and main active compound in cinnamon oil which is exempt from pesticide regulations under FIFRA (Federal Register 1996). This compound has been commercialized as Cinnamite<sup>®</sup> for control by contact of greenhouse whitefly and aphids. One previous study (Figure 1) documented vial-scale control of stored grain insects. We tested the hypothesis that cinnamic aldehyde is an effective fumigant for stored grain and oilseeds. We used the lesser grain borer, *Rhyzopertha dominica* (F.), obtained from the Miles City (eastern Montana) grain elevator and mass cultured in the Montana State University (MSU) Stored Grain Entomology Laboratory incubator (28 +/-1° C, 70 +/- 5% RH, 12:12::light:dark). We also tested lab cultures recently derived from California populations of the Indian mealmoth, *Plodia interpunctella* (Huebner), and the cigarette beetle, *Lasioderma serricorne* (F.).

In 40 cc airtight vials held at incubator conditions, the 24 hour LC<sub>50</sub> s obtained in three separate experiments ranged from 1-2.5 mg cinnamic aldehyde (in liquid form with limited volatility and no wick arrangement to increase volatilization) per cc fumigated space in our studies (Figure 1) which was about 1 order of magnitude higher than the previous study that used paper wicks to significantly increase speed of volatilization (Huang and Ho 1998). With adult *R. dominica* (0-72 hrs post emergence) we documented an anesthetic response followed by recovery preceding mortality (Figure 2). 100 % mortality was obtained at 10 mg cinnamic aldehyde per cc of space fumigated. The addition of wheat into the vial system decreased mortality. We added a wick system and upscaled to a 7,281 cc column of soft white wheat without aeration. Higher mortality was obtained with *R. dominica* caged along the side of the bin compared to in the center of the bin. The highest mortality (85%) was obtained next to the plenum (under which were the wicks with the cinnamic aldehyde). Determining that delivery was the main problem, we moved to 240 cc forced air mini-columns of

wheat (Figure 3). With heated grain and cinnamic aldehyde plus a larger diameter (0.5 cm) delivery tube, 90 % mortality was achieved with *R. dominica*.

Because larvae of *P. interpunctella* are resistant to other terpenoids, we targeted this stage and found that with a 48 hour exposure at 2.5 mg cinnamic aldehyde per cc space fumigated, 100% mortality was obtained (Figure 4). With pupae of *P. interpunctella* which are sensitive to other terpenoids, we were only able to achieve 80% mortality at 24 hours with 10 mg cinnamic per cc. If we increased the length of the fumigation to 14 days, 95% mortality was achieved at the lowest dose tested (0.5 mg cinnamic per cc) and 100% mortality at 2.5 mg cinnamic per cc.

Adult *L. serricornis* achieved 100% mortality at 20 hrs with the highest dose tested (10 mg cinnamic per cc space fumigated). By 48 hrs, 100% mortality was achieved with 1 mg cinnamic per cc. This insect is resistant to high concentrations of other terpenoids and alkaloids and thus was included to provide a picture of the diversity of responses possible with cinnamic aldehyde and postharvest insects.

We concluded that cinnamic aldehyde may be developed into an effective fumigant for stored grain and oilseeds as well as other postharvest plant commodities. Low concentrations can achieve 100 % mortality in the 24-48 hr ideal fumigation time, even for more difficult to manage stages of some of the stored grain and oilseed insects. Since this fumigant is already widely consumed by humans in the US and throughout the world and exempt from registration, the delivery/grain penetration problems are worth overcoming by development of new methods.

Plans for 2000: Complete peer refereed manuscript describing the 1998-1999 studies. Solve delivery problems in grain column with *R. dominica* and complete embryo studies with *P. interpunctella*. Investigate combination of this compound with other natural fumigants to increase efficacy for more resistant insect species and stages.

#### Publications:

Dunkel, F.V., M.J. Broughton, S. Jaronski, J.B. Demoney, and K. Fox. Evaluation of cinnamic aldehyde as a fumigant for stored product insects. *J. Economic Entomology*. In author review.

Kumar, A., F.V. Dunkel, M.J. Broughton, and S. Sriharan. 2000. Effect of root extracts of Mexican marigold, *Tagetes minuta* (Asterales: Asteraceae), on six nontarget aquatic macroinvertebrates. *Environmental Entomology*. 29:in press.

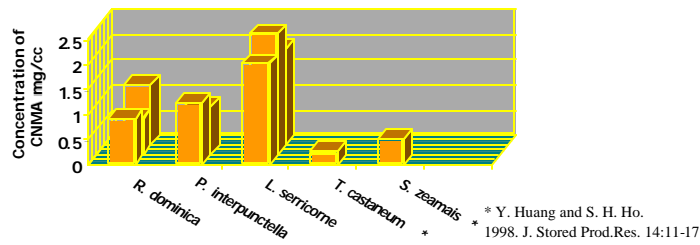


Figure 1. 24 hour LC<sub>50</sub> for stored product insects fumigated with cinnamic aldehyde. (Several repeats of our experiments in comparison with Huang and Ho [1998])

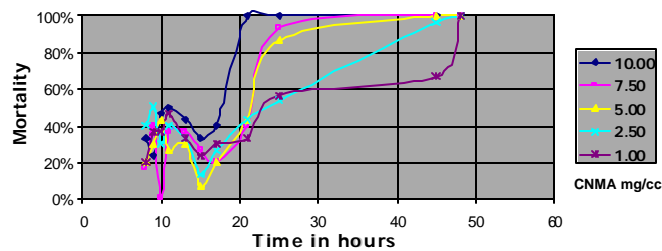


Figure 2. Time-based mortality of the lesser grain borer, *Rhyzoperthadominica*,

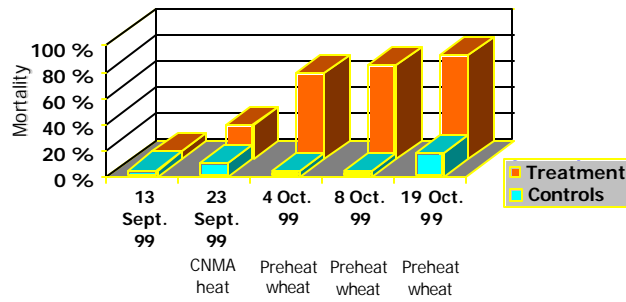


Figure 3. Five separate experiments in forced air mini-columns, each experiment with increasingly improved delivery techniques.

Effect on Cinnamaldehyde Fumigation on Mortality

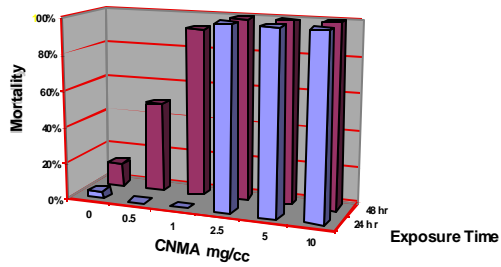


Figure 4. Response of larvae of Indian mealmoth, *Plodia interpunctella* to 24 and 48 hour fumigation by cinnamic aldehyde.

## NC-213 Progress Report for 1999

From: Kansas State University  
Grain Science and Industry  
USDA ARS  
GMPRC, Manhattan, Kansas

By: Bh. Subramanyam  
Rennie Roesli  
Anil Menon  
Alan Dowdy

NC-213 Objective: B

Procedure: 2b

Project Objective: 1) Temperature profiles and distribution during heat treatment of KSU pilot flour and feed mills during heat treatment with gas, electric, and steam heaters. 2) Response of insects exposed to extreme temperatures and a range of humidities during heat treatment of mills. 3) Use of pheromone and food-baited traps to monitor stored product insects before and after heat treatment of mills. 4) Develop a model to predict mortality of selected stored product insects exposed to increasing lethal temperatures.

Results for 1999: 1) The temperature distributions and profile obtained on all 4 floors of the KSU pilot flour mill and cleaning house heated with gas and electric heaters was essentially similar. With gas and electric heaters, time to reach the target temperature of 50C took 11-24 hours from the ambient temperature. The temperature above 50C was maintained for about 13-28 hours with both types of heaters. Data from heat treatment with gas of KSU pilot feed mill have not been analyzed. With steam heaters, it took more than 25 hours to obtain the target temperature of 50C across all 4 floors of the KSU pilot flour mill and cleaning house. Also, temperatures above 50C were maintained for about 2-58 hours among the floors of the flour mill and cleaning house. 2) All insect species (about 6 species) exposed in cages with and without food died within 12 hours during heat treatment (with gas or electric heaters) of KSU pilot flour and feed mills. During steam heat treatment of KSU pilot flour mill, both temperature and relative humidity affected mortality of red flour beetles exposed in enclosures containing different concentrations of glycerol solutions. However, temperature appeared to have a stronger effect on mortality than relative humidity. Temperatures above 43C and exposure times above 21 hours were required to produce red flour beetle mortality. It took at least 34 hours to reach 50C in the enclosures used in these experiments. A crude degree hour model (base temperature, 34C) to predict red flour beetle mortality was developed. There was a linear relationship between red flour beetle mortality and degree hours, and this linear model explained 67% of variation in mortality of the insects. More work is needed to develop a reliable model. 3) The condition of sticky material in the trap (Phercon 1C) was unaffected by exposure to high temperatures.

Except for the red flour beetle lure concentration, concentration in lures of the Indianmeal moth and almond moth were not affected by exposure to high temperatures during heat treatment. Red flour beetle lure concentration dropped by 40% during the heat treatment. Insect populations (Indianmeal moth, almond moth, and several species for beetles) were monitored before and after heat treatment in KSU pilot flour and feed mills. Insect populations could not be detected immediately after a heat treatment. However, populations were captured in traps 2-4 weeks following a heat treatment. Insects were captured in traps after heat treatment in the first floor where raw ingredients enter the mills.

Plans for 2000: 1) Simulate heat treatment using a programmable oven, and observe effects on survival and reproduction of Indianmeal moth and cigarette beetle. 2) Model the influence of temperature on the mortality of insects.

Publications:

Reports are posted on the following web site.

[http://www.oznet.ksu.edu/dp\\_grsi/heatrt.htm](http://www.oznet.ksu.edu/dp_grsi/heatrt.htm)

The last 2 links contain the reports.

Impact: To generate data to determine the value of using heat treatment as an alternative to methyl bromide fumigation of flour and feed mills. Use traps to determine the degree and duration of efficacy of a heat treatment.

## NC-213 Progress Report for 1999

From: Indiana (Purdue University)  
Agricultural & Biological Engineering  
Entomology  
Botany & Plant Pathology  
USDA, ARS  
GMPRC, Manhattan, Kansas

By: Dirk E. Maier  
Mike D. Montross  
Linda J. Mason  
Charles P. Woloshuk  
James L. Throne

NC-213 Objective: B

Procedure: 2c

Project Objective: To investigate various time/temperature patterns of ambient and chilled aeration on management of stored-grain pests using pilot bin experiments and computer simulation.

Results for 1999: An axisymmetric finite element model was developed that takes into account the heat, mass, and momentum transfer that occurs in upright corrugated steel storage structures due to conduction, diffusion, and natural convection. Periods of aeration, dry matter loss distribution, and maize weevil density in corn were estimated. Heat and mass balances were used to calculate the temperature and relative humidity in the headspace and plenum assuming permeable grain surfaces. Two seasons of pilot bin experiments validated the model. The average standard error between the experimental and predicted temperatures was 2.4 degrees C (1.8 to 3.1 degrees C range) and the moisture content was 1.0 percentage point. Non-aerated, automatic ambient aeration, and automatic chilled aeration were evaluated in the replicated pilot bins as alternative methods to control insect development during summer storage. Ambient and chilled aeration reduced development of red flour beetles and maize weevils by 34% and 70% over non-aerated storage, respectively. Two locations were investigated (Indianapolis, IN and Minneapolis, MN) to demonstrate the application of the model to control insects in conventionally sized steel bins that were cooled during the fall and winter. The non-aerated and ambient aerated strategies behaved similarly until late summer when the maize weevil density increased dramatically in the non-aerated bins. Chilled aeration controlled maize weevil density at its initial population, but at an energy consumption of fourteen to sixteen times greater than ambient aeration. The simulation results indicated that automatic aeration increased the average bin temperature relative to non-aerated storage, which negated most of the benefits observed in the pilot bins.

Plans for 2000: 1) Apply the new model to peaked grain masses and 2) Expand the new model to investigate partial cooling of a grain mass.

Publications:

Montross, M.D. 1999. Finite element modeling of stored grain ecosystems and alternative pest control techniques. Unpublished Ph.D. dissertation. Purdue University, West Lafayette, IN.

Issues: Protection of stored grains and oilseeds has in the past heavily relied on fumigants and residual chemicals. In many cases, insects have become resistant, products have been banned due to environmental or health concerns, and consumers have become more apprehensive. Research has to focus on alternative stored product pest control technologies that can be incorporated into an overall IPM strategy to maximize grain quality.

What's been Done: The results of this project indicate that an optimal scenario for the non-chemical control of stored grain insect pest includes ambient aeration during the fall, winter, and early spring with non-aerated storage during the summer. Moisture "migration" in the traditional sense did not occur in a cooled grain mass stored into the summer. Instead, a more realistic theory of moisture exchange between the grain mass and headspace and plenum was developed. Permeability had a major influence on the magnitude of moisture accumulation. Moisture accumulation occurred primarily due to natural convection currents that entered and exited the headspace, which can be minimized by proper ventilation.

Impact: Our research over the past 10 years has established grain chilling as a feasible alternative pest control and grain conditioning technology. Approximately 20 chillers are in operation in the U.S. from at least three manufacturers (including one U.S. company). The first commercial U.S. unit has been in operation at a rice processing facility in California since January 1994. Over 200 million pounds of milled rice used to make crispy rice by a leading breakfast cereal manufacturer are annually conditioned with one of our systems. The retail value of this breakfast cereal is over \$600 million per year.

Funding sources:

USDA National Research Initiative Competitive Grants Program, Electric Power Research Institute Agricultural Technology Alliance, Private Industry

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URL: <http://www.GrainQuality.org>

## NC-213 Progress Report 1999

From: Kansas State University  
Grain Science and Industry  
USDA, ARS  
GMPRC, Manhattan, Kansas

By: Bh. Subramanyam  
Carl Reed  
Frank Arthur

NC-213 Objective: B

Procedure: 2b

Project Objective: Evaluate the fate and efficacy of Spinosad on stored wheat.

Results for 1999: Spinosad at 1 ppm (w/w) effectively killed and suppressed population growth of the lesser grain borer and Indianmeal moth. At this rate, mortality of rice weevil adults took 14 days. However, population suppression of rice weevils was dose dependent, and 3 ppm or higher was required for >90% progeny suppression. The red flour beetle and sawtoothed grain beetle adults were not effectively controlled by Spinosad; however, larvae hatching from eggs laid by these species succumbed to Spinosad at 3 ppm or higher. The density of each species used in these laboratory tests was 500-100 times higher than the Federal Grain Inspection Standard for infested grain. Despite the "worst case scenario" used in our tests, the results obtained were promising.

Plans for 2000: Spinosad will be applied to newly harvested hard red winter wheat at 1 and 3 ppm. Treated and untreated wheat will be placed in round metal bins and populations of insects in these bins will be monitored over a 2-year period. The residues of Spinoisad in bran, germ, and flour of milled wheat will be determined from samples removed at monthly intervals. Effect of different temperatures and humidities on Spinosad stability on wheat will be determined. Effect of Spinosad on different classes of wheat will also be evaluated under laboratory conditions.

### Publications:

Subramanyam, Bh., J. Nelson, R. Meronuck, and E. A. Flora. 1998. Evaluation of spinosad on stored product insects. In Proceedings of the 7th International Conference on Stored Product Protection, 14-19 October 1998, Beijing, China. (In Press).

Impact: Spinosad is being explored as an alternative to the organophosphate grain protectants Reldan and Malathion, which are at risk of being canceled under the 1996 FQPA.

## NC-213 Progress Report for 1999

From: USDA, ARS

By: Paul W. Flinn  
David W. Hagstrum

NC-213 Objective: B

Objective: 2b

Project Objective: Conduct quantitative ecological, behavioral and population dynamics studies on stored-grain insects and their natural enemies. Develop computerized decision-support systems for managing stored-grain insects.

Results for 1999: A temperature-mediated functional response was fit to *Theocolax elegans* attacking the Lesser Grain Borer. Parasitoid search rate did not change much with temperature, however parasitoid handling time did. The wasp did not develop at temperatures of 35C. Parasitoid handling time was longest at 20C, and shortest at 30C. The maximum number of parasitized kernels in 24 hours was 20 at 30C.

Plans for 2000: Develop a predictive population dynamics model of *Theocolax elegans* and the lesser grain borer on wheat.

What's been Done: We developed a model that can predict the rate of parasitism for *Theocolax elegans* attacking the lesser grain borer, over a range of temperatures.

Impact: Compared to other stored-grain parasitoid wasps, the functional response of *T. elegans* was reduced more at temperatures below 25 and above 30C. For *T. elegans* to be effective in suppressing *R. dominica*, it may be necessary to cool the grain to temperatures below 30C as soon as possible using aeration. This would also have the beneficial effect of suppressing *R. dominica* development in stored grain.

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: C. S. Chang  
J. L. Steele  
D. Wang

NC-213 Objective: B

Procedure: 3a

Project Objective: Validate energy performance of a new heat pump grain-drying concept.

Sub-Title: Energy efficiency of a new heat-pump grain drying concept

Results for 1999: An experimental closed-loop heat-pump drying system was developed and evaluated for energy performance. The potential reduction in energy to remove water from shelled corn was confirmed by near continuous prototype operation for 360+ hours during the 1998 harvest season. The system consisted of a stationary drying bed, a conventional heat pump, an air to air heat exchanger, a trim condenser and a system to record grain and air conditions for performance evaluations. Tests with three corn lots and one milo lot were conducted in 1998. The average performance, ratio of input energy to mass of water removed, for the corn lots was 510 Btu/lb based on grain lot weight differences before and after drying. The best energy performance observed in 4-6 hr periods was 440 Btu/lb. The average drying capacity was 9 bu/hr based on an equivalent moisture removal from 25 to 15.5% w.b. per dry bu. The average thermal energy transfer rate of the air-air heat exchanger ranged from 550 to 718 Btu/min and averaged 28% of the total (source-sink) thermal energy transfer rate. The average efficiency of the air-air heat exchanger was about 35%, and the average COP was 6.4 including the air-air thermal transfer and 4.7 excluding that transfer. Refrigerant flow control during ambient air temperature swings (50-90F) was difficult and required manual adjustment from time to time during operation. This and other management difficulties indicate that the refrigerant, air and grain flow controls need greater integration for unattended and sustained operational performance. The observed efficiencies for the air-air exchanger, the evaporator and the condenser components were significantly lower than the design targets. The observed energy input (440-550 BTU/lb of water removed) was less than the projected theoretical efficiency (300 BTU/lb) as a result of the low air-air exchanger component efficiency.

Plans for 2000: Cooperative Research and Development Agreement terminated in 1999. Complete analysis and manuscript preparations.

Publications:

Steele, J.L., Wang, D. and Chang, C.S. 1999. Energy Efficiency of a New Heat Pump Grain Drying Concept. Presented at the American Dry Millers Conference, Peoria, IL, June 3-4, 1999.

Patrico, J., Editor. 1999. A kinder, gentler grain dryer. An experimental system promises a low heat, low energy future. Progressive Farmer, August 1999. J.L. Steele contributed graphs and data and reviewed the article prior to publication.

Issues: Energy consumption for artificial grain drying is significant and can be reduced. The energy efficiency of a proposed heat pump grain drying system needed validation before further development or adoption could be pursued.

What's been Done: Computer simulations of the energy performance of the proposed heat pump grain drying system were completed to assist in the design and specification of a prototype. A prototype (10 bu/hr) was assembled at GMPRC, instrumented and tested during the 1998 harvest season. Preliminary partial results were compiled for reporting above.

Impact: Based on experimental results, the total energy required to dry grain could be less than 25% of that current used in high temperature batch drying systems. Grain drying costs would likely be reduced a lesser amount if fixed equipment costs and management costs are included. The closed loop concept inherent in this approach has other related benefits for improved grain quality production and preservation, especially when food grade grain production is an objective.

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPC

By: T. Herrman  
J. L. Steele  
K. Stiegert  
S. Sun

NC-213 Objective: B

Procedure: 3a

Project Objective: Survey Kansas country elevator facilities for storage capacity, daily receiving rates and capacities, and project their potential for segregating HRW wheat by quality characteristics. Determine milling, mixing and baking performance predictions based on rapid whole wheat assessments at elevator receiving points. Develop a methodology for rapid and economical segregation of wheat at elevator receiving points as a function of quality and the facilities available.

Sub-Title: Quality Oriented Marketing of Hard Winter Wheat

Results for 1999: Simulation models were developed using engineering, receiving, and quality data collected from 50 country grain elevators. Simulations were run for elevators possessing different receiving capabilities including receiving capacity, and number of receiving points. A method for segregating wheat was developed based on a single quality variable defined as "dough factor". Reducing the segregation scheme to two quality categories resulted in approximately 80% accuracy using single kernel weight, single kernel weight standard deviation, and bulk protein content. Thirty bushel samples of the commercially segregated wheat were milled at the K-State flour mill and baking performances were determined. Validations of the segregation model were completed in 1999.

Plans for 2000: Complete final report and extend the dough factor segregation/marketing system for commercial adoption.

Publications:

Baker, S., Herrman, T.J., and T. Loughin. (In Press). Segregating hard red winter wheat into dough factor groups using single kernel measurements and whole grain protein analysis. Cereal Chem.

Baker, S., Herrman, T.J., and T. Loughin. (In Press). Use of regression and discriminant analyses to develop a quality classification system for hard red winter wheat. Cereal Chem.

Herrman, T. and Boland, M. 1999. Segregation strategies. Feed & Grain. Feb/March pp 20-25.

Herrman, T.J., Boland, M. and Heishman, A. 1999. Economic feasibility of wheat segregation at country elevators. The Second Annual National Wheat Industry Research Forum pp 13-16.

Herrman, T.J. 1999. Identity preservation: operational aspects of a value-enhanced marketing strategy. GEAPS 70<sup>th</sup> Annual International Technical Conference and Exposition pp. 59-70. March 6-9, 1999 Tampa, FL.

Issues: Greater utilization and application of new technologies for rapid objective grain quality assessment in the market channel. The feasibility of utilizing new technologies for segregating HRW at the first point of sale is unknown.

What's been Done: Quality segregation models were developed using capacity, receiving rates, and quality data and cost/benefit curves were used to select feasible real-time segregation scenarios. A method for segregating wheat was developed based on the single quality variable "dough factor". A decision tree for quality segregation of HRW wheat was tested during the 1998 harvest at three commercial grain elevators. Baking performances of the segregated wheat were determined. Project results were presented to numerous audiences.

Impact: The adoption of single kernel physical measures and other new technologies for quality assessment are beginning to be utilized. The concept of a single quality parameter such as 'dough factor' which is a combined index of milling yield and protein quality is new, but will be adopted quickly if the economic benefits, milling and baking performances, of the segregated wheat are economically beneficial. Progressive publication and demonstration of the developed technology is underway.

## NC-213 Progress Report for 1999

From: USDA, ARS  
Grain Quality & Structure Research Unit

By: O. K. Chung  
B. W. Seabourn  
J. B. Ohm  
J. D. Hubbard  
M. S. Caley

NC-213 Objective: C

Procedure: 1a

Project Objective: Evaluate kernel characteristics, milling properties, and dough and bread making properties of hard winter wheat progenies. Determine protein and lipid contents, and composition and interaction among these components of cereal grains as they relate to storage, handling, and end-use properties.

Results for 1999: We at the Hard Winter Wheat Quality Laboratory (HWWQL) continue to evaluate intrinsic quality parameters of several thousand hard winter wheat lines from 14 federal, state, and private nurseries. Data were generally sent to breeders electronically, followed by written reports upon request. For the Southern (SRPN), Northern (NRPN), and Western Plains (WPRPN) Regional Performance Nursery samples, several intrazone production area composites were also tested for quality to study the environmental adaptability of each line. Quality data of the SRPN, NRPN, and WPRPN Regional Nurseries are posted on the Graingenes web site; a copy of the data may be obtained in electronic format via the internet by directing your browser to the Graingenes gopher at [gopher://greengenes.cit.cornell.edu/](mailto:gopher://greengenes.cit.cornell.edu/). Using a simple, user-friendly relational database system, we provided simultaneous assessment of multiple quality traits. It was the second year for us to distribute the database to all wheat breeders at the annual Breeders Field Day.

A web page (<http://gqu1.usgmrl.ksu.edu/gqu/HWWQL/HWWQLHome.htm>) for the HWWQL was provided so that breeders and other industry customers could easily access regional performance nursery data via the internet. The web page also allows for the HWWQL to more rapidly respond to customer needs. We were able to predict gliadin and insoluble glutenin (IG) contents from the NIR spectra of whole kernel wheat. Since IG has been confirmed in a number of studies to play an important role in bread making, particularly dough strength, our results indicate that NIR may be useful in plant breeding programs and quality laboratories where rapid screening for dough strength of large numbers of wheat lines is needed. We have continued to study the relationships of bread making with wheat and/or flour characteristics, including single kernel parameters, NIR hardness scores, gluten, pasting, and mixograph parameters, and flour particle size distributions. We have developed several methods including: (a) a supercritical fluid extraction (SFE) system for non-starch total lipid extraction from

lyophilized dough and cereal free lipid extraction from flours of rice, barley, rye, 3 wheats (hard red spring, winter, and durum), oats, and corn meal; (b) an enhanced solvent extraction (ESE) system for genistein from soybean flours; and (c) an HPLC system using an evaporative light-scattering detector (ELSD) and a diode array detector (DAD) for free glycolipid content determination in wheat flour.

Plans for 2000: Continue to evaluate intrinsic quality parameters of hard winter wheat breeding lines; continue to improve the activities of the HWWQL as a Regional Wheat Quality Laboratory with efficient service and regional collaboration; conduct studies on prediction of end-use quality using testing parameters (physical and chemical characteristics) including SKCS data, NIRS6500 scans, computerized mixograph data; and study dynamic rheological changes and multiple interactions during dough mixing by FTIR and Raman spectroscopy.

Publications:

Chung, O.K. and Pomeranz, Y. Cereal processing. Chapter 6. Pages 243-307.

In: Food Proteins: Properties and Applications. S. Nakai and H.W. Modler (eds.). John Wiley & Sons, Inc., New York. Vol. II. 1999.  
(Book Chapter)

Chung, O.K. and Ohm, J.B. Food supply at the year 2035: Enough? Pages 4-11.

In: Genetic Engineering in Cereals. J.W. vander Kamp and R.N. Chibbar (eds.), Proceedings of the ICC/AACC Symposium. ICC, Vienna, Austria. 1999. (Symposium Proceedings)

Chung, O.K. and Ohm, J.B. Cereal lipids. Chapter 14. Pages 415-476.

In: Handbook of Cereal Science and Technology. K. Kulp and J.G. Ponte, Jr. (eds.), 2nd edition. Marcel Dekker, Inc., New York. 1999.  
(Book Chapter)

Chung, O.K. and Ohm, J.B. Food supply at the year 2035: Enough? Pages 487-

490. In: Cereals 98. L. O'Brien, A.B. Blakeney, A.S. Ross, and C.W. Wrigley (eds.), Proceedings of the 48th Australian Cereal Chemistry Conference. August 17-20, Cairns, Queensland, Australia. Cereal Chem. Div., Royal Australian Chemical Institute, N. Melbourne, Australia. 1999.

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- Haley, S.D., May, R.D., Seabourn, B.W., and Chung, O.K. A relational database utility for synthesis of hard winter wheat regional quality data. *Crop Sci.* 39:309-315. 1999.
- Ohm, J.B. and Chung, O.K. Gluten, pasting, and mixograph parameters of hard winter wheat flours in relation to bread-making. *Cereal Chem.* 76:606-613. 1999.
- Ohm, J.B. and Chung, O.K. Estimation of free glycolipids in wheat flour by high performance liquid chromatography. *Cereal Chem.* 76:873-876. 1999.
- Sayaslan, A., Chung, O.K., Seib, P.A., and Seitz, L.M. Volatile compounds in five starches. *Cereal Chem.* (In press)
- Chung, O.K., Ohm, J.B., Caley, M.S., and Seabourn, B.W. Prediction of baking characteristics of hard winter wheat flour using computer-analyzed mixograph parameters. Page 148. In: *Cereals Across the Continents*. F. de A. Marquez, E. Diaz, and C.M. Rosell (eds.), Abstract Book of 17th ICC Conference, June 6-9, 1999. IATC-CSIC, AETC & MAPA, Valencia, Spain. 1999.

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- Downing, J.M., Chung, O.K., Seib, P.A., and Hubbard, J.D. Rapid extraction of genistein from soybean flours using enhanced solvent extraction. Page 212-213. In: Abstract Book of the 84th AACC Annual Meeting, October 31-November 3, 1999. Seattle, WA. 1999.
- Hubbard, J.D., Chung, O.K., and Downing, J.M. Non-starch total lipid extraction from lyophilized dough by a supercritical fluid extraction (SFE) system. Page 208-209. In: Abstract Book of the 84th AACC Annual Meeting, October 31-November 3, 1999. Seattle, WA. 1999.
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- Ohm, J.B. and Chung, O.K. Effect of kernel weight and hardness on end-use properties of hard winter wheats. Page 266. In: Abstract Book of the 84th AACC Annual Meeting, October 31-November 3, 1999. Seattle, WA. 1999.

Issues: A proper selection of wheat breeding lines to be released for commercial cultivars is the most important step in improving U.S. wheat quality for domestic and export markets. We at the Hard Winter Wheat Quality Laboratory (HWWQL) must work to connect the wheat quality attributes desired by industry with those being pursued by breeders.

What's been Done: This was the second year for us to provide breeders a simple, user-friendly relational database system for the summarization and interpretation of wheat end-use quality data of over 40 parameters from the HWWQL.

Impact: The relational database system provides simultaneous assessment of multiple quality traits on a standardized scale and summarization of quality ratings for genotype across multiple nurseries. A working copy of the database was provided (free of charge) to all breeders. The lipid and genistein extraction methods will be safer and more economical due to very little usage of organic solvents and they are more rapid than the conventional methods.

## NC-213 Progress Report for 1999

From: USDA, ARS  
Grain Marketing and Production Research Center

By: George Lookhart

NC-213 Objective: C

Procedure 1A

Project Objective: Develop methods to characterize cereal proteins and/or protein fractions. Develop methods to identify components related to end-use properties.

Results for 1999: We have continued to develop and utilize High-performance capillary electrophoresis (HPCE) methods for cereal proteins. Wheat flour gliadins and glutenins were characterized by HPCE, Sodium dodecylsulfate polyacrylamide gel electrophoresis (SDS-PAGE), and SDS-capillary electrophoresis (CE). The SDS-CE separations were higher resolving and faster than SDS-PAGE. Glutenin high molecular mass subunits were readily separated and differentiated by SDS-CE, even those not distinguishable by SDS-PAGE. A capillary zone electrophoresis (CZE) method was developed that used unique buffers and improved sample handling to provide faster and more accurate wheat protein separations and characterizations. A CZE method was developed to separate barley hordeins and identify barley cultivars. This technique was used to quickly and accurately identify many barley cultivars.

Plans for 2000: Development of faster and more sensitive analytical methods for characterizing cereal proteins will be attempted. Develop CZE methods to characterize Wheat, Maize, and Sorghum proteins for cultivar identification and for correlation to their end-use properties.

### Publications:

Bean, S.R. and Lookhart, G.L. 1998. Faster capillary electrophoresis separation of wheat proteins through modifications to buffer composition and sample handling. *Electrophoresis* 19: 3190-3198.

Lookhart, G.L., and Bean, S.R. 1999. Cereal Proteins: Composition of their major fractions and methods for identification. In: Kulp, K. and Lorenz, K. (eds.), *Handbook of Cereal Science and Technology*. Marcel Dekker, Inc., New York, NY. Chapter 11. (In Press)

- Lookhart, G.L., Bean S.R., and Jones, B.L. 1999. Separation and characterization of barley (*Hordeum vulgare* L.) hordeins by free zone capillary electrophoresis. *Electrophoresis*: 20, 1605-1612.
- Bean, S. R., Lookhart, G.L. 1999. Sodium dodecyl sulfate capillary electrophoresis of wheat proteins. 1. Uncoated capillaries. *Journal of Agricultural and Food Chemistry*: 47, 4246-4255.
- Bean, S.R., Lookhart, G.L., and Bietz, J.A. 2000. The use of acetonitrile as a buffer additive for the separation and characterization of maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* L. Moench) storage proteins by FZCE. *J. Agric Food Chem.* Accepted Nov 1999.
- Bean,S.R., G.L. Lookhart. 2000. Ultrafast capillary electrophoretic analysis of cereal storage proteins and its applications to protein characterization and cultivar differentiation. *Journal of Agricultural and Food Chemistry.* Accepted Nov 1999.
- Anjum, F.M., Lookhart, G.L., Walker, C.E. 2000. High molecular weight glutenin subunit composition of Pakistani hard white spring wheats grown at three locations for two years and its relationship with end-use quality characteristics. *J. Sci. Food Agric.*80:1-7.
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- Jianmin Zhao, Scott Bean, Fredy Altpeter, Patrick McCluskey, George Lookhart, Hua-Ping Zhou, Vimla Vasil and Indra K. Vasil. 2000. Expression and Stability of field grown High Molecular Weight Glutenin subunit 1Ax1 transgenic Wheat. *Cereal Chem.* In Review.
- Gaines,C.S., Raeker, M., Tilley,M., Finney,P.L., Wilson,J. D., Bechtel, D.B., Martin,R.J., Sieb,P.A., Lookhart,G.L., and Donelson, T. 2000. Associations of Starch Gel Strength, Granule Size, Partial Waxiness, Milling Quality, and Kernel Texture of Twelve Soft Wheat Cultivars. *Cereal Chemistry* In Review.
- Jianmin Zhao, Scott Bean, Fredy Altpeter, Patrick McCluskey, George Lookhart, Hua-Ping Zhou, Vimla Vasil and Indra K. Vasil. 2000. Improving Dough Strength of Wheat with Overexpression of High Molecular Weight Glutenin Gene 1Ax1. *Nature Biotechnology.* In Review.

Issues: Identification of cereal cultivars is very important. The end-use quality of wheat, for example, is determined by nearly equal proportions of its genetic and environmental factors. Therefore, the only way to quickly predict end use properties (Quality) is to quickly identify the cultivar.

What's been Done: We have developed high performance liquid chromatography and high performance capillary electrophoresis methods to quickly (less than 10 min) and accurately identify cereal grain cultivars from grains to bulk flours. We have also developed a method to identify barley cultivars.

Impact: The utilization of these methods would allow breeders to quickly and accurately identify their breeding stocks (know when a certain protein with known positive characteristics is present) and allow maltsters to identify barley cultivars of known malting quality.

## NC 213 Progress Report for 1999

From: Iowa State University  
Agricultural and Biosystems Engineering

By: Charles R. Hurburgh Jr.  
G. R. Rippke  
Juraj Siska

NC 213 Objective: C

Procedure: 1a

Project Objective: Optimize performance of near-infrared analyzers.

Results for 1999: Near-infrared spectroscopy requires a multivariate calibration to convert spectral data to predicted values for constituents such as protein, oil, starch and hardness. Different calibrations for the same factor, developed from separate databases targeted at specific genetic situations, are in use which leads to the potential for discrepancies. A study of four corn calibrations and four soybean calibrations for Foss Infratec analyzers showed 20-200% increases in standard deviation across individual units even when all calibrations statistically matched chemical references. The accuracy of calibrations developed for particular situations was 20-80% worse (relative to references) than broad-based calibrations when diverse material was analyzed. These results demonstrate the need to select market use calibrations carefully for maximum uniformity and applicability, and to use only one calibration for trading applications where comparisons are made.

As near-infrared analysis becomes more widespread in trading and in other general applications, there is a need for criteria on which to evaluate performance. There are four areas of interest in evaluating near-infrared results: 1) accuracy relative to reference data; 2) precision (repeatability) among repeat analyses; 3) standardization across like units; and 4) sensitivity to temperature variations and other non-standard conditions. Data from four years' experience with corn (moisture, protein, oil, starch, density) and soybeans (moisture, protein, oil) in 150 near-infrared transmission analyzers of two brands was used to support performance targets for these areas. Targets are expressed in percentage of original validation standard error of prediction (SEP) relative to references. Two of the more important targets are for transferability to be 50% or less of SEP and for precision (repeatability) to be 33% or less of SEP. Approximately 10,000 data points, collected during both initial standardization and subsequent on-site quality control, were used to develop the criteria. An AACC guideline method has been accepted.

Plans for 2000: Publish data. Integrate Iowa State and GIPSA calibration databases.

Publications:

Hurburgh, C. R., Jr., G. R. Rippke and T. J. Brumm. 1999. The impact of multiple calibrations on the accuracy of near-infrared analyzers in grain markets. *Cereal Foods World*. 44(8):526 (abstr).

Hurburgh, C. R., Jr., G. R. Rippke and T. J. Brumm. 1999. Performance expectations for near-infrared analyzers. *Cereal Foods World*. 44(8):526 (abstr).

Hurburgh, C. R., Jr. 1999. Near-infrared methods. AACC Method 39-40, American Association of Cereal Chemists, St. Paul, MN. Approved November 1999.

Siska, Juraj J., Hurburgh, C. R., Jr., and P. P. Siska. 1999. The standardization of near-infrared instruments using master selection and the Wiener filter method. *J. Near-Infrared Spectroscopy*. Accepted.

Siska, Juraj J., Hurburgh, C. R., Jr., and P. P. Siska. 1999. Impact of engineering parameters on calibration transfer and on standardization diagnostic software. *J. Near-Infrared Spectroscopy*. Accepted.

## NC 213 Progress Report for 1999

From: Iowa State University  
Agricultural and Biosystems Engineering

By: Sylvie A. Roussel  
G. R. Rippke  
Charles R. Hurburgh Jr.

NC 213 Objective: C

Procedure: 1a

Project Objective: Optimize performance of near-infrared analyzers.

Results for 1999: Near Infrared Transmittance spectroscopy (NIT) is commonly used to assess the quality of whole grains, in a rapid and non-destructive way. The spectrometers used in this study are Foss/Tecator Infratec and Foss/NIR Systems instruments, which are based on different sample presentations.

Calibrations are built on a “master” instrument and then transferred to “slave” units using different standardization techniques. The objective of this paper is to evaluate different pre-processing and processing techniques, with regards to their prediction accuracy and their robustness in prediction on other copies of the same instrument.

Three processing algorithms were compared: (i) a linear regression model (Partial Least-Squares Regression: PLS), (ii) a local regression model (Locally Weighted Regression: LWR2, which includes spectra and chemical values in the neighborhood computation) and (iii) a non-linear model (Neural Networks: NN). All were implemented in MATLAB®.

Pre-processing techniques were applied to increase the model robustness, for instance by reducing the number of wavelengths using Genetic Algorithms. Pre-processing is a crucial phase for neural networks; additional pre-processing algorithms were tested for NN, including principal component and auto-associative networks. Different pruning algorithms were also implemented as an alternative for NN structure optimization.

These models were compared on corn moisture and protein content assessment using various indices. Calibration accuracy is evaluated by the SEP in cross-validation on the calibration set. Robustness is assessed by the SEP, the transferability index and the slope and bias, obtained on independent test sets from independent “slave” units. Their robustness against noisy data is also assessed.

For LWR2 and NN, many trials were necessary to tune the model parameters. Locally Weighted Regression outperformed PLS and NN models for moisture and protein prediction, with 350-400 neighbors and a y-value contribution to the neighborhood computation of 90% in a database containing 3700 samples. However, PLS showed a

better transferability than LWR2 models on certain standardization runs of slave units for moisture prediction.

Neural network pruning proved to be very efficient, especially with the algorithm of “minimum variance contribution”, providing the best results for less than 15 inputs. But, NN did not handle the database non-linearity as accurately as LWR2. NN had similar problems of transferability as LWR2 models.

Plans for 2000: Develop macros to implement LWR and optical standardization in on-line Excel applications. Continue study of calibration optimization.

Publications:

Roussel, S. R., G. R. Rippke, and C. R. Hurburgh, Jr. 2000. Accuracy and robustness comparison of different processing algorithms for grain quality assessment. Proc. Pittcon 2000.

## NC-213 Progress Report for 1999

From: USDA, ARS  
Grain Quality and Structure Research Unit

By: M. Tilley

NC-213 Objective: C

Procedure: 1a

Project Objective: Develop a fast and accurate method for the determination of waxy status of wheat.

Results for 1999: A sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) mini gel method for the analysis of granule bound starch synthase (GBSS) proteins was developed. Enhanced separation was achieved by omission of SDS in the gel matrix. The system was utilized to screen 46 lines from the Kansas State University wheat breeding program. Using this system we identified 16 lines null at the Wx-A1 allele, 4 lines null at the Wx-B1 allele, and 3 lines null at the Wx-A1 and Wx-B1 alleles. This procedure can be simplified further by the use of a commercial mini gel system that employs prepared cassettes. A manuscript detailing the methodology is currently in review.

Plans for 2000: The project is completed.

### Publications:

Gaines, C.S., Raeker, M., Tilley, M., Finney, P.L., Wilson, J. D., Bechtel, D.B., Martin, R.J., Seib, P.A., Lookhart, G.L., and Donelson, T. 2000. Associations of starch gel strength, granule size, partial waxiness, milling quality, and kernel texture of twelve soft wheat cultivars. *Cereal Chem.* (In press).

Issues: In order to remain competitive in the global market place, US wheat producers will be required to produce wheat that is optimal for the production of specialized products. A method or methods that can quickly detect and discriminate GBSS is needed to advance the breeding of a US waxy wheat.

What's been Done: Analysis of GBSS in lines from the Kansas State University wheat breeding program was performed using an SDS-PAGE mini gel method without SDS in the gel matrix. Of the 46 lines analyzed 16 lines null at the Wx-A1 allele, 4 lines null at the Wx-B1 allele, and 3 lines null at the Wx-A1 and Wx-B1 alleles were identified.

Impact: The development of rapid, sensitive tests that provide unequivocal determination of the waxy status of wheat should be useful to wheat breeders.

## NC 213 Progress Report for 1999

From: Iowa State University  
Agricultural and Biosystems Engineering  
Department of Food Science

By: Charles R. Hurburgh Jr.  
G. R. Rippke  
Craig Heithoff  
Connie L. Hardy  
Sylvie A. Roussel

NC 213 Objective: C

Procedure: 1a

Project Objective: Develop grain-trade applications for near-infrared analyzers.

Results for 1999: Genetic modifications (referred to as GMOs), such as insect or herbicide resistance, are causing increased consumer concern in international grain markets. Sales of guaranteed non-GMO grain are increasing, causing grain buyers to isolate certain grain varieties for these markets. Grain buyers need a method of product identification that is faster and simpler than chemical methods used by laboratories.

The Iowa State University Grain Quality Laboratory has successfully identified Roundup Ready™ (RR) soybean samples (a GMO) with near-infrared spectroscopy (NIR) technology. Sample sets of 1998-crop RR and non-RR samples were used to develop discriminate analysis calibrations for three models of near-infrared analyzers.

Figure 1 shows the spectral differences between RR and non-RR samples. There was a general offset plus specific effects in wavelengths around 910 nm and around 1000 nm. These correspond to C-H overtones, which supports other published reports that the RR modifications may alter fiber structure. The average nutritional values (protein, oil, crude fiber, and saturated fats) were not significantly different between RR and non-RR samples.

The Foss Grainspec™ and Foss/Tecator Infratec™ near-infrared transmittance instruments correctly identified 99.0% and 89.7% as being either RR or non-RR, respectively. These are the two models most often used by grain buyers. On an independent validation set of 20 non-RR and 19 RR samples, the Infratec instrument correctly identified 95% of the non-RR samples and 84% of the RR samples.

The calibrations were field-tested in working Infratec units during harvest 1999. An update of the calibrations, using a much larger database and alternate mathematics, is being done.

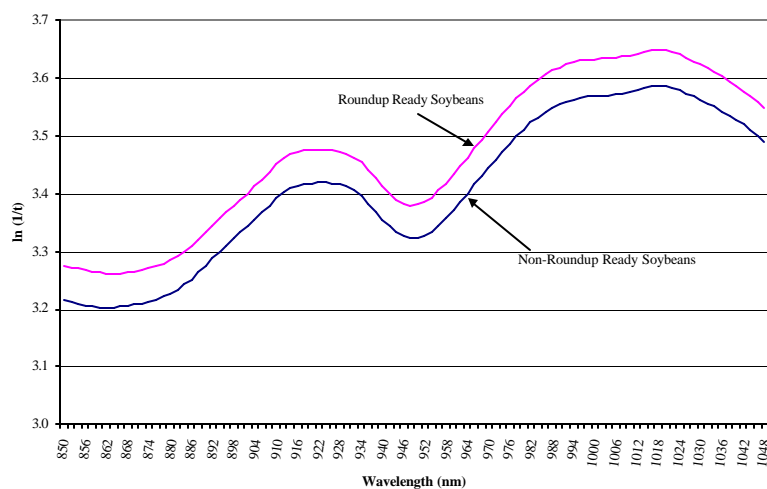


Figure 1. Near-Infrared Transmittance Spectra of Roundup Ready and Non-Roundup Ready Soybeans

Plans for 2000: Complete calibrations for RR soybeans and 2 corn events. Field test and license for market use. Estimate lower limit of detection in blended lots.

Publications:

Hurburgh, C. R. Jr., G. R. Rippke, C. Heithoff, S. A. Roussel, C. L. Hardy. 2000. Detection of genetically modified grains by near-infrared spectorscopy. Proc. Pittcon 2000. [www.pittcon.org](http://www.pittcon.org).

Hurburgh, C. R. Jr., G. R. Rippke and C. Heithoff. 2000. Near-infrared spectroscopy system and method. U.S. Patent Applications. 09/317,363 and 09/317,378.

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: O. K. Chung  
J. L. Steele  
I. Y. Zayas

NC-213 Objective: C

Procedure: 1b

Project Objectives: Develop digital image methodology to objectively assess bread quality.

Sub-Title: Develop digital image methodology to objectively assess bread quality.

Results for 1999: Computer program development for computation of image texture parameters continued. A sub-set of pup loaf images was identified for in-depth study. New methods of assessing bread crumb grain using light sensors were discussed with Kansas State University researchers.

Plans for 2000: Compute image texture features of pup loaf slices where slice boundaries and unimportant regions are omitted.

Issues: Objective methods for bread crumb grain assessment in a wheat quality research laboratory are needed.

What's been Done: A database of pup loaf slice images representing the baking results of breeder samples evaluated in the Hard Winter Wheat Quality Laboratory over the last three years was acquired. The data base includes expert crumb grain scores; milling, mixing and baking performance parameters; and other physical and chemical properties of the originating wheat. Software to produce new image texture parameters for further evaluation was refined.

Impact: Objective evaluation of pup loaf crumb grain should lead to better correlation of baking performance with other measures of wheat quality and performance.

## NC-213 Progress Report for 1999

From: USDA, ARS  
Grain Marketing and Production Research Center  
Engineering Research Unit

By: F. E. Dowell  
C. R. Martin  
J. L. Steele

NC-231 Objective: C

Procedure: 1b

Project Objective: Measure single kernel quality attributes

Results for 1999: Development of the integrated SKCS 4100+NIR, which is now being produced commercially by Perten Instruments (SKCS 4170), was completed and kernel orientation and lighting for the imaging system are now being optimized. This instrumentation can provide the grain industry with a rapid, automated means of determining single kernel attributes such as morphological characteristics, moisture, hardness index, color, protein, vitreousness, scab damage and insect infestation.

Plans for 2000: Continue with plans to incorporate other independent measures such as machine vision capabilities on the SKCS. We also will continue collaborative investigations of the potential of SKCS measurements to predict single kernel protein and color and the milling and baking performance of wheat. We will investigate variables that influence system physical measurements and expand the application of the system to physical measurements of other grains. We will also continue investigations of additional uses for NIR analytical technology including the measurement of insect characteristics.

### Publications:

Baker, J.E., Dowell, F.E. and Thorne, J.E. 1999. Detection of parasitized rice weevils in wheat kernels with near-infrared spectroscopy. *Biol. Control* 16:88-90.

Dowell, F. E. 1998. Automated color classification of single wheat kernels using visible and near-infrared reflectance. *Cereal Chem.* 75(1):142-144.

Dowell, F.E., Ram, M.S. and Seitz, L.M. 1999. Detection of scab, vomitoxin, and ergosterol in single wheat kernels using NIR spectroscopy. *Cereal Chem.* 76(4):573-576.

Wang, D., Dowell, F.E. and Lacey, R.E. 1999. Single wheat kernel color classification using neural networks. *Trans. ASAE.* 42(1):233-240

Wang, D., Dowell, F.E. and Lacey, R.E. 1999. Single wheat kernel size effects on near-infrared reflectance spectra and color classification. *Cereal Chem.* 76(1):34-37.

Wang, D., Dowell, F.E. and Lacey, R.E. 1999. Predicting the number of dominant R alleles in single wheat kernels using visible and near-infrared reflectance spectra. *Cereal Chem.* 76(1):6-8.

Wang, D., Dowell, F.E. and Lacey, R.E. 1999. Single wheat kernel color classification by using near-infrared reflectance spectra. *Cereal Chem.* 76(1):30-33.

Whitaker, T.B., Hagler, W.M., Jr., Giesbrecht, F.G., Dorner, J.W. Dowell, F.E. and COLE, R.J. 1998. Estimating aflatoxin in farmers' stock peanut lots by measuring aflatoxin... *J. Assoc. Off. Anal. Chem.* 81(1):61-67.

Issues: Many grain characteristics, such as scab damage or internal insects, are not uniformly expressed in each kernel or uniformly distributed in a sample. Thus, a means of rapidly measuring single kernel attributes is needed.

What's been Done: We integrated a NIR spectrometer with a kernel singulator that allows rapid, automated detection of single kernel attributes.

Impact: This integrated system will provide the grain industry with information that will allow them to make more decisions concerning storage, segregation, milling, etc.

## NC-213 Progress Report for 1999

From: University of Illinois  
Agricultural Engineering  
Identity Preserved Lab

By: Marvin R. Paulsen  
Binying Ye  
Steven Mbuvi  
Muti Bajaj

NC-213 Objective: C

Procedure: 1b

Project Objective: To develop methods to automatically detect and measure physical defects and morphological factors of corn and soybean kernels that relate to quality and end-use.

Results for 1999: Stress crack percentages tend to be higher in years where more percentage points of moisture are removed by artificial drying. Extractable starch tends to be higher when stress crack percentages are lower but this may also be indicative of favorable kernel filling and field drying conditions. The cost saved by a one percentage point improvement in extractable starch is variable but is influenced by price differentials between increased starch offset by reduced gluten meal and gluten feed estimated at about 2.9 cents per bushel and avoiding a decrease in milling plant capacity. A 5% reduction in capacity would spread capital costs over fewer bushels making costs go up by 4 to 6 cents per bushel. If starch was improved by using less severe drying conditions, a 10% improvement in germ oil recovery is also possible. It is difficult to determine the maximum improvement, but a one percentage point increase in extractable starch is easily worth 4 to 6 cents per bushel. Laboratory-dried corn had a 0.9 to 16.0 percentage point range in extractable starch reduction due to drying at 90 to 100C rather than ambient temperatures. Corn obtained from commercial crossflow dryers had a maximum reduction of 3.1 percentage points for corn dried at 110C. The crossflow configuration did not reduce extractable starch as much as the laboratory dryers. The crossflow configuration likely does not reduce extractable starch equally across the column of dried grain, thus more variability is obtained from commercial dryers and the effects on reducing extractable starch are not as extreme as with laboratory shallow layer dryers.

Near-infrared transmittance calibrations for the Infratec 1229 predicted reductions in extractable starch of 0.3 to 3.1% points for the 90 to 100C laboratory-dried corn and up to 2.3 percentage points for the corn dried in a commercial crossflow dryer at 110C. For the crossflow dryers at drying air temperatures of 99C (210F) and above, consistent reductions in extractable starch were found. At temperatures of 88C (190F) and below reductions in extractable starch were variable, probably due to the sample containing

corn from the outer parts of the column of dried grain that did not reach a temperature high enough to reduce extractable starch. Reducing drying air temperature of crossflow dryers can enable extractable starch levels to be maintained high, however the value of the additional extractable starch must be greater than the loss in energy efficiency and the cost for reduced drying capacity. Drying systems with less airflow will incur less loss in energy efficiency when temperature is lowered than will systems using higher airflows.

Plans for 2000: Are to add more high-temperature dried samples and other types of corn that have very low and very high extractable starch percentages in the calibration and validation test sets.

Publications:

Zhang, T., Q. Zhang, and M.R. Paulsen. Data smoothing filter design using genetic algorithms. ASAE Paper No. 99-3021. ASAE. St. Joseph, MI. (1999).

Paulsen, M.R., S.W. Mbuvi, A.E. Haken, B. YE and R.K. Stewart. Extractable starch as a quality measurement of dried corn. ASAE Paper No. 99-6023. ASAE. St. Joseph, MI. (1999).

Issues: Ability to quickly measure extractable starch in corn

What's been Done: Starch yield is influenced by corn variety, environmental conditions, and by drying methods that involve application of heat in the presence of moisture. Past research has shown starch yields vary between 58 to 72% depending on hybrids, with an additional 5 to 6% point variation due to drying methods.

Impact: Presently most researchers and dryer manufacturers consider stress cracks to be the primary indicator of corn drying quality; however for corn used for wet milling extractable starch is a highly important indicator of value. With appropriate calibrations it can be quickly measured using NIT or NIR instruments. With selection of corn varieties with high extractable starch combined with drying methods, higher extractable starch corn can be obtained with an minimum estimated increase in value of 4-6 cents per bushel per percentage point of extractable starch, after accounting for co-product values.

Funding source:

Illinois Council on Food and Agricultural Research; Optimum Quality Grains, LLC., Illinois Agricultural Experiment Station

Contacts:

Marvin R. Paulsen, 360-B Agricultural Engineering Sciences Bldg., 1304 W. Pennsylvania Ave., Urbana, IL 61801; 217-333-7926 Fax: 217-244-0323 e-mail: [mrp@age.uiuc.edu](mailto:mrp@age.uiuc.edu)

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: E. K. Haque  
C. Pasikatan  
C. K. Spillman  
J. L. Steele

NC-213 Objective: C

Procedure: 1b

Project Objectives: Develop a methodology to relate the physical properties of wheat kernels to milling energy and optimum mill settings.

Sub-Title: Develop a methodology to relate the physical properties of wheat kernels to milling energy and optimum mill settings.

Results for 1999: Experimental results showed that a particular combination of sample presentation, spectral preprocessing, particle size classification, and NIR wavelength range has potential for rapid prediction of particle size (mass) fractions for ground material from a first break roller mill. Test results confirmed previous studies in that scattered light is the carrier of particle size information, not absorbed light. A calibration standard error of performance (SEP) across seven wheat classes (durum, hard red winter, hard red spring, hard white, soft red winter, soft white wheat, white club) ranged from 3.5 to 4.2. Improvement in prediction performance was obtained (SEP of 2.9 to 3.0) when spectra were pre-classified according to hard and soft wheats. Greater improvement in prediction performance was obtained with calibrations specific to one wheat class (SEP of 1.0 or less). In representative sampling of first-break ground wheat, the better samplers were the spinning riffler and the Gamet rotary divider which gave consistent measures of particle size (geometric mean diameter and geometric standard deviation) independent of sampling amount. Representative samples as small as 5g could be obtained by these samplers when sampling was completed in one or two sample dividing cycles.

Plans for 2000: Develop an algorithm combining the measures of single kernel properties of input wheat, energy requirement and particle size information from ground wheat for controlling roller mill gap settings for optimum break release. Identify the best combination of presentation method, spectral preprocessing, and wavelengths needed for rapid prediction of mass particle size distributions in first break ground wheat. Develop the theory and procedures for particle size estimation by NIR scattering and conceptualize an online particle size prediction system for first break roller mill applications. Demonstrate or simulate an algorithm and control system performances.

Publications:

Pasikatan, M.C., Steele, J.L., Milliken, G.A., Spillman, C.K. and Haque, E. 1999. Particle Size Distribution and Sieving Characteristics of First-Break Ground Wheat. ASAE Paper No. MC99-129. Presented at the 1999 ASAE Mid\_Central Conference, April 30\_May 1, Ramada Inn, St. Joseph, MO.

Pasikatan, M.C., Steele, J.L., Spillman, C.K., HAQUE, E. and Higgins, J.J. 1999. Representative Sampling of First-Break Ground Wheat. ASAE Paper No. 99\_6017. Presented at the 1999 ASAE Annual International Meeting, July 18-21, Sheraton Center, Toronto, Ontario, Canada.

Issues: Translation of single kernel physical measures to roller mill performances, gap settings, roll speeds and ground material size distribution is needed to advance single kernel technology and improve flour mill performances.

What's been Done: An instrumented two-roll mill has been developed. Milling, energy and ground material size relationships with single kernel parameters were determined. The feasibility of predicting particle size fractions of the ground wheat from a first-break roller mill was demonstrated. Methods of sub-sampling first break roller mill material were evaluated. Sample presentation methods for spectral assessment were evaluated.

Impact: Successful research will provide a rapid method of determining particle size fractions (mass) with NIR spectral assessments, an understanding of how roller mill performance relates to resulting size distributions, the energy required to create new particle surface area and how that performance can be predicted based on the SKCS measures of single kernel physical properties.

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: C. W. Deyoe  
J. Gwartz  
P. McCluskey  
J. L. Steele

NC-213 Objective: C

Procedure: 1b

Project Objective: Obtain wheat samples and corresponding mill performance data from two SRW, two SWH and one HRS commercial mills. Process locally all samples for SKWCS data, dockage and test weight. Determine the performance of the existing HRW wheat milling model and the model modifications or adaptations needed to achieve satisfactory mill performance predictions for SRW, SWH and HRS wheat.

Sub-Title: Use of SKCS Data for Commercial Milling of SRW, SWH and HRS Wheat

Results for 1999: Additional commercial mills were enlisted as project cooperators through visitation and presentation of existing mill prediction model performances for SRW, HRS and SWH wheat. Collection and processing of second year samples representing SRW, HRS and SWH commercial mills was completed. One additional SWH mill has provided samples. Two mills have supplied SRW wheat samples. One SRW(1) mill is located in the upper SRW area (IL, IN, OH) and the second SRW(2) represents a more southern area (KY, TN). A third mill provided samples of HRS representing the northern U.S. and a fourth mill from the Pacific Northwest (PNW) region provided samples of SWH. A second PNW mill has submitted samples of SWH for testing and inclusion in the database. The cooperating mills were asked to supply samples of dirty wheat (wheat before cleaning) as well as clean mill mix samples. SRW, HRW, and HRS wheat samples from the 1999 crop survey were obtained to provide additional commercial wheat representation. SRW samples from AK, IN, IL, OH, MO, NC and VA were included in Buhler Experimental Milling tests. Experimental mill tests were completed on the SRW and SWH samples. Single kernel weights and single kernel diameters of the 1999 HRW crop appear similar to those of the 1998 crop. Samples damaged by extensive rains during harvest were lower in SKH values (average differences of 10 to 20 hardness units) than that observed for the 1998 crop. Data for the SRW samples revealed some mixed wheat samples in certain regions, but there were less mixed samples from Ohio than observed in 1998. The extensive amount of low SKH values for HRW has prompted studies on cumulative ash for composites of "hard" or "soft" from selected sampling regions.

Plans for 2000: Complete the scope of the project, analyze prediction performances and summarize project results.

Publications:

Deyoe, C. 1998. Using single kernel characteristics in grain purchasing and the milling industry. Presented at the AIB Single Kernel Workshop, AIB, Manhattan, KS, August 24-26, 1998.

Deyoe, C. 1999. Using single kernel characteristics in grain purchasing and the milling industry - updated version. Presented at the AIB Single Kernel Workshop, Fort Worth, Texas, May, 1999.

Deyoe, C. 1999. Using single kernel characteristics in grain purchasing and the milling industry - updated version. Presented and copies provided to a Foreign Trade Team.

Issues: Greater utilization and application of new technologies for rapid objective grain quality assessment in the market channel. A mill performance prediction model for classes of wheat other than HRW is needed.

What's been Done: Identified four cooperating mills that were willing to provide SRW, HRS and SWH wheat samples, obtained first year samples and mill performance results, reviewed the mill prediction model and possible applications on site with the cooperating SRW mills. Preliminary results were presented to various domestic and international industry groups.

Impact: The adoption of single kernel physical measures and other new technologies for quality assessment are beginning to be utilized. Adoption of the mill prediction methods depends on demonstrations that the model can be applied to any specific mill. Millers need to see how this can be done for their mill and class of wheat being milled.

## NC 213 Progress Report for 1999

From: Iowa State University  
Agricultural and Biosystems Engineering  
Department of Economics  
Department of Food Science

By: L. A. Johnson  
Connie L. Hardy  
Charles R. Hurburgh Jr.

NC 213 Objective: C

Procedure: 2a

Project Objective: Relate quality attributes to processing value.

Results for 1999: Two comprehensive corn attribute studies were peer-reviewed and published.

Plans for 2000: This work is complete. We will be emphasizing amino-acid levels in soybeans in the 2000 year.

### Publications:

Johnson, L. A., C.P. Baumel, C. L. Hardy, and P. J. White. 1999. Identifying valuable corn quality traits for starch production. Publ. EDC – 194, University Extension, Iowa State University, Ames, IA. [www.iowagrains.org](http://www.iowagrains.org).

Johnson, L. A., C. L. Hardy, C. P. Baumel, T. H. Yu, and J. L. Sell. 1999. Identifying valuable corn quality traits for livestock feed. Publ. EDC – 195, University Extension, Iowa State University, Ames, IA. [www.iowagrains.org](http://www.iowagrains.org).

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: D. L. Brabec  
M. D. Shogren  
J. L. Steele

NC-213 Objective: C

Procedure: 3a

Project Objective: Instrument a 10g mixograph for both moving and fixed bowl operation. Determine the systematic response of the mixograph pin motion, velocities and torque cycles. Develop procedures to torque calibrate the moving and fixed bowl systems. Determine differences in moving vs. fixed bowl mixograms. Demonstrate that mixograms are equivalent when the system dynamics of the spring mass platform are taken into account. Develop standardized mixogram analysis procedures and evaluate the effect of flour mass, absorption, mixing speed and moving pin direction. Instrument two variable speed 100g mixers and compare the mixing results with that of a 10g mixograph at various levels of speed, flour mass and absorption. Determine acceptable methods of adding NIR spectra acquisition and analysis on the 10g and 100g mixers.

Sub-Title: Analysis and interpretation of digitized mixograms for objective assessment of flour quality.

Results for 1999: Additional data and comparisons between mixer sizes confirmed the equality of mixing energy per unit of flour on two sizes of mixers, the 10 g mixograph and an instrumented 100 g mixer, when mixer dynamics are taken into account. Adoption of new mixograph analysis procedures were proposed. Collection of NIR spectra during mixing was synchronized with the 10g moving pin positions.

Plans for 2000: Continue tests of comparison between the 10g and 100g instrumented mixers. Continue development of computerized motor speed control for the 10g and 100g mixers. Determine acceptable methods of adding NIR spectra acquisition and analysis on the 10g and 100g mixers.

### Publications:

Steele, J.L., Shogren, M.D. and Brabec, D.L. 1999. Mixograph analysis guidelines based on mixograph dynamics. Poster Paper, AACC Tri-sectional Meeting, Manhattan, KS.

Steele, J.L., Shogren, M.D. and Brabec, D.L. 1999. Mixograph analysis guidelines based on mixograph dynamics. Presentation, Annual Meeting AACC, Seattle, WA, November 1999.

Issues: While mixograms have been used for many years to assess mixing and baking qualities of wheat, the correct and full interpretation of mixograms is in question with the advent of digitized analysis. Some of the parameters used to describe mixing properties have no theoretical basis, especially when mixer dynamics is not understood. Correct translation of laboratory scale mixing results to larger, different speed, and/or different mixing action mixers is not clear, even among smaller laboratory mixers, and especially for large commercial mixers.

What's been Done: A 10g mixograph was instrumented in a way that allows extraction of dough mixing torques/forces exclusive of instrument dynamics. When the same flour is mixed in mixers of differing dynamics, the correctly extracted mixing properties of the flour were found to be the same, regardless of mixer dynamics. A 100g mixer was similarly instrumented to further demonstrate equality of method, study a larger mixer, mixing speeds and absorption responses. The equality of mixing energy per unit of flour on two sizes of mixers, 10 g and 100 g, was confirmed.

Impact: Better understanding of dough mixing, mixer instrumentation and potential to translate small mixer and new varietal performances to large commercial mixers.

## NC 213 Progress Report for 1999

From: Iowa State University  
Agricultural and Biosystems Engineering  
Economics  
Food Science

By: Charles R. Hurburgh Jr.  
L. A. Johnson

NC 213 Objective: C

Procedure: 2a

Project Objective: Relate quality attributes to processing value.

Results for 1999: Two comprehensive corn attribute studies were peer-reviewed and published.

Plans for 2000: This work is complete. We will be emphasizing amino-acid levels in soybeans in the 2000 year.

### Publications:

Johnson, L. A., C.P. Baumel, C. L. Hardy, and P. J. White. 1999. Identifying valuable corn quality traits for starch production. Publ. EDC – 194, University Extension, Iowa State University, Ames, IA. [www.iowagrains.org](http://www.iowagrains.org).

Johnson, L. A., C. L. Hardy, C. P. Baumel, T. H. Yu, and J. L. Sell. 1999. Identifying valuable corn quality traits for livestock feed. Publ. EDC – 195, University Extension, Iowa State University, Ames, IA. [www.iowagrains.org](http://www.iowagrains.org).

## NC-213 Progress Report for 1999

From: USDA, ARS  
Grain Marketing and Production Research Center

By: L. M. Seitz

NC-213 Objective: C

Procedure: 3a

Project Objective: Identify fungi-grain interrelationships which may regulate invasion and damage of grain by storage fungi, and identify volatiles associated with unacceptable odors in grain.

Results for 1999: Off-odor is an indicator of poor quality grain regardless of whether the grain will be used for food, feed, or other industrial purpose. Analyses of volatile compounds in 750 grain samples (corn, sorghum, soybeans, and wheat) with all types of off-odors were conducted to identify compounds that caused or were associated with off-odors. The acquired data showed that volatile compounds could be grouped together and associated with a type of odor, i.e., one group with musty odor, another group with sour odor, and so forth with other odors such as insect, smoke, and weed-like. Detection of specific volatile compounds in grain can provide important information about the quality of the grain, not only relating to off-odors but also relating to problems that developed in storage or transport such as insect infestation, mold growth, and overheating. Evaluation of results from a sensor-array based "electronic nose" instrument showed that more development work would be needed to achieve satisfactory classification of odors in various types of grain samples. Volatiles in samples of doughs, breads, and popcorn were identified and relationships between compounds and flavors were evaluated. An ergosterol assay, along with rapid-scanning near-infrared methodology, for measuring fungal contamination in single wheat kernels with various levels of scab infection was published.

Plans for 2000: Evaluation of sensory and chemical data collected from large groups of grain samples will be continued. Publications will be written on compound-odor associations, relationships among compounds, and how volatile compounds can indicate problems in stored grain caused by insects, molds, and spontaneous heating. Information will be developed on odor vs. compound relationships that could be used to aid odor assessments during grain inspections. Continued efforts on volatile compound analyses will be focused on flours, doughs, bread ingredients, freshly baked breads, and other cereal-based food products.

Publications:

L. M. Seitz, M. S. Ram, and R. Rengarajan. 1999. Volatiles obtained from whole and ground grain samples by supercritical carbon dioxide and direct helium purge methods: observations on 2,3-butanediols and halogenated anisoles. *J. Agric. Food Chem.* 47:1051-1061.

M. S. Ram, L. M. Seitz, and R. Rengarajan. 1999. Use of an autosampler for dynamic-headspace extraction of volatile compounds from grains and effect of added water on the extraction. *J. Agric. Food Chem.* 47: 4202-4208.

F. E. Dowell, M. S. Ram, N. Zhang, T. J. Herrman, and L. M. Seitz. 1999. Predicting scab, vomitoxin, and ergosterol in single wheat kernels using near-infrared spectroscopy. *Cereal Chem.* 76:573-576.

A. Sayaslan, O. K. Chung, P. A. Seib, and L. M. Seitz. 1999. Volatile compounds in five starches. *Cereal Chem.* [In press]

L. M. Seitz and M. S. Ram. 1999. Volatile methoxybenzene compounds in grains with off-odors. *J. Agric. Food Chem.* [In review].

Issues: A safe, objective method for classifying odors is needed for routine use by grain inspectors. Rapid methods are needed for determining grain quality.

What's been Done: From sensory and volatile compound analyses of several groups of samples (up to 750 samples per group), we have developed a list of more than 40 compounds that are associated with off-odors in grains. Various types of methodology, including some automation, for determining volatile compounds in whole grain samples were developed. Results of limited tests with sensor-array based "electronic nose" instruments indicated that more development work was needed to achieve satisfactory classification of odors in grain samples.

Impact: The information could be used to set up an objective reference method for odor determinations and it will aid development and testing of "electronic nose" instruments. Detection of specific volatiles could indicate deterioration of grain by molds, insects, and heating during storage or transport.

## NC-213 Progress Report for 1999

From: University of Nebraska  
Food Science & Technology

By: Lloyd B. Bullerman

NC-213 Objective: C

Procedure: 3b

Project Objective: Evaluate the use of ergosterol as an early indication of mold activity in grain and/or feeds and correlate this to detection of mold growth using colony count methods and mycotoxin production. Develop HPLC and ELISA methods for detection and quantification of moniliformin in cereal grains.

Results for 1999: The relationship of mold count, ergosterol and ochratoxin A production was studied at different inoculum levels of *A. ochraceus* NRRL 3174 and *P. viridicatum* NRRL 3260 grown on sterile long grain white rice. Ergosterol and ochratoxin A were detected after 3 days of incubation and reached maximum levels at 7-10 days, then declined. Ergosterol measurement by high performance thin-layer chromatography (HPTLC) was a useful method to detect fungal activity, which corresponded to ochratoxin production. Total mold counts were detectable before ergosterol or ochratoxin A, but since plate counts take 3-5 days, the ergosterol method was still quicker. Polyclonal antibodies against moniliformin were produced and an indirect enzyme-linked immunosorbant assay (ELISA) was developed, but sensitivity was low and improvements are needed.

Plans for 2000: Work on increasing the sensitivity of the ELISA for moniliformin.

### Publications:

Saxena, J., C. Munimbazi, and L. B. Bullerman. 2000. Relationship of mold count, ergosterol and ochratoxin A production. *J. Food Mycology* 3: (In Press).

Castelo, M. M. 1999. Stability of mycotoxins in thermally processed corn products. Ph.D. Dissertation, University of Nebraska, Lincoln.

Issues: A good biochemically based method for detection and quantitation of moniliformin would supplement chemical methods and facilitate studies of the stability of moniliformin during thermal processing.

What's been Done: The work was done to compare mold count with ergosterol content and ochratoxin production by two ochratoxin producing molds to see if correlations might exist. An attempt was made to develop an antibody based ELISA test for moniliformin.

Impact: The work further documents the usefulness of ergosterol determination as a means of early rapid detection of mold activity and possible mycotoxin production. An ELISA test for moniliformin will be used as another test to monitor the effects of thermal processing on moniliformin and will help facilitate that research.

## NC-213 Progress Report for 1999

From: University of Nebraska  
Food Science & Technology

By: Lloyd B. Bullerman

NC-213 Objective: C

Procedure: 3c

Project Objective: Determine effects of processing on *Fusarium* spp., fumonisins, moniliformin, deoxynivalenol and zearalenone by monitoring the survival of the organisms and toxins.

Results for 1999: The stability of aflatoxins, fumonisins and moniliformin through the corn flake manufacturing process was studied. Significant reductions of aflatoxins (77-85%) were observed. Reductions of fumonisins (up to 93%) were observed only in the presence of glucose and glucose in combination with maltose. The presence of these sugars did not affect aflatoxin reduction. Reduction of moniliformin was less (27-36%) and was not affected by the presence of sugars. Extrusion cooking of corn grits contaminated with moniliformin resulted in small reductions (up to 34%) of moniliformin. Greatest losses of fumonisin (up to 93%) during extrusion cooking of contaminated corn grits occurred in the presence of 10% glucose and slow (40 rpm) screw speeds. In another study, moniformin was found to be fairly stable in several heat processes and temperatures. It was least stable at pH 10 and in the tortilla process.

Plans for 2000: Work will be done to optimize the parameters and extrusion conditions to obtain greater reductions of fumonisins, moniliformin, deoxynivalenol and zearalenone in the extrusion process in general and extruded corn and wheat products in particular.

### Publications:

Castelo, M. M. 1999. Stability of mycotoxins in thermally processed corn products. Ph.D. Dissertation. University of Nebraska, Lincoln.

Pineda-Valdes, G. 1999. Heat stability of moniliformin in corn. M.S. Thesis. University of Nebraska, Lincoln.

Issues: Mycotoxins, including aflatoxins, fumonisins, moniliformin, deoxynivalenol and zearalenone may contaminate corn and wheat. Information is needed to determine the fate of these mycotoxins in several thermal food processes that are used to convert raw corn and wheat into processed food products.

What's been Done: Several thermal food processes were studied for their effect on the stability or amount of loss of aflatoxins, fumonisins and moniliformin, mycotoxins that are sometimes found in corn.

Impact: The work showed that the different mycotoxins had differing degrees of stability in different processes. Aflatoxins were significantly reduced by the corn flake process, whereas fumonisin and moniliformin were more stable in that process. Adding glucose to corn grits before processing significantly reduced fumonisin levels during both corn flake manufacture and extrusion cooking. Moniliformin was fairly stable in the corn flake process and extrusion, but was greatly reduced with the alkaline process of tortilla manufacture. This information will be of help to regulatory agencies in doing risk assessments of the mycotoxins in processed cereal products and may serve as a guide to the food industry in adjusting processes to achieve the greatest reductions of these toxins in processed foods.

## NC-213 Progress Report for 1999

From: University of Illinois  
Agricultural and Consumer Economics

By: Lowell D. Hill  
Marvin Paulsen  
Karen Bender

NC-213 Objective: D

Procedure: 1c

Project Objective: Estimate Differences in Value of Products Derived from Processing Corn and Soybeans.

Results for 1999: Japanese wet millers provided destination quality data on every vessel of corn received from the United States and South Africa between 1990 and 1996. Vessels from U.S. origins were matched with FGIS quality data from gulf ports (NOLA) and the pacific northwest (PNW). The analysis provided additional insights into quality problems of Japanese wet millers.

The results of this analysis identified several important relationships as well as failing to support some earlier assumptions held by processors.

1. In general, the quality of corn at a particular grade level in NOLA ports does not show economically important differences from corn in PNW ports at the time of loading. At both NOLA and PNW origins, Grade 2 corn is significantly better than Grade 3 corn in terms of MOIS, DKT, BCFM, and TW, but differences are less than differences between grade limits. On average, at the time of loading, Grade 2 and Grade 3 corn were better than grade limits in the contract.
2. Changes in corn quality occur between U.S. and Japanese ports. While MOIS content on average changed by only 0.04 percent, BCFM, DKT, and TW were significantly worse at destination. S.A. corn was also higher in defective kernels (a combination of DKT and BCFM) upon arrival in Japan compared to S.A. quality specifications for Grade 1.
3. Most quality differences between corn originating in PNW and NOLA ports were not significant at destination, and the effect of differences at the time of loading was reduced during transit. The exception was that the increase in DKT between PNW and Japan was much greater than the increase in DKT in corn loaded at NOLA. As at origin, Grade 2 corn at destination was superior overall to Grade 3 corn from both NOLA and PNW ports.

4. The average quality of S.A. corn differed from that of U.S. corn when measured in Japan. U.S. yellow corn was significantly higher in MOIS, BCFM, starch content, and stress cracks, and significantly lower in DKT, TW, and germination rate than S.A. yellow corn. U.S. white corn was significantly higher in MOIS, TW, starch content, stress cracks, and significantly lower in germination rate than S.A. white corn.
5. The starch yield predicted by Japanese processors for each vessel was associated with differences in starch content, BCFM, and country of origin. The regression equation explained 84 percent of the variation in predicted starch yield. However, predicted starch yield bore little relationship to actual starch yield (correlation = 0.20).
6. The coefficients for the variables of starch content, country of origin, germination rate, and level of defects (including foreign material, insects, and spoilage) were statistically significant in the model with actual starch yield. Overall this relationship was not strong, however. Since these variables explained only 42 percent of the variation in actual starch yield over time.
7. Japanese processors expect S.A. corn to yield more starch than U.S. corn, and it usually does, despite slightly higher average starch content in U.S. corn. Although numerous quality factors were examined, and all products were converted to a dry basis to eliminate the effect of moisture, no combination of variables was a successful predictor of actual starch yield reported by Japanese processors. Percent of kernels with stress cracks (an indicator of severe drying practices) was not a significant variable in the regression analysis.
8. Although Japanese buyers on average paid a 4.5 percent premium for S.A. over U.S. corn, analysis of monthly weighted average data revealed little relationship between reported prices for corn wet milling and its predicted or actual starch yield. Higher yields of starch (actual and predicted) and superior quality in terms of BCFM and stress cracks justify the premiums paid for S.A. corn, but the data available for this study were not adequate to demonstrate a relationship between price premiums and any set of quality attributes including yield of starch.
9. Quality factors of S.A. corn at destination were compared with the allowable limits for those factors at origin in South Africa. Actual origin data was unavailable so the maximum factor limits for South Africa Grade I yellow corn were used as a substitute. Assuming that the corn was within Grade I factor limits at the time of loading, percent moisture had decreased and percent defective kernels had increased by the time the corn arrived in Japan. Statistical analysis was not conducted since no actual observations were available at origin.

Publications:

Reimer, Jeffrey J., Lowell D. Hill, Karen L. Bender. Comparative Quality for the Japanese Corn Starch Industry. Department of Agricultural and Consumer Economics. Illinois Agricultural Experiment Station, University of Illinois at Urbana-Champaign. AE-4725. Feb. 19, 1999.

Reimer, Jeffrey J., Unpublished Thesis, "The Implicit Price of Corn Quality Characteristics in U.S Exports to Japan". Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign. June 1999.

Bode, Glen W., Unpublished Thesis, " A Hedonic Price Model for Japanese Soybean Imports". Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign. June 1999.

Issue: Can the U.S. compete with South Africa in supplying corn to Japanese wet millers? What are the best strategies for reducing quality losses in the export market for corn?

What's been Done: Japanese wet millers were solicited for data on shipments received from all countries of origin. They provided information for six years on every vessel identified by name and origin. These data were analyzed for comparison between origin and destination data and for comparison between U.S. and South Africa origins.

Impact: Japan wet millers were given a basis for specifying superior quality in their contracts, primarily percent of kernels containing stress cracks. The information was sufficiently important to the wet milling industry in Japan that one of the wet millers used the data in a presentation at a conference where he was speaking to a U.S. audience.

Insert Table 1 here.

Insert Table 2 here.

## NC-213 Progress Report for 1999

From: University of Illinois  
Agricultural and Consumer Economics

By: Lowell D. Hill  
Marvin Paulsen  
Karen Bender

NC-213 Objective: D

Procedure: 1d

Project Objective: Estimate the demand for different quality attributes for soybeans used for tofu in Korea.

Results for 1999: The differences in consumer preferences for tofu were matched with varieties to identify those attributes correlated with consumer preferences. There were distinct differences in consumer preferences and yield of tofu (Table 1) among varieties. However the plans to do a demonstration shipment to Korea processors was not completed due to lack of cooperation from the Government agency issuing tenders for delivery of food quality soybeans to Korea. Although the ultimate objective of a demonstration shipment was not achieved, there were several important conclusions from the research.

1. Although yield and quality of tofu differ among varieties, traditional quality measurements such as protein, seed size and hilum color measured at the country elevator will not provide a basis for segregation to meet the needs of Korean tofu processors as a result of the low correlations between attributes of soybeans and tofu. (Table 2)
2. Oil and protein contents were found to influence the chemical composition of tofu but were not satisfactory predictors of quality and yield, even though these attributes along with seed size are frequently used by Japanese importers when purchasing tofu soybeans.
3. A multiple regression model generated a predictive equation for selecting soybeans that would generate higher yields of tofu. However, the model explained less than 40% of the variation in tofu yield from over 500 samples. The attributes significantly correlated with tofu yield were test weight (lower test weight gave a higher yield), soybean moisture content (higher moisture gave a higher yield), and protein (higher protein gave a higher yield). These results indicate a need for finding other attributes related to yield. None of the measures from this study are satisfactory substitutes for selecting by variety on the basis of past experience.

4. Specifications of soybeans with fewer defects (lower foreign material, splits and damage) hold promise for increasing Korean processors preferences for US soybeans. However, control of imports by AFMC and the economic benefit of income from cleaning at importing elevators, continue to be major obstacles to changing the contract to reduce defects below the limits specified in US grade No. 1.

5. Yield and consumer preference tests conducted at the University of Illinois, the Identity Preserved Grain Laboratory and Korean processors' laboratory in Seoul, all provided comparable results, including a relatively low ranking for the Korean grown variety. This provides credibility for research conducted at the University laboratory without the need for in-country testing.

6. Increased interest in importing soy meal, suggests that there may be other forms of soybeans for Korean processors that could bypass import restrictions on raw soybeans. Exploratory research indicates that production and export of soy meal is economically feasible and commercial firms are being encouraged to increase the export volume of full fat soy meal to Korean processors.

Publications:

Bode, Glen, Karen Bender, Lowell Hill, Kyung-won Lee, Jin Faller, Steve Mbuvi, Bradley St. Bonnett. Soybean Quality for Korean Tofu Processors. AE-4729. November, 1999.

Issue: Korean tofu processors want higher quality soybeans for processing, but have no guidelines for selecting by attribute. Identity preserved shipments are too costly and are not allowed by the Korean Ministry of Agriculture within their quota system. Bulk shipments based on readily measured attributes would allow the use of numerical grade plus additional criteria.

What's been Done: Tofu samples made from a wide range of varieties were evaluated by panelists. Differences in preferences were correlated with attributes of soybeans. The quality specifications required to obtain shipments meeting the needs of tofu processors were identified.

Impact: Korean processors were found to have a preference for soy meal over raw soybeans and a private firm is developing the equipment, technology, and the market channel for shipping meal. This will bypass government restrictions on imports and reduce costs of shipping and processing. In addition, Korean processors were encouraged to buy U.S. beans in preference to Canadian and Chinese in response to the efforts made by the U.S. researchers.

Comments: This project was funded by a grant from the Federal/State Marketing Improvement Program, the Illinois department of Agriculture, and the Office of Research, College of Agricultural, Consumer, and Environmental Sciences at the University of Illinois.

Insert Table 1 here.

Insert Table 2 here.

## NC 213 Progress Report for 1999

From: Iowa State University  
Agricultural and Biosystems Engineering

By: Hyesun S. Park  
Charles R. Hurburgh Jr.

NC 213 Objective: D

Procedure: 2

Project Objective: Evaluate the international competitiveness of U.S. quality.

Results for 1999: Samples (177) of soybean meal from 18 countries (including USA) were analyzed for protein, oil, fiber increase activity, amino acids and digestibility. Near-infrared calibrations were developed for protein, oil, and fiber, for three transmission and three reflectance analyzers.

From the various data sources and the physical sampling of soybean meal, the following summary points are made.

1. Meal of U.S. origin was more consistent, and of higher feeding value (more digestible, lower fiber, often higher protein, better quality protein) than meal of other origins. This is a marketing advantage the U.S. can use.
2. Common near-infrared analyzers can measure proximate analysis of meal with the following relative accuracy, expressed as data range divided by standard error of prediction (versus reference)

Moisture:	24-32
Protein:	17-21
Oil:	34-43
Fiber:	15-18

A relative accuracy of 15 is considered excellent for useful quantification.

3. Amino acid levels can be tracked from whole soybeans into soybean meal. Analysis of soybean samples shows that reduced total protein (e.g. in northern growing areas) does not necessarily mean reduced feeding value of meal even at lower nominal protein levels. Likewise soybean modifications that sharply increase limiting amino acids even at the expense of total protein may be best directed at protein deficit areas.

Plans for 2000: Relate soybean quality as determined by the annual survey to plant output meal quality. Repeat world survey.

## NC-213 Progress Report for 1999

From: University of Illinois  
Agricultural and Consumer Economics

By: Lowell D. Hill  
Marvin Paulsen  
Karen Bender

NC-213 Objective: D

Procedure: 3c

Project Objective: To estimate the cost of identity preserved contracts as an alternative to grade designation for specialty grains.

Results for 1999: A survey of grain handlers and processors identified a wide range of costs differing by type of firm and by type of commodity. (Tables 1, 2, and 3) Specialty crops represented only 9 percent of the total volume handled for the grain elevators responding to the survey. This average included a wide range, with minimum of less than 1 percent and a maximum of 40 percent of their volume handled.

A survey of all the country elevators in Illinois provided more detail on cost and revealed that in many cases there was a net loss when all costs were included in the analysis.

Plans for 2000: The survey of country elevators will be repeated and additional analysis will be published.

### Publications:

Bender, Karen, Lowell Hill, Benjamin Wenzel, and Robert Hornbaker.

"Alternative Market Channels for Specialty Com and Soybeans". February 1999.

AE-4726. Department of Agricultural and Consumer Economics,

University of Illinois at Urbana-Champaign.

Swanson, Burton. Illinois Specialty Com and Soybean Handlers Directory 1999.

AE- 4727. April, 1999. Department of Agricultural and Consumer Economics,

University of Illinois at Urbana-Champaign

Wenzel, Benjamin. Unpublished MS Thesis, "An Analysis of the Influence of Market Structure Variables on Price Differentials Between Elevators for Com in Illinois" Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign. June 1999.

Issue: The increased number of quality specifications by domestic and foreign processors requires more information about market demand and sources of supply.

What' been Done: The survey of grain handlers and oil processors was completed to identify firms handling specialty grains and the type of grain being handled. A directory was published to aid farmers in finding outlets for their specialty grains. Cost and returns by grain and by firm type were calculated.

Impact: Producers have better information on which to base decisions about participating in specialty grain contracts.

Comments: This project was supported by funds from the Soybean Research and Development council, and the Illinois council on Food and Agricultural Research (C-FAR).

Insert Table 1 here.

Insert Table 2 here.

Insert Table 3 here.

## NC 213 Progress Report for 1999

From: Iowa State University  
Agricultural and Biosystems Engineering  
Economics

By: Charles R. Hurburgh Jr.  
Robert Cogdill  
Roger G. Ginder

NC 213 Objective: D

Procedure: 4a

Project Objective: Develop a marketing system for soybeans, based on protein and oil values.

Results for 1999: Based on the information from the PHP study in 1998, the oilseed processor AGP Inc., instituted an oil content premium scale on October 1, 1999. At the same time the study was repeated, with emphasis on certain varieties that showed yield plus composition potential in 1998. Producers were again asked to send samples to Iowa State University for analysis. The goal was to concentrate sampling enough to allow reliable conclusions about some varieties that are widely grown in the AGP trade areas.

The county groupings and associated plants remained the same, except that a Nebraska location was added. Eight varieties were targeted at each location except Hastings.

O'Brien (IA) – Sheldon  
Carroll (IA) – Manning  
Wright (IA) – Eagle Grove  
Adams (NE) -- Hastings

AGP installed NIR analyzers at the plants, and the lab at Eagle Grove was designated as the system reference. Plant premiums began at 19.5% oil (as-is moisture). The premium scale was \$0.01/bu plus \$0.01/bu/0.1% pt up to 20.3% oil and \$0.005/bu/0.1% pt above 20.3%.

Table 1 gives an overall summary of survey data. Protein and oil values were both lower than in 1998, likely because of rainfall shortages in August and September. The Iowa averages for the 1999 national survey were very close to the average of this data. The location with the highest oil and thus the most likely to pay premiums on oil alone actually had the lowest total of protein and oil.

The estimated percentage of samples that would qualify for an oil premium varied from 0.0% at Manning to 48% at Sheldon (Table 2). The samples qualifying for premium had 0.7% pt more oil and 0.8% pt less protein than average. In normal or high protein years, this tradeoff would likely not create meal production difficulties. This year, however, at

the two Iowa locations (Eagle Grove and Sheldon), the high-oil beans would not produce 47.5% protein meal. This stems from the overall low protein levels in 1999 soybeans.

Few targeted-variety samples were returned. There were only three cases where enough samples were available to evaluate performance – Garst D236 in Wright County, and Croplan 2126 and Croplan 261 STS in O’Brien County. In general, the above-average composition ranking held up, but in two of the three, the above-average yield ranking did not. Greater effort is needed to organize a varietal database, perhaps through seed dealers and/or seed companies, especially since several major seed companies do not enter public variety trials.

The percentage of samples that were above average in yield and protein + oil was similar to previous years – 20-25%. However, many varieties were represented only once or twice.

The comparison of NIR and laboratory data was quite good. Four datapoints (of the 160) were deleted as outliers. With 10 samples per set, differences of less than 0.4 (protein) or 0.3 (oil) were not statistically significant. Overall, the NIR (ISU) had an average standard deviation of 0.48% pts and 0.33% pts, relative to its calibration lab (Woodson-Tenent) for protein and oil, respectively. These are very close to the original calibration performance statistics, and smaller than those reported by USDA for their NIR calibrations. The labs (AGP plants vs. Woodson-Tenent) had average standard deviations of 0.48% pts and 0.32% pt, quite reasonable numbers. The variability among wet labs is about the same as the variability between NIR and its reference lab.

Plans for 2000: Begin educational efforts with producers and seed companies. Organize long-term strategy for data collection and aggregation. Utilize amino-acid data in procurement strategy.

Publications:

Two in preparation. Data – [www.iowagrains.org](http://www.iowagrains.org).

Table 1. Summary of ISU/AGP soybean study samples, 1999 crop

Plant Location (county)	n	Yield (bu/acre)		Protein (%)		Oil (%)		Sum (%)	
		Avg	Range	Avg	Range	Avg	Range	Avg	Range
Eagle Grove, IA (Wright)	115	48	24-65	34.3	31.2-37.0	18.7	17.3-20.2	53.0	48.6-55.0
Manning, IA (Carroll)	103	49	20-66	35.6	32.4-37.0	17.5	15.5-18.9	53.1	49.9-55.7
Sheldon, IA (O'Brien)	149	56	33-70	33.3	29.5-37.0	19.1	17.6-21.3	52.4	49.7-55.5
Hastings, NE	92	57	38-72	35.0	31.1-37.1	18.9	17.2-20.8	53.8	51.1-55.8
Overall	459	52.5		34.55	29.5-38.0	18.55	17.2-21.3	53.10	49.6-55.8
IA Avg., '99 Nat'l Survey				34.39		18.41		52.80	

Basis 13% moisture  
Sum = protein + oil

Table 2. Estimated percentage<sup>a</sup> of ISU/AGP soybean study samples qualifying for oil premiums, 1999 crop

Location	Estimated % Qualifying <sup>a</sup>	Average of Qualifying Samples			
		Yield (bu/a)	Protein (%)	Oil (%)	Sum (%)
Eagle Grove, IA	31	46	33.4	19.4	52.8
Manning, IA	0	NA	NA	NA	NA
Sheldon, IA	48	54	32.6	19.7	52.2
Hastings, NE	38	55	34.0	19.6	53.5

<sup>a</sup> Assuming 11% as-is moisture content  
Basis 13% moisture  
Sum = protein + oil

Table 3. Evaluation of targeted soybean varieties, 1999 Crop

Category	Variety	n	Sum Difference <sup>a</sup> (% pts.)	Yield Difference <sup>a</sup> (bu/a)
Eagle Grove (IA)				
Targeted Varieties	Novartis S21-A1	1	0.8	14.5
	Pioneer 9233	2	0.1	7.8
	Garst D236	7	0.9	-3.2
	LOL 2646	2	-0.2	-0.1
	Stine 2686	1	0.3	-3.6
	Latham 640	1	-1.3	-6.6
		14		
		(12%)		
Above avg. yield and sum	22 Varieties	30	+ 0.8	+ 7.1
		(26%)		
Manning (IA)				
Targeted Varieties	None received	0		
Above avg. yield and sum	11 Varieties	19	+ 0.5	+ 0.4
		(18%)		
Sheldon (IA)				
Targeted Varieties	Croplan 2126	16	0.0	5.0
	Croplan 221STS	1	0.9	-0.1
	Croplan 261STS	5	1.0	-1.9
	Novartis S21-A1	2	0.4	-1.1
		23		
		(15%)		
Above avg. yield and sum	23 Varieties	32	+ 0.6	+ 5.9
		(21%)		
Hastings (NE)				
Targeted Varieties	None	—		
Above avg. yield and sum	10 Varieties	27	+ 0.5	+ 6.4
		(29%)		

<sup>a</sup> From the location average  
Basis 13% moisture  
Sum = protein + oil

## NC 213 Progress Report for 1999

From: Iowa State University  
Economics  
Agricultural and Biosystems Engineering

By: Roger G. Ginder  
Christian Edmiston  
Charles R. Hurburgh Jr.

NC 213 Objective: D

Procedure: 4a

Project Objective: Estimate the market distribution of soybean protein and oil premiums.

Results for 1999: Soybean pricing systems were evaluated, using quality data from the processor study and the national survey. Of all strategies, pricing on a floating Estimated Processed Value per bushel (EPVB) with hedging of meal and oil to protect values was the most efficient and least contestive among participants. Conversely, fixed cutoff levels were the least efficient and the most likely to create controversy.

A spreadsheet was developed to estimate the impact on processors, handlers, producers and genetics suppliers, if high EPVB and high yield soybeans were preferentially planted. This would restrict planting to approximately 20-25% of the current genetic pool. A series of assumptions was used to create the summary in Table 1. Both the increase in grain volume and grain value were considered.

Processors benefit most from composition, less from volume. Handlers and producers are volume-sensitive; composition value is small to them. Genetics companies stand to loose greatly if germplasm base is restricted but will take substantial producer revenues if seed prices are adjusted. Handlers will likely get only small shares of the total value pool created by selection of high-value soybeans.

For the processor, as crush margin decreases, the impact of composition increases relative to yield (volume). As the incremental value of composition (EPVB) increases, again the impact of quality becomes larger relative to volume.

**Table 1. Estimated changes in gross revenue from planting high-value, high-yield soybeans<sup>a</sup>**

Action	Estimated percent change in gross revenue			
	Processor	Handler	Producer	Genetics
No premiums paid by processor <sup>c</sup>	25.6%	-4.7%	27.6%	-188.0%
Component value shared <sup>b,c</sup>	16.9%	14.8%	29.5%	-188.0%
Component value shared, seed cost increase <sup>b,c,d</sup>	16.9%	14.8%	16.0%	137.6%

<sup>a</sup> Yield increase: 4.5 bu/a, Component value increase: \$0.09/bu.

<sup>b</sup> 50% processor, 20% handler, 30% producer.

<sup>c</sup> Processor and handler test all inbound soybeans. Crush margin: \$0.50/bu.

<sup>d</sup> Genetics company recovers cost of lost germplasm plus 20% internal ROI.

Plans for 2000: Publish findings. Refine current processor premium scales. Prepare educational materials. Add amino acid variations to calculation process.

Publications: Two in progress.

## NC-213 Progress Report for 1999

From: University of Illinois  
Agricultural and Consumer Economics

By: Lowell D. Hill  
Marvin Paulsen  
Karen Bender

NC-213 Objective: D

Procedure: 4a

Project Objective: To introduce composition data into the transactions for soybeans, and make information available to producers, country elevators, and processors.

Results for 1999: The research effort during 1999 focused on organizing the system for collecting, summarizing and distributing information on oil and protein contents of soybeans. Installation of NIR equipment and the technology for downloading the data were completed. Procedures were developed for summarizing the data, calculating estimated processed value (EPV) and transmitting that information to the Illinois Market News Service for publication. Producer surveys revealed that yield is the primary criteria on selecting soybean varieties, however educational programs and information can also alter responses. The group identified as IQS participated in an in-depth series of educational meetings between surveys. Their rating of composition as a criterion for seed selection increased from 1.8 to 2.5 (Table 1). No other group showed a similar change. Yield still dominated the choice of all groups.

Plans for 2000: The project has been extended with grants for another two-year program. Additional cooperators will be recruited and sufficient data collected to allow for regional reports in addition to state summaries. Educational programs with farmers' and elevator managers will encourage price differentials in buying and selling soybeans at the country elevator. The 3-group producer survey will be repeated in January 2000.

### Publications:

Hill, Lowell, Karen Bender, Todd doehring, and Bradley St. Bonnet. Farmers' Selection Criteria for Soybean Varieties. November 1998. AE-4724.

Bekric, Aleksandar, Lowell Hill, Karen Bender, Todd Doehring.  
Illinois Farmers' Selection Criteria for Soybean Varieties, 1999.  
November 1999. AE-4730.

**Issue:** Producers and first handlers have little information about the oil and protein content of their soybeans and therefore no basis for negotiating for prices equal to differentials in value.

**What's been Done:** Country elevators were persuaded to install NIR equipment and to run an analysis on samples from the 1999 crop. These results were summarized and published weekly. Surveys of three groups of producers were conducted annually to provide an estimate of the effect of information on selection criteria for varieties for planting by farmers.

**Impact:** Weekly reports by the Illinois Market News Service provided advance information that the 1999 crop would be low in protein content. Wide differences among samples, varieties and locations provided country elevators with the opportunity to segregate and to channel shipments to their best available market.

**Comments:** This project was funded with a grant from the Federal/State Marketing Improvement program.

Insert Table 9 (?) here.

## **NC 213 Progress Report for 1999**

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: D. S. Chung  
C. K. Spillman  
J. L. Steele

NC-213 Objective:

Procedure:

Sub-Title: Development of a uniform wheat dockage and shrunken and broken determination procedure.

Project terminated in 1998, no report in 1999.

## NC 213 Progress Report for 1999

From: USDA, ARS  
Engineering Research Unit, GMPRC

By: S. Eckhoff  
D. Eustace  
E. Jones  
M. Paulsen  
J. L. Steele

NC-213 Objective:

Procedure:

Sub-Title: Evaluate grain grading, tolerances and procedures to determine garlic in wheat.

Project terminated in 1998, no report in 1999.